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This is an interdisciplinary conference. Topics include controllability and optimization of dynamic systems; theory of systems of automatic control; conception of design of informative systems; informative technologies in mathematical simulation; recognition of images and geo-informative technologies; and computer logic and neuro-information.

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P R O G R A M

OF THE SECOND INTERNATIONAL SCIENTIFIC
CONFERENCE IN THE REPUBLIC OF KAZAKHSTAN

INFORMATION TECHNOLOGIES AND CONTROL

KazITC`99

Dezember 6-10, 1999
Almaty, Kazakhstan

European Office
of Aerospace Research
and Development (EOARD)

OF THE SECOND INTERNATIONAL SCIENTIFIC
CONFERENCE IN THE REPUBLIC OF KAZAKHSTAN

INFORMATION TECHNOLOGIES AND CONTROL

Dear____

We invite you to take part in opening and work International conference "INFORMATION TECHNOLOGIES AND CONTROL".

The conference begins on 7th December 1999 at 10 a. m. in the conference hall of the hotel "Kargalinsky".

Conference Committee

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KAZITC'99

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PLENARY PAPERS

OPTIMAL REDUNDANCY MANAGEMENT IN RECONFIGURABLE CONTROL SYSTEMS BASED ON NORMALIZED NONSPECIFICITY
N. Eva Wu
and George J. Klir

In this paper, the notion of normalized nonspecificity is introduced. The nonspecificity measures the uncertainty of the estimated parameters that reflect impairment in a controlled system. Based on this notion, a quantity called a reconfiguration coverage is calculated. It represents the likelihood of success of a control reconfiguration action. This coverage links the overall system reliability to the achievable and required control, as will as diagnostic performance. The coverage, when calculated on-line, is used for managing the redundancy in the system

COUPLED-WAVE ANALYSIS OF SUPERIMPOSED BRAGG GRATINGS BASED ON 3-BEAM HOLOGRAPHIC RECORDING AND READOUT
David D. Reagan
and Monish R. Chatterjee

When three plane waves of light are used in two separate pairs to record an interference pattern in a holographic material, the two gratings that result may be analyzed by considering them to be superimposed. Beginning with the classic coupled wave formalism, relationships can be obtained for the nature of coupling between the various scattered orders when such a pair of superimposed gratings is illuminated by one, two or three READ beams (assuming Bragg matching relative to the WRITE conditions). In this paper, the response of the superimposed gratings to one, two and three READ beams is analyzed along the lines of the work by Case [JOSA 65, 724 (1975)]. In particular the amplitude distributions among the scattered orders (typically three), and the resulting scattering efficiency are evaluated for beam splitter, beam combiner, cross-coupled and conjugate cross-coupled modes of operation

ABOUT GLOBAL ITERATIVE ALGORITHMS OF OPTIMIZATION OF CONTROL PROCESSES
V. F. Krotov

The survey of successive improvement shuttled type methods of the control of dynamic systems is given. New results are addused

THE CONTROLLABILITY OF INTEGRO-DIFFERENTIAL EQUATIONS WITH PHASE RESTRICTIONS
S. A. Aisagaliev
and T. S. Aisagaliev

The new approach to the problem of controllability of integro-differential equations under the phase coordinates and control value restrictions is proposed. The necessary and sufficient conditions of controllability are obtained and the method of the solution construction for boundary problems is developed

GENERALIZED MODEL OF ACCELARATED SCIENCE DEVELOPMENT
R. M. Yusupov

The paper gives analysis of possible trajectories of science development depending on parameters, reveals trajectoriesand conditions of science degradation. The statistic data corroborating the model adequacy to real negative processes in development of the Russia science during the last decade are presented. These data are: the number of people engaged in research and development, financing allocated for science from the federal budget, indices of publishing and patenting activities, the number of defended doctors and candidates theses

SYNTHESIS OF ADAPTIVE FUNCTIONAL OPTIMAL CONTROL SYSTEMS (STRONG ADAPTIVE SYSTEMS)
V. M.Kuntsevich
and A.V. Kuntsevich

The problem of construction of adaptive control systems has already more than thirty-years history and extensive literature. One of the first fundamental works in this area was work of A. A. Feldbaum. In a basis of the theory, advanced by him, (called then "the theory of dual control systems") the hypothesis that all uncertain quantities and processes considered at the solving of optimal control synthesis problem have stochastic (in mathematical sense of this word) a nature with the known statistical characteristics was set. This direction of the theory of adaptive control systems had the rather numerous followers. At the end of seventieth and in the beginning of the eightieth years in connection with intensive investigation of methods of guaranteed estimates obtaining in identification problems and development of the general control theory in conditions of unstochastic uncertainty also development of a new direction in the theory of adaptive control systems intensively began. Most full to the present time the methods of synthesis of a special class of adaptive control systems (specific lost optimal or weak adaptive control systems) are developed. In general statement the synthesis problem for adaptive control systems, which are optimal in functional sense, or strong adaptive control systems, as far as it is known under the literature, now is not still solved.
I this report the solving of strong adaptive control systems synthesis problem for following classes of objects is considered: 1) objects without memory, 2) dynamic objects

METHODS OF CONSTRUCNION CONTROL SYSTEMS WHIGH POTENTIAL OF ROBUST STABILITY
A. A. Ashimov and M. A. Beycenbi

The offered approach, to the choice of control laws for objects with uncertain parameters in a class of structurally stable reflections from the catastrophes, allows to build systems of control by a highly boosted potential of robust stability

PROTECTION OF DIGITAL IMAGES USING SELF EMBEDDING
J. Fridrich and M. Goljan

In this paper, we propose a technique for selfembedding an image into itself as a means for protecting the image content. After selfembedding, it is possible to recover portions of the image that have been cropped out, replased, or otherwise tampered. The methods is based on transforming small 8×8 blocks using a DCT, quantizing the coefficients, and carefully encoding them in the least siqnificant bits of other, distant squares. If two least siqnificant bits are used for encoding, the quality of the recovered image is roughly equivalent to a 50% quality JPEG.

REPRESENTATIONS OF BOOLEAN FUNCTIONS BY THE FORMULAS OF SPECIAL TYPES IN VARIOUS BASES — EXISTENCE CONDITIONS, SEARCH METHOD, PROBLEMS OF COMPLEXITY
N. Peryazev

One of the problems of Boolean functions theory and its Application is the necessity of the representing of functions by specially given forms. In this paper he operator approach is proposed for polynomial expansions of the Boolean functions. The operator approach allows introducing a new class of polynomial expansions and polynomial canonical forms. The certain estimates for complexity of polynomial normal forms were obtained. The criterion of existence of representation of functions by real-one formulas in certain bases, among them, consisting of all Boolean functions of 2 variables was found. New methods of minimization of Boolean functions in classes of polynomial normal forms and binary terms were proposed

UNSTABILITI AND STABILIZING OF DEVELOPMENT OF MARKET MECHANISMS OF ECONOMIC SYSTEM
A. A. Ashimov and M. A. Beycenbi

On mathematical model of economic systemic showed the diversity of types of price levels on goods market, which varies from simple equilibrium points to plural periodic or chaotic attractors. Therefore is proposed an approach for forming functions of surplus demand and sappy from class structure-stable reflections, which allows to utmost increase the sphere of robust stability of equilibrium trajectories of development of economic system

MULTI-AGENT INTEGRATED INFORMATION SECURITY SYSTEM FOR COMPUTER NETWORKS: ARCHITECTURE AND AGENT INTERACTION
V. Gorodetski, V. Skormin, L. Popyack, I. Kotenko

This paper presents various aspects of the development of a network-distributed, integrated information security system, configured according to the principles of multi-agent technology. Within the multi-agent framework, the emphasize is placed on the description of architectures, functions, and methods of synthesis of the basic information security agents responsible for particular tasks (intrusion detection, access control, identification and authentication, learning and adaptation to novel types of attacks), and meta-agents operating on the host and network levels. Some principle issues of establishing interaction of agents and meta-agents, resulting in agent coordination and cooperative behavior, are described. A review and analysis of modern research efforts and projects in the area of network security assurance, including the efforts and directions of research of the authors, is given

DIFFERENS METHODS FOR SOLVING CONVECTION-DIFFUSION PROBLEMS ON UNSTRUCTURED
A. A. Samarskii and P. N. Vabishchevich

In the present work there are discussed possibilities to solve problems of mathematical physics on unstructured grids. The emphasis is on approximation of the convection/ diffusion equation as the most important application. The main attention is given to constructing difference schemes on triangular grids (as the most general unstructured grids). Approximations on the grids designed via the Delaunay triangulation are highlighted as the most optimal.

The basic for constructing discrete analogs is the balance method (integro-interpolation approach), which in publications in English is referred to as the finite volume method. Positive features of this approach are very attractive in case of unstructured grids. For the Delaney triangulation we have Voronoi cells as control volumes.

In constructing difference schemes for hydrodynamics problems or convective heat/ mass transfer the emphasis is on monotone schemes, i.e. schemes satisfying the maximum principle. In the present study there are considered monotone schemes for unstructured grids designed via the Delaney triangulation using the integro-interpolation method where Voronoi cells are employed as control volumes. Monotone schemes for convection/ diffusion problems are developed on the

GEOINFORMATION TECHNOLOGIES APPLICATION AT KAZAKHSTAN ECOLOGICAL PROBLEMS ANALYSIS
E. A. Zakarin

The application at the Geoinformation systems and technology in area at the ecological monitoring are discuses. A Geoinformation system is the effectiveness facility at analysis and control of ecological processes, especially at nature protection measures. GIS is not only the base of cartographic data, but is also the tool for expert analysis of territories development projects. GIS of such kind, unifying territorial processes monitoring and modeling, are presented in this paper

KAZITC'99
PROGRAM

Monday, December 6

10.00-18.00 Registration
14.00-18.30 City Tour (The bus departs from the workshop venue)

Tuesday, December 7

09.00-10.00 Registration
10.00-10.30 Opening Session
10.30-11.00 Coffee break

Plenary session **(Conference hall)**
Chairman: Professor N. Eva Wu

11.00-11.40 N. Eva Wu, George J. Klir (Center for Intelligent Systems, Binghamton University)
Optimal Redundancy Management in Reconfigurable Control Systems Based on Normalized Nonspecificity

11.40-12.20 David D. Reagan (Alstom Signaling, Inc, USA),
Monish R. Chatterjee (Department of Electrical Engineering, Watson School, Binghamton University, USA)
Coupled-Wave Analysis of Superimposed Bragg Gratings Based on 3-Beam Holographic Recording and Readout

12.20-13.00 V. M. Matrosov (Russian Academy of Sciences, Russia)
Information Technologies and Management of Consciousness in a Society

13.00-14.30 Lunch

Session of Section 1. **"Controllability and Optimality of Dynamic Systems" (Aud. 2)**
Co-chairmans: Professor S. A. Aisagaliev, Professor M. T. Dzhenaliev

14.30-14.50 M. T. Dzhenaliev (Institute of Mathematics, Kazakhstan),
K. Smatov (Kazakh National Technical University)
The Method of Generalized Lagrange Multipliers in Optimal Control Problems

14.50-15.10 Sh. A. Aipanov (Al-Farabi Kazakh State University)
On the Problem of Space Vehicle Soft Landing at the Target Point on Planet Surface

15.10-15.30 A. Sourantchiev, R. Seilkhanova (Al-Farabi Kazakh State University)
On Necessary Conditions of Optimality for Burger's Control Problem

15.30-15.50 M. I. Tleubergenov (Institute of Mathematics, Kazakhstan)
On the Inverse Stochastic Circuit's Problem

15.50-16.10 S. S. Zhumatov (Institute of Mathematics, Kazakhstan)
The Synthesis of a Non-Autonomous System Indirect Control

16.10-16.30 Coffee break

16.30-16.50 T. Dossum (Al-Farabi Kazakh State University)
Control in the Model Equation with Nonlinear Performance of a Material

16.50-17.10 S. A. Aisagaliev, D. G. Shanazarov (Al-Farabi Kazakh State University)
Controllability and Limited Cycles of Control Systems in Critical Case

17.10-17.20 E. Mamytbekov, M. Orazbekov (Al-Farabi Kazakh State University)
The Recursive Scheme of Normalization in a Disturbance Problem of Two Bodies Utilizing the Method of Infinite Systems

17.20-17.30 L. Sharabaeva (Al-Farabi Kazakh State University)
An Optimal Control Problem of the Velocity of the Gas Stream

Session of Section 2. **"Automatic Control System Theory" (Conference hall)**
Co-chairmans: Professor D. Zh. Syzdykov, Professor M. A. Beysenbi

14.30-14.50 D. Zh. Syzdykov, G. M. Kamenova (Kazakh National Technical University)

Practical Engineering Identification Methods on the Basis of General Parameter

14.50-15.10 T. T. Omorov, Dj. Sh. Sharshenaliev (Institute of Automatics of National Academy of Sciences of Kyrgyz Republic)
Principle of Guaranteed Dynamics in the Theory of Control

15.10-15.30 M. A. Biysenbi, B. A. Erghanov (Institute of Information and Management Problems of MS HE RK, Kazakhstan)
The Syntheses of Modal Regulator with Increased Potential Robust Stability

15.30-15.50 M. A. Biysenbi, A. I. Utepbergenova (Institute of Information and Management Problems of MS HE RK, Kazakhstan)
Stability with Respect to the Limits of Qualitative Variations in Asymptotically-Stable Robust Control Systems

15.50-16.10 I. G. Ten (Automation Institute of National Academy of Sciences Kyrgyz Republic)
A Syntheses Method of Control Systems with Varying Organization

16.10-16.30 Coffee break

16.30-16.50 T. T. Omorov, E. T. Uspeev (Institute of Automatics of National Academy of Sciences of Kyrgyz Republic)
Synthesis of Control Laws for Linear Discrete Systems on the Basis of the Admissibility Concept

16.50-17.10 S. E. Kushakova, N. T. Omurbaev, T. T. Omorov (Institute of Automatics of National Academy of Sciences of Kyrgyz Republic)
Synthesis of Automatic Systems Under Parametric Uncertainty

17.10-17.20 T. N. Biyarov, A. M. Suleimenova (Al-Farabi Kazakh State University)
About Motion Instability in Automatic Control System

17.20-17.30 A. V. Zagranichniy (Kazakh National Technical University)
Application of MID-Square Method for Estimation of General Parameters in Orthogonal Directions

17.30-17.40 B. K. Kuchkarov, O. P. Volobueva (Civil Aviation Academy, Almaty, Kazakhstan)
Correlation-Extremal Combined System Synthesis Concept for a Navigation Complex

17.40-17.50 S. Ivlev, S. P. Sokolova (Institute of Problems and Management, Kazakhstan)
A Central Approach in Solving the Task of Parametric Synthesis of Control System for Multidimensional Intervally Specified Objects

<u>Session of Section 9.</u> **"Computer Logic and Neuro-information Technologies" (Aud. 1)**

Co-chairmans: Professor V. P. Dobritsa, Professor B. S. Baizhanov

14.30-14.50 B. S. Baizhanov (Informatics and Control Problems Institute)
Generic Queries of Databases Embedded in a Weakly o-Minimal Universe

14.50-15.10 V. P. Dobritsa (Al-Farabi Kazakh State University)
On the Equivalence of Programming Language

15.10-15.30 A. A. Moskvitin (Sobolev Institute of Mathematics Siberian Branch of Russian of Sciences)
User-Oriented Task Specification Languages

15.30-15.50 K. Sydykov, I. Nepomnjashchikh (GEOTEX)
Seismic Fades Mapping: New Neural Network Technology, Methodology and Optimization

15.50-16.00 R. D. Arefyev, B. S. Baizhanov, V. V. Verbovskiy (Informatics and Control Problems Institute)
Elementary Ordered Generic Queries of a Database

16.00-16.10 A. I. Omarov (Al-Farabi Kazakh State University)
Informative Systems of Data Base

16.10-16.30 Coffee break

16.30-16.40 B. Sh. Kulpeshov (Informatics and Control Problems Institute)
Queries of Databases Over a Countable Categorical Ordered Domain

16.40-16.50 V. V. Verbovskiy (Informatics and Control Problems Institute)
On Quasi o-Minimal Group Domain of Databases

16.50-17.00 O. V. Karsaev (St.Petersburg Institute for Informatics and Automation of the Russian Academy of Sciences, Russia)
Agent's Knowledge Representation for Argumentation Baaed Decisions Making

17.00-17.10 B. S. Baizhanov, T. I.Kabdoldanova, V. V. Verbovskiy (Informatics and Control Problems Institute)
Interpretation of Temporal Logic of Actions in a Language of the First Order Logic

17.10-17.20 D. N. Belyashov, I. V. Emelyanova, A. V. Tichshenko (Geophysical Observatory "Kaskelen"), L. M. Karunova, N. G. Makarenko (Institute of Mathematics Academy of Sciences RK)
Fractals and Neural Networks for Prediction of the Caspian Sea Dynamics

17.20-17.30 D. N. Belyashov, I. V. Emelyanova, A. V. Tichshenko (Geophysical Observatory "Kaskelen"), L. M. Karunova, N. G. Makarenko (Institute of Mathematics Academy of Sciences RK)
Using Topological Dynamics and Neural Network Methods for Seismic Event Discrimination

Wednesday, December 8

Plenary session **(Conference hall)**
Co-chairmans: Professor R. M. Yusupov,
Professor V. M. Kuntsevich

09.30-10.10 S. A. Aisagaliev, T. S. Aisagaliev (Al-Farabi Kazakh State University)
The Controllability of Integro-Differential Equations with Phase Restrictions

10.10-10.50 R. M. Yusupov (St.Petersburg Institute for Informatics and Automation of the Russian Academy of Sciences)
Generalized Model of Accelerated Science Development

10.50-11.20 Coffee break

11.20-12.00 A. A. Ashimov, M. A. Beycenbi (Institute of Problems of Informatics and Management, Kazakhstan)
Instability and Development Stabilization of Market Mechanisms of Economic System

12.00-12.40 V. M. Kuntsevich, A. V. Kuntsevich (Spase Research Institute, Ukraine; Karl-Franzens University of Graz, Austria)
Synthesis of Adaptive Functional Optimal Control Systems (Strong Adaptive Systems)

12.40-13.20 J. Fridrich, M. Goljan (Center for Intelligent Systems, SUNY Binghamton)
Protection of Digital Images Using Self Embedding

12.40-13.20 N. Peryazev (Irkutsk State University, Russia)
Representations of Boolean Functions by Formulas of Special Types in Various Bases (Existence Conditions, etc.)

13.20-14.30 Lunch

Session of Section 3. **"Modeling of Socio-Economic Systems" (Conference hall)**
Co-chairmans: Professor T. N. Biyarov,
Professor N. M. Kulzhabayev

14.30-14-50 A. A. Ashimov, M. A. Beicembi, O. D. Buyanova (Institute of Problems and Management, Kazakhstan)
Simulation Models of Economic System Development

14.50-15.10 N. M. Kulzhabayev (Kazakh National Technical University)
Solutions of Criterial Management Problems by an Active System

15.10-15.30 S. N. Boranbayev (Kokshetau University, Kazakhstan)
Optimal Problem of Net Structure

15.30-15.50 G. J. Daukeev, A. A. Zhakupov, B. I. Tuzelbayev (Almaty Institute of Power Engineering and Telecommunication, Kazakhstan)
Economic-Mathematical Model in a Technique of Formation of the Tariff on Services of Transmission of the Electric Power

15.50-16.10 V. Z. Abdullina (Institute of Problems and Management, Kazakhstan)
Modeling of the Population Development

16.10-16.30 Coffee break

16.30-16.40 S. E. Kerimkulov (Kazakh State Academy of Mamagement)
About Optimization and Regulation of the Summary National Accounts of Income Generation

16.40-16.50 T. N. Biyarov, E. K. Mamytbekov, M. N. Kuanyschkalieva (Al-Farabi Kazakh State University)
The Dynamic Model of Optimal Development Multibranch Economic Taking in to Consideration the Pollution of the Environment

16.50-17.00 V. Kulikova, E. Matveeva (North Kazakhstan University, Petropavlovsk)
Analysis of the Market of Products on the Game-Theoretic Model Basis

17.00-17.10 Y. Y. Ismail, M. Z. Arslanov (Joint-Stock Company "Informatics and Computing Technique", Kazakhstan)
Simulation of the Organization-Economic Control Mechanism of the Informatization Process

17.20-17.30 A. Moldabecova (Al-Farabi Kazakh State University)
The Latency Modeling in Investments Mastering

17.30-17.40 B. Dlimbetov, S. Zhusipbecov (Kazakh State Academy of Mamagement)
Natural Resources in Economy of Kazakhstan

Session of Section 5. **"Information Technologies in Mathematical Modeling" (Aud. 1)**

Co-chairmans: Professor Sh. S. Smagulov, Professor A. T. Lukyanov

14.30-14.50 Sh. S. Smagulov, M. B. Gabbassov, G. Azamatov, M. Mukimbekov (Al-Farabi Kazakh State University)
New Information Technologies in Oil-And-Gas Industry

14.50-15.10 I. S. Verghbitzka, P. G. Itskova A. T. Lukyanov (Al-Farabi Kazakh State University)
The Information Technology in the Mathematical Simulation of Ethane Oxidation

15.10-15.30 A. A. Durmagambetov (Karaganda State University)
Computer Tomography Applications for Petroleum Industry

15.30-15.50 A. Kaltayev, J. E. Leblane (Al-Farabi Kazakh State University, Department of Aerospace Engineering, Nagoya University)
Simulation of the Deflagration to Detonating Transition in a Tube

15.50-16.10 A. K. Karimov, M. B. Abdramanova (Al-Farabi Kazakh State University)
Two-Dimensional Problem of Non-Isothermal Filtration

16.10-16.30 Coffee break

16.30-16.50 A. T. Lukyanov (Al-Farabi Kazakh State University)
Providing Information for Scientific Research

16.50-17.00 A. Aidossov, N. S. Zaurbekov (Republican Interbrain the Institute is Scientific-Pedagogical "Eko - Kazakhstan")
Dissertating of Set of Equation of Dynamics of Atmosphere and Construction of Finite Difference Approximation

17.00-17.10 G. T. Balacaeva, A. K. Kudebayeva (Al-Farabi Kazakh State University)
Computer Design in Modeling Processes of Aerodynamics and Heat-Mass Exchange

17.10-17.20 L. M. Dairbaeva A. J. Akjalova (Al-Farabi Kazakh State University)
Numerical Solution of the Problem of Piston Less Forcing Out Oil by Water

17.20-17.30 P. G. Itskova, A. Sh. Akjalova, Zh.Y. Askarova, A. R. Gavrilov, T. J. Kabirova, E. V. Popov, D. O. Tuleuova (Al-Farabi Kazakh State University)
Use of Information Technologies for Modeling Physical Phenomena

17.30-17.40 A. Kaltayev, A. H. Essawy (Al-Farabi Kazakh State University, Department of Mathematics-Faulty of Science - University of El-Minia, Egypt)

Computer Modeling of the Propagation and Interaction of Several Flames

17.40-17.50 E. M. Kripak (Rudny industrial institute, Kazakhstan)
Research of Opportunities Excel for Automation of the Decision of a Number of Nonproduction Problems

17.50-18.00 S. T. Muhambetzhanov, S. G. Musiralieva (Al-Farabi Kazakh State University)
About Variable Permeability of Oil Bed Actual Data

Session of Section 8. **"Image Recognition and Geo-Information Technologies" (Aud. 2)**
Co-chairmans: Professor M. B. Aidarkhanov
Professor A. Muhamedgaliev

14.30-14.50 M. B. Aidarkhanov, L. L. La (Institute of Informatics and Control Problems, Kazakhstan)
On Stability of Group Fuzzy Classifications

14.50-15.10 A. Muhamedgaliev, B. Orazov (Committee on Land Resources Management Under the Ministry of Agriculture of the Republic of Kazakhstan. Research-and-Production Enterprise of Cartographic and Geoinformation Systems "CartInform")
Modern Situation and Prospects of Digital Cartography Development in the Republic of Kazakhstan

15.10-15.20 S. A. Mustafin (Institute of Problems of Computer Science and Control the Ministry of Science and Higher Education Republic of Kazakhstan)
Methods of Creation of the List of Contour Points of Simply Connected Regions of Various Forms

15.20-15.30 B. E. Bekmukhamedov, M. G. Razakova (Space Research Institute of the Ministry of Science and High Education RK)
GIS and Remote Sensing Methods for Mapping and Protection of Forests of Kazakhstan

15.30-15.40 E. N. Amirgaliev (Kazakh National Technical University)
Learning System in Image Recognition in Composition of GIS Technology

15.40-15.50 E. R. Suleimenov (Almaty, Kazakhstan)
Recursive Grammar Development for the One Class of Contextual Languages

15.50-16.00 M. Aidarkhanov, E. Suleimenov (Almaty, Kazakhstan)
Recursive Grammar for Description and Recognition of Some Class of Objects

16.10-16.30 Coffee break

Session of Section 2. **"Automatic Control System Theory" (Aud. 2)**
Co-chairmans: Professor D. Zh. Syzdykov,
Professor M. A. Biesembi

17.10-17.20 D. P. Volobueva (Kazakh National Technical University)
Analytical Design of Optimal Control Systems for Particular Class of Objects

17.20-17.30 J. A. Vorozheikin (Institute of Problems of Compute Science and Control of the Ministry of Science and Hiegher Formation, Kazakhstan)
Robust Stability of Nonlinear Automatic Control Systems with a Nonunique State of Equlibrium for a General Case with One Nonlinearity

17.30-17.40 N. R. Yunicheva (Institute of Problems and Management, Kazakhstan)
Interval Approach to Synthesis of Control Systems of Uncertain Object

17.40-17.50 O. I. Shiryueva (Informatics and Control Problems Institute of MS HE RK)
Group Lee Formulation Conditions for Control Systems of Intervally-Defined Objects

Thursday, December 9

Plenary session **(Conference hall)**
Co-chairmans: Professor V. Gorodetski,
Professor E. A. Zakarin
Professor V. M. Matrosov

09.30-10.10 A. A. Samarskii, P.N. Vabishchevich (Institute for Mathematical Modeling RAS, Russia)
Different Methods for Solving Unstructured Convection-Diffusion Problems

10.10-10.50 V. Gorodetski (SPIIRAN, Russia), V. Skormin (Binghamton University, USA), L. Popyack (US Air Force, USA), I. Kotenko (SPIIRAN, Russia)
Multi-Agent Integrated Information Security System for Computer Networks: Architecture and Agent Interaction

10.50-11.20 Coffee break

11.20-12.00 A. A. Ashimov, M. A. Beicembi (The Institute of Informatics and Management Problems of MS HE RK, Kazakhstan)
Methods of Control Systems Design with a Potential for Robust Stability

12.00-12.40 E. A. Zakarin (Space Research Institute Ministry of Education and Science, Kazakhstan)
Geoinformation Technology Application to the Analysis of Ecological Problems of Kazakhstan

13.00-14.30 Lunch

<u>Session of Section 7.</u> **"System Concepts and Application to the Utilization of the Earth Resorses and Ecology" (Aud. 1)**

Co-chairmans: Professor A. Ph. Tsekhovoy,
Professor T. M. Ermekov,
Professor D. G. Bukeihanov

14.30-14.50 E. Y. Rogov, A. E. Rogov (Mining Institute names D. Kunaeva)
Underground Constructions Reliability Assessment

14.50-15.10 T. M. Ermekov, K. K. Tulebav, Sh. A. Dilbaev (Mining Institute names D. Kunaeva)
Simulation of Explosion Effects from Extended Cylindrical Charges

15.10-15.30 D. G. Bukeihanov, C. G. Galiev, A. H. Dgakcibaev, C. D. Bukeihanov
Analysis of Interconnection and Interaction of Internal and External Factors and Parameters of the "Opencast" System

15.30-15.50 A. Ph. Tsekhovoy, Zh. Zh. Sultanbekova (Kazakh National Technical University)
Formulation of Computational Procedures with Consequent Definition of Expert Systems for Automated Design of Open Mining Operations

15.50-16.00 A. Ph. Tsekhovoy, S. K. Baimukhamedova (Kazakh National Technical University)
System Analysis and Synthesis of the Ore Excavation Task Control Problems

16.00-16.10 P. A. Tsehovoy (Kazakh National Technical University)
Distributed Information Processing Principle Applied to the Problem of Mining Firm Design

16.10-16.30 Coffee break

16.30-16.40 R. K. Uskenbaeva, I. G. Dadaeva, S. K. Baimuchamedova (Kazakh National Technical University)
Methods of Group Complex Object Governing

16.40-16.50 A. K. Kenzhebayev, E. M. Baymukhamedov, A. U. Kozhantov (Kazakh National Technical University)
Application of Ore Loss and Dilution Normalization Method at Various Stages of Mining of Quality Requirements and Designing of Opencasts

16.50-17.00 U. A. Dzharlkaganov, A. U. Dzharlkaganov (Kazakh National Technical University)
Statistical Optimization of Networks in Quarry Load Flows

17.00-17.10 A. Ph. Tsekhovoy, A. T. Tujakbaeva, A. A. Akylbekova (Kazakh National Technical University)
The Urgency of Creation of the Republican Network of Monitoring and Ergonomics for Labor Protection in Mining Industry

<u>Session of Section 4.</u> **"The Concept, Technology and Practice of Designing of Information Systems" (Aud. 3)**

Co-chairmans: Professor U. A. Tukeyev,
Professor I. T. Utepbergenov

14.30-14.50 K. N. Naribaev, M. K. Orunkhanov,

U. A. Tukeyev (Al-Farabi Kazakh State University)
A Corporate Information System of Al-Farabi Kazakh State National University

14.50-15.10 B. K. Abdrakhmanov (Center of Interbank and Financial Telecommunications Republic of Kazakhstan)
Distributed Integrated Financial Information System

15.10-15.20 G. M. Mutanov, V. P. Gusakov, A. A. Bubenko (State Public Enterprise North-Kazakhstan University)
Corporate Information Network of the Higher Education Institution

15.20-15.30 I. T. Utepbergenov, B. A. Chensizbayev, S. S. Ospanov (Academy of Public Service under the President of the Republic of Kazakhstan)
Conceptual Approach for Designing Information Systems of Public Administration Institutions of the Republic of Kazakhstan

15.30-15.40 B. Munbaev, R. Kirznev (J.S.A.B., Kazakhstan)
About an Integrated Automated Banking System J. S. A. B. (Joint Stock Agroindastrial Bank)

15.40-15.50 R. Kirznev, B. Munbaev (Joint Stock Agroindustrial Bank Republic of Kazakhstan)
The Concept of an Information Model of a Bank

15.50-16.00 V. N. Ustugov, B. A. Chensizbayev, A. A. Kuandykov (Kazakhstan, Akimat, Almaty)
Decision-Making Social-Economic Problems on the Basis of System Monitoring

16.00-16.10 B. K. Abenov (Al-Farabi Kazakh State University)
Development Problems of Student Information Automated Systems for Result Forecasting

16.10-16.30 Coffee break

16.30-16.40 B. A.Chensizbaev (Kazakhstan, Akimat, Almaty)
Methods of Building of Economic Monitoring System

16.50-17.00 N. Becturganov, A. Buldybayev, Sh. Seilov, R. Kim, S. Yermakov (Ministry of Culture, Information and Public Accord, Republican State Enterprise "Kazteleradio", Republican State Enterprise "Almaty TV & Radio Transmitting Station")
Issues of Radio & TV Broadcasting Network of the Republic of Kazakhstan Development

17.00-17.10 Sh. Seilov, R. Kim, S. Yermakov (Republican State Enterprise "Almaty TV & Radio Transmitting Station")
National Allocation Table of the Republic of Kazakhstan in the Range 3 Khz – 400 Ghz

17.10-17.20 S. B. Kashkimbaev, B. J. Bisarinov (Closed Joint Stock Company «Interbank Financial Telecommunications Center» Republic of Kazakhstan)
Application of Modern Information Technologies in Monitoring Systems of the Enterprises and Organizations

17.20-17.30 O. A Rakhmatulin. (OJSC "Kazzink", Republic of Kazakhstan)
The Architecture of Parallel High Performance Computing Systems

<u>Session of Section 5.</u> **"Information Technologies in Mathematical Modeling" (Aud. 2)**

Co-chairmans: Professor Sh. S. Smagulov, Professor T. A. Lukyanov

16.30-16.40 G. N. Pachshenko, E. T. Ayaganov (Institute of Problems of Informatics and Control of Science Ministry HE RK)
Interval Stability of an Elementary Immunological Model

16.40-16.50 N. V. Popova, S. Ya. Serovaisky, A. A. Ulman, M. V. Filonov (Al-Farabi Kazakh State University)
Cartographic and Mathematical Model of Soil Particle Transfer

16.50-17.00 Sh. Smagulov, A. K. Karimov (Al-Farabi Kazakh State University)
A New Approach to the Numerical Solution of the Problem of Forecasting Thermo Hydrodynamic Processes in a Porous Medium

17.00-17.10 V. V. Shershnev, A. Zh. Yeskalieva (Institute of Mathematics Department of Science and Higher Education Republic of Kazakhstan)

Simulation of Dynamics of a Tunnel in Water-Saturated Medium

17.10-17.20 Zh. S. Azamatov (Al-Farabi Kazakh State University)
Program Realization of the Estimation of the Interaction Between Extraction and Pressure-Raising Wells in Oil Technology

<u>Session of Section 6.</u> **"Information Technology and Indastrial Control" (Conference hall)**

Co-chairmans: Professor D. N. Shukayev, Professor G. M. Tochtabayev

14.30-14.40 D. N. Shukayev (Kazakh National Technical University)
Extension Method for Allocation of Resources in Parallel Structure Systems

14.40-14.50 G. M. Tochtabayev, A. Mustafina, A. Ibrayev (Kazakh National Technical University)
Application of Decision Making Theory for Forming a Scientifically-Jostled Curriculum Specialty

14.50-15.00 M. Sh. Baybatshaev (Kazakh National Technical University)
Mathematical Models of Collective Behavior of Robotic Systems by Methods of Discrete Analysis

15.00-15.10 L. A. Alexeyeva, A. N. Dadaeva (Institute of Mathematics)
Simulation of Thermo-Stressed of an Oil Layer in the Vicinity of a Well

15.10-15.20 G. I. Hasenova (Kazakh National Technical University)
Problems of Construction of Models on the Basis of the Thermodynamic Approach

15.20-15.30 K. S. Ivanov (Kazakh National Technical University)
Automatic Control of Processes of Power Transmission

15.30-15.40 N. K. Abdigaliev, V. V. Belobabov, E. V. Lobanov, B. N. Lyan, D. Zh. Syzdykov, I. B. Chaplenko (Opened Joint-Stock Company "National Center on Radio Electronics and Communication of the Republic of Kazakhstan")
Traffic/Material Control System for Export Transportations

15.40-15.50 A. A.Kuandikov (Kazakh National Technical University)
Group Methods of Control of Specifically Dangerous Objects

15.50-16.00 N. T. Isembergenov, E. I. Shin (Kazakh National Technical University)
Asynchronous Generators of the Wind Power Plants with an Automatic Stabilization of Frequency and Voltage

16.00-16.05 G. G. Piven, M. R. Nurguzhin, A. A. Epov, A. A. Mahov (The Karaganda State Technical University)
Informatization of Teaching Procedure in the INTRANET Environment of the Karaganda State Technical University

16.05-16.10 M. R. Nurguzhin, G. T. Danenova, T. J. Katsaga (The Karaganda State Technical University)
Main Principles of Realization of MKA in Automated Design Systems

16.10-16.30 Coffee break

16.30-16.35 D. Mukanov (Joint-stock Company Kazchermetavtomatika Karaganda)
The System Approach to Automation of Metallurgical Processes: Experience and Problems

16.35-16.40 Y. M. Leschenko (Institute of Automation of National Academy of Sciences of Kyrguz Republic)
Automation of Polysilicon Manufacturing Process on the Basis of a Computer Monitoring-Control System

16.40-16.45 G. M. Tochtabaev, B. K. Muchanov, K. K. Erenchinov (Kazakh National Technical University)
Optimal Process Control of Electrical Purification of Gases with Forecasting of Perturbations

16.45-16.50 S. S. Zhussupbekov, S. K. Abdigaliyev (Kazakh National Technical University)
Optimum Control of a Thermal Mode Reverberatory Smelting of Copper Concentrates

16.50-16.55 D. I. Bayguatov, S. S. Zhussupbekov, L. V. Sokolovskaya, S. O. Alekseyev

(Kazakh National Technical University)
Modeling of Electric Smelting Lead Containing Dusts of Copper Production

16.55-17.00 Z. M. Yarmuchamedova (Kazakh National Technical University)
Modeling and Optimization of Solutions Granulation Processing The Pseudo-Liquefied Layer

17.00-17.05 V. A. Khan, V. Yu. Akselrod, D. I. Baiguatov, P. P. Korshunov, R. Z. Zhalelev, V. I. Toporov, A. F. Ogol, A. M. Zolotarev, A. S. Shamgunov, G. Sh. Kamerdinov, M. S.Bekenov (Joint-stock Company “Sistemotekhnika”, Kazakhmys Corporation, Institute of Metallurgy and Concentration of Ministry of Science and High Education of RK)
The Automated Monitoring and Control System of main Processing of a Metallurgical PGV Package on BMZ, Corporation "Kazakhmys"

17.05-17.10 V. A. Khan, P. N. Malyshev, D. I. Baiguatov, R. Z. Zhalelev, V. I. Toporov (Joint-stock Company “Sistemotekhnika”, Kazakhmys Corporation, Institute Of Metallurgy And Concentration of Ministry of Science and High Education of RK)
Monitoring and Control of an Integrated Power Complex of PGV at Balkhash Integrated Mining-And-Metallurgical Works

17.10-17.15 S. Zh. Galiyev, A. Kh. Jaxybayev, G. T. Kaumenov, A. L Koraykin (The Scientific center “Mining Technology”, Kazakhstan)
Simulation of the Operation of Mining Transport Systems in Conditions of the Trains Traffics Transformations

17.15-17.20 M. Zh. Mukimbekov (Al-Farabi Kazakh State University)
Application of Standard Software Packages in Development of Gas and Oil Fields

17.20-17.25 B. D. Hisarov, G. I.Utesova (Almaty Institute of Power Engineering and Telecommunication RK)
Mathematical Modeling of Installation of “Klaus 400”

17.25-17.30 B. D. Hisarov, J. M. Rahimbekov (Almaty Institute Energy And Communication Kazakhstan)
Mathematical Formulation of the Optimal Control Problem of Power System Machinery Working in Parallel Scheme

17.30-17.35 A. A. Zhakupov, B. D. Hisarov, B. I. Tuzelbayev (Kazakhstan, Almaty)
Creation of Imitating Model of an Optimum Reserve of Capacity at Situation of Emergency in the Grid of Republic of Kazakhstan

17.35-17.40 A. A. Dzhusupov (Kazakh National Technical University)
Redundancy Management of Computer System With Multiplexes

17.40-17.45 A. Nurlibaev, S. Rahimbergenov (ASU, Kazakhstan)
About the Permutations Lattices

17.45-17.50 M. N. Kondybaev, E. K. Yaroslavceva (Kazakh National Technical University)
Automatic Control of Adapting of Keying Units

17.50-17.55 E. S. Miroshnichenko (Kazakh National Technical University)
Control Automation by Dynamics of Movement of a Linkage

17.55-18.00 A. A. Aitmuhambetov, S. N. Boranbayev (Kokshetau University, Kazakhstan)
Solution Methods of Network Configuration Synthesis

18.00-18.05 N. K. Abdigaliev, V. V. Belobabov, E. V. Lobanov, B. N. Lyan, B. K. Mukhanov (Kazakh National Technical University)
Information/Monitoring System of the Mobile Machinery of Mining Operation

Distribution of plenary and sectional meetings on audiences

Audience / Data	Conference hall	Audience N 1	Audience N 2	Audience N 3
07.12.99	Plenary Session			
	Section 2	Section 9	Section 1	
08.12.99	Plenary Session			
	Section 3	Section 5	Section 8 Section 2	
09.12.99	Plenary Session			
	Section 6	Section 7	Section 5	Section 4

Section 1. Controllability and Optimality of Dynamic Systems

Section 2. Automatic Control System Theory

Section 3. Modeling in the Socio-Economic Systems

Section 4. The Concept, Technology and Practice of Designing of Information Systems

Section 5. Information Technologies in Mathematical Modeling

Section 6. Information Technology and Industrial Control

Section 7. System Concepts and Application on the Utilization of the Earth Resources and Ecology

Section 8. Image Recognition and Geo-Information Technologies

Section 9. Computer Logic and Neuro-information Technologies

Abstracts papers of the Second International Scientific Conference in the Republic of Kazakhstan "Information Technologies and Control"

PLENARY PAPES

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OPTIMAL REDUDANCY MANAGEMENT IN RECONFIGARABLE CONTROL SYSTEMS BASED ON NORMALIZED NONSPECIFICITY

In this paper, the notion of normalized nonspecificity is introduced. The nonspecificity mea-sures the uncertainty of the estimated parameters that reflect impairment in a controlled system.
Based on this notion, a quantity called reconfiguration coverage is calculated. It represents the likelihood of success of a control reconfiguration action. This coverage links the overall system reliability to the achievable and required control, as well as diagnostic performance. The coverage, when calculated on-line, is used for managing the redundancy in the system.

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COUPLED-WAVE ANALYSIS OF SUPERIMPOSED BRAGG GRATINGS BASED ON 3-BEAM HOLOGRAPHIC RECORDING AND READOUT

When three plane waves of light are used in two separate pairs to record an interference pattern in a holographic material, the two gratings that result may be analyzed by considering them to be superimposed. Beginning with the classic coupled wave formalism, relationships can be obtained for the nature of coupling between the various scattered orders when such a pair of superimposed gratings is illuminated by one, two or three READ beams (assuming Bragg matching relative to the WRITE conditions).
In this paper, the response of the superimposed gratings to one, two and three READ beams is analyzed along the lines of the work by Case [JOSA 65, 724 (1975)]. In particular the amplitude distributions among the scattered orders (typically three), and the resulting scattering efficiency are evaluated for beam splitter, beam combiner, cross-coupled and conjugate cross-coupled modes of operation.

AQ F02-08-1609

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MULTI-AGENT INTEGRATED INFORMATION SECURITY SYSTEM FOR COMPUTER NETWORKS: ARCHITECTURE AND AGENT INTERACTION

This paper presents various aspects of the development of a network-distributed, integrated information security system, configured according to the principles of multi-agent technology. Within the multi-agent framework, the emphasis is placed on the description of architectures and functions of the basic information security agents responsible for particular tasks (intrusion detection, access control, identification and authentication, learning and adaptation to unknown intruder), and meta-agents operating on the host and network levels. Some principle issues of establishing interaction of agents and meta-agents, resulting in agent coordination and cooperative behavior, are described. A review and analysis of modern research efforts and projects in the area of network security assurance, including the efforts and directions of research of the authors, is given.

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GENERALIZED MODEL OF ACCELERATED SCIENCE DEVELOPMENT

The paper gives analysis of possible trajectories of science development depending on parameters, reveals trajectoriesand conditions of science degradation. The statistic data corroborating the model adequacy to real negative processes in development of the Russia science during the last decade are presented. These data are: the number of people engaged in research and development, financing allocated for science from the federal budget, indices of publishing and patenting activities, the number of defended doctors and candidates theses.

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INSTABILITY AND DEVELOPMENT STABILIZATION OF MARKET MECHANISMS OF ECONOMIC

On mathematical model of economic system is showed the diversity of types of price levels on goods market, which varies from simple equilibrium points to plural periodic or chaotic attractors. Therefore is proposed an approach for forming functions of surplus demand and supply from class structure-stable reflections, which allows to utmostly increase the sphere of robust stability of equilibrium trajectories of development of economic system.

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METHODS OF CONTROL SYSTEMS DESIGN WITH A POTENTIAL FOR ROBUST STABILITY

The offered approach, to the choice of control laws for objects with uncertain parameters in a class of structurally stable reflections from the theories of catastrophes, allows to build systems of control by a highly boosted potential of robust stability.

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THE CONTROLLABILITY OF INTEGRO-DIFFERENTIAL EQUATIONS WITH PHASE RESTRICTIONS

The new approach to the problem of controllability of integro- differential equations under the phase coordinates and controll value restrictions is proposed. The necessary and sufficient conditions of controllability are obtained and the method of the solution construction for boundary problems is developed.

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REPRESENTATIONS OF BOOLEAN FUNCTIONS BY FORMULAS OF SPECIAL TYPES IN VARIOUS BASES (EXISTENCE CONDITIONS, ETC.)

One of the problems of Boolean functions theory and its Application is the necessity of the representing of functions by specially given forms. In this paper the operator approach is proposed for polynomial expansions of the Boolean functions. The operator approach allows to introduce a new class of polynomial expansions and polynomial canonical forms. The certain estimates for complexity of polynomial normal forms were obtained. The criterion of existence of representation of functions by real-one formulas in certain bases, among them, consisting of all Boolean functions of 2 variables was found. New methods of minimization of Boolean functions in classes of polynomial normal forms and binary therms were proposed.

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SYNTHESIS OF ADAPTIVE FUNCTIONAL OPTIMAL CONTROL SYSTEMS (STRONG ADAPTIVE SYSTEMS)

The problem of construction of adaptive control systems has already more than thirty-years history and extensive literature. One of the first fundamental works in this area was work of A. A. Feldbaum. In a basis of the theory, advanced by him, (called then "the theory of dual control systems") the hypothesis that all uncertain quantities and processes considered at the solving of optimal control synthesis problem have stochastic (in mathematical sense of this word) a nature with the known statistical characteristics was set. This direction of the theory of adaptive control systems had the rather numerous followers. At the end of seventieth and in the beginning of the eightieth years in connection with intensive investigation of methods of guaranteed estimates obtaining in identification problems and development of the general control theory in conditions of unstochastic uncertainty also development of a new direction in the theory of adaptive control systems intensively began. Most full to the present time the methods of synthesis of a special class of adaptive control systems (specific lost optimal or weak adaptive control systems) are developed. In general statement the synthesis problem for adaptive control systems, which are optimal in functional sense, or strong adaptive control systems, as far as it is known under the literature, now is not still solved.

I this report the solving of strong adaptive control systems synthesis problem for following classes of objects is considered: 1) objects without memory, 2) dynamic objects

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DIFFERENT METHODS FOR SOLVING UNSTRUCTURED CONVECTION-DIFFUSION PROBLEMS

In the present work there are discussed possibilities to solve problems of mathematical physics on unstructured grids. The emphasis is on approximation of the convection/ diffusion equation as the most important application. The main attention is given to constructing difference schemes on triangular grids (as the most general unstructured grids). Approximations on the grids designed via the Delaunay triangulation are highlighted as the most optimal.
The basic for constructing discrete analogs is the balance method (integro-interpolation approach), which in publications in English is referred to as the finite volume method. Positive features of this approach are very attractive in case of unstructured grids. For the Delaney triangulation we have Voronoi cells as control volumes.
In constructing difference schemes for hydrodynamics problems or convective heat/ mass transfer the emphasis is on monotone schemes, i.e. schemes satisfying the maximum principle. In the present study there are considered monotone schemes for unstructured grids designed via the Delaney triangulation using the integro-interpolation method where Voronoi cells are employed as control volumes. Monotone schemes for convection/diffusion problems are developed on the basis of the regularization principle for difference schemes. Nonliner unconditionally monotone difference schemes arc-constructed for the time-dependent transport equation.

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GEOINFORMATION TECHNOLOGY APPLICATION TO THE ANALYSIS OF ECOLOGICAL PROBLEMS OF KAZAKHSTAN

The application at the Geoinformation systems and technology in area at the ecological monitoring are discuses. A Geoinformation system is the effectiveness facility at analysis and control of ecological processes, especially at nature protection measures. GIS is not only the base of cartographic data, but is also the tool for expert analysis of territories development projects. GIS of such kind, unifying territorial processes monitoring and modeling, are presented in this paper.

V. F. Krotov

ABOUT GLOBAL ITERATIVE ALGORITHMS OF OPTIMIZATION OF CONTROL PROCESSES

The survey of successive improvement shuttled type methods of the control of dynamic systems is given.

SECTION "CONTROLLABILITY AND OPTIMALITY OF DYNAMIC SYSTEMS"

Muvasharkhan Dzhenaliev, Kossy Smatov

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THE METHOD OF GENERALIZED LAGRANGE MULTIPLIERS IN OPTIMAL CONTROL PROBLEMS

In the work the optimal control problems prescribed by operator relations in the Banach spaces are considered. The development of the absolute minimum theory based on theV.F.Krotov lemma is given.

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ON THE PROBLEM OF SPACE VEHICLE SOFT LANDING AT THE TARGET POINT ON PLANET SURFACE

We consider the time-optimal problem of space vehicle (SV) soft landing at the target point on planet surface. We assume that lander engine's thrust G is a fixed value and SV motion is controlled by rotation of thrust direction. SV motion equations [1] may be represented as

$$\dot{s}=v, \quad \dot{h}=w,$$

$$\dot{w}=\frac{v^2}{R+h}-g(h)-\frac{F(h,V)w}{mV}+\frac{G\sin\theta}{m}, \quad \dot{v}=\frac{wv}{R+h}-\frac{F(h,V)v}{mV}+\frac{G\cos\theta}{m}, \qquad (1)$$

where s is a SV coordinate in relation to the target point, h is an altitude over the planet surface, w is a vertical component of the SV velocity, v is a horizontal component of the SV velocity, θ is an angle included between $\vec{v}$ and $\vec{G}$, R is the planet radius, $g(h)$ is a gravitational acceleration, $F(h,V)$ is an air drag, V is a SV velocity, m is a SV mass.
We try of solution of the time-optimal control problem on differential constraints (1), initial conditions $h(t_0)=h_0$, $w(t_0)=w_0$, $v(t_0)=v_0$ and final conditions $s(t_*)=0$, $h(t_*)=0$, $w(t_*)=0$, $v(t_*)=0$.
This problem may be solved using maximum principle of Pontryagin and quasilinearization method [2], where at each step of iterative process the analytical method of solution of linear-quadratic optimal control problem for systems with fixed endpoints of trajectories is applied [3, 4].
The concrete example that confirms an efficiency of suggested method is considered. A contolled SV, which begins descent with initial velocity 6 *km/s* from height of 45 *km* and distance of 40,8 *km*, can accomplish soft landing nearly at the target point on the planet surface (a range deviation is less than 6 *sm*).

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ON NECESSARY CONDITIONS OF OPTIMALITY FOR BURGER'S CONTROL PROBLEM

It is considered the optimal control problem of system governed by one-dimensional Burgers`s equation. It was taken a necessary condition of optimality due to the Bellman`s approach which the optimal control and adjoined state must satisfy.

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ON THE INVERSE STOCHASTIC CIRCUIT'S PROBLEM

One of the inverse problems of dynamics - the circuit's problem by given properties of motion into the class of stochastic differential Ito's equations of second order is considered. The necessary and sufficient conditions of the existence of given integral manifold of the building system of stochastic equations are received.

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THE SYNTHESIS OF A NON-AUTONOMOUS SYSTEM INDIRECT CONTROL

The problems of high speed regulator and reregulation for of Popov's non-autonomous system of indirect control , with defined characteristics are resolved .

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CONTROL IN THE MODEL EQUATION WITH NONLINEAR PERFORMANCE OF A MATERIAL

The method of a functional Liapunov is applied to the model equation of the reactor of a new type.

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CONTROLLABILITY AND LIMITED CYCLES OF CONTROL SYSTEMS IN CRITICAL CASE

By sinking a source problem in tantamount problem of controllability, constructive methods of limited cycles building were received.

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THE RECURSIVE SCHEME OF NORMALIZATION IN A DISTURBANCE PROBLEM OF TWO BODIES UTILIZING THE METHOD OF INFINITE SYSTEMS

The matrix clone the theory of normal forms of differential equations grounded on a method of infinite systems is offered, according to which one the finite-dimensional non-linear system of ordinary differential equations (ODE) is resulted in a countable system of linear differential equations.

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AN OPTIMAL CONTROL PROBLEM OF THE VELOCITY OF THE GAS STREAM

The process of purification of the flue gases in the catalitic fixed-bed reactor by Optimal Control Problem is investigated. The qualitative analysis of the differential equations system is accomplished. The solvability of the Optimal Control Problem for bilinear case is ascertained. The necessary Maximum Principle-type Optimal Control condition is obtained and their numerical solution is realized.

SECTION "AUTOMATIC CONTROL SYSTEM THEORY"

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PRACTICAL ENGINEERING IDENTIFICATION METHODS ON THE BASIS OF GENERAL PARAMETER

The problems and methods of parametric identification of complicated objects of control of high dimension and presence of noise are given. The new principles of construction of systems of identification in these conditions are confirmed on the basis of a method of general parameter simple enough in structural implementation.

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PRINCIPLE OF QUARANTEED DYNAMICS IN THE THEORY OF CONTROL

The fundamentals of the new theory of control by multidimensional dynamic systems, based on the concepts of an admissibility of transients are discussed.

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THE SYNTHESES OF MODAL REGULATOR WITH INCREASING POTENTIAL OF ROBUST STABILITY

In the report the method of parametric syntheses of the modal regulators with the increased potential of robust stability under incomplete object controllability on Kalman is expounded.

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STABILITY WITH RESPECT TO THE LIMITS OF QUALITATIVE VARIATIONS IN ASYMPTOTICALLY-STABLE ROBUST CONTROL SYSTEMS

Method of estimation of proximity nominal system with increased potential robust stability to borders of qualitative changes.

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A SYNTHESIS METHOD OF CONTROL SYSTEMS WITH VARIED ORGANIZATION

Synthesis method of control systems with varied organization only are considered in this article. This method to be based on transformation of optimal control synthesis initial problem into sequence of control synthesis problem on set of structural differences control laws.

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SYNTHESIS OF THE LAWS OF CONTROL FOR LINEAR DISCRETE SYSTEMS ON THE BASIS OF THE ADMISSIBILITY CONCEPT

New approach to synthesis of automatic regulators for multi measured longitudinal systems of control is directed to the case of discrete line determine stationary systems. Resulted analytical conditions provide guarantee for achievement of direct engineer quality identifications.

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SYNTHESIS OF AUTOMATIC SYSTEMS UNDER PARAMETRICAL UNCERTAINTY

The procedure of the synthesis of the law of control of the specified structure with a linear stationary object given parametrical uncertainty in the representation of an object is offered for consideration. The offered approach is based on admissibility concept.

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ABOUT INSTABILITY OF MOTION OF AUTOMATIC CONTROL SYSTEM

Many real mechanical systems are under the influence of small disturbing forces not to be considered at its mathematical modeling.
Since the elaboration of fine mathematical model is connected with the great difficulties it is an important to solve the problem of instability of disturbed equation. At solving concrete applied problems investigation of instability of motion is of great important not only for momentary acting indignation but for constant acting indignation. There are various constant working disturbances: the small, small on average and which are disappeared on the infinity.
Differential equations without disturbances have been considered:

$$\frac{dx_s}{dt} = X_s(t, x_1, \dots, x_n) \qquad s = 1, \dots, n \qquad (1)$$

where the right parts of these equations are continuous in the field

$$t \geq t_0, \quad |x_s| \leq H \qquad (2)$$

and assume the existence of unique solution at initial conditions specified in advance
$t_0, x_1^0, \dots$
x_n^0 in the field (2), $X_s(t, 0, \dots, 0) = 0$,
$s = 1, \dots, n$

$$\frac{dx_s}{dt} = X_s(t, x_1, \dots, x_n) + R_s(t, x_1, \dots, x_n)$$
$$s = 1, \dots, n$$

where functions R_s are characterize constant acting disturbed factors.
We consider constant acting indignation which are small on average and disappeared on the infinity i.e answer the next condition in the field (2)

$$\int_{t_0}^{t} |R_s(\tau, x_1, \dots, x_n)| d\tau \langle \rho \qquad s \equiv 1, \dots, n \qquad \rho - \text{ small enough positive number.}$$

The conditions of instability of nonlinear differential equations have been received when the right parts of equations without acting indignation (1) answer the next conditions in the field (2).
right parts of equations without acting indignation (1) answer the next conditions in the field (2).

$$|X_s(t, x)| \leq L(t) \sum_{k=1}^{n} |x_k| + M(t) \sum_{k,i=1}^{n} |x_k||x_i|$$
$$s = 1, \dots, n$$

$$|X_s(t, x)| \langle b \sum_{k=1}^{n} |x_k| + \frac{c}{n} \sum_{k,i=1}^{n} |x_k||x_i| \quad s = 1, \dots, n$$

where b, c- are positive numbers $t \in [t_0, T]$, $\qquad T \langle t_0 + \frac{1}{bn} \ln \frac{b + ac}{ac}$

at the presence of constant acting indignation are small on average and disappeared on the infinity.
Previously the lemmas similar to Granuol-Bellman Lemma have been proofed.
The theorem about instability of motion of automatic control systems at constant acting indignation are small on average and disappeared on the infinity has been proofed. The theorem about instability of motion of automatic control systems at constant acting indignation are small on average and disappeared on the infinity has been proofed.

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APPLICATION OF MID-SQUARE METHOD FOR ESTIMATION OF GENERAL PARAMETERS IN ORTHOGONAL DIRECTIONS

In mathematical model development according to the measurements of input and output signals the mid-squares method (MSM) and its modifications have acquired the wide extension.
One of the approaches allowing to rescue the difficulties during the matrix inversion and its nonsingularity is connected with the estimation of scalar or vector general parameter.
The linear approximations are viewed in the following shape

$$Z = HX_i + V \qquad (1)$$

where $Z = [z_1, z_2, ..., z_k]^{\mathrm{T}}$ - vector of measured output signal $\dim Z = k \times 1$; $H = [h_1, h_2, ..., h_k]^{\mathrm{T}}$ - matrix of measured input signals; $\dim H = k \times n$, $V = [v_1, v_2, ..., v_k]^{\mathrm{T}}$ - vector of not measured noise, $\dim V = k \times 1$, k -sample number; X_i - vector of constant parameters, dim $X_i = n \times 1$, that is chosen in the shape:

$$X_i = X_0 + q_i b_i, \qquad (i = 1,2,..n) \qquad (2)$$

where b_i - scalar parameter for i - approximation, $q_1, q_2, ..., q_i, ..., q_n$ - is the system of orthonormalized vectors, generating n - dimensional metric space, X_0 - initial value of estimation vector, that is considered to be equal for every approximation (1).
The estimations b_i are searched by the minimum of quadratic form

$$J_i = 1/2(Z - H(X_0 + q_i b_i))^{\mathrm{T}} G^{-1}(Z - H(X_0 + q_i b_i)) \qquad (3)$$

where G^{-1} - matrix of weighting factors with dimension $k \times k$.
Then the estimations of general parameters b_i are searched by algorithm

$$b_i = (q_i^{\mathrm{T}} H^{\mathrm{T}} G^{-1} H q_i)^{-1} q_i^{\mathrm{T}} H^{\mathrm{T}} G^{-1}(Z - HX_0) \qquad (4)$$

The expression (4) is used for for construction of the following estimating procedures:
1. Sequential estimator b_i in directions determined by vectors q_i with the attained accuracy control on variance of general parameter.
Parallel estimator b_i in n orthogonal directions defined by the choice of basis $(q_1, q_2, ..., q_n)$. The calculation of estimations X is performed in direction q_l
2. That realized the minimum variation of general parameter, or by the solution of linear equation

$$X = X_0 + QM\{B\} \qquad (5)$$

where $Q = [q_1, q_2, ..., q_n]^{\mathrm{T}}$], $B = [b_1, b_2, ..., b_n]^{\mathrm{T}}$ - vector of general parameters, $\dim B = n \times 1$.
The MSM estimation of general parameter allows to rescue the difficulties connected with matrix inversion by the change of n – dimensional optimization problem for n one – dimensional problems. Thus, the possibility to stop the estimation of parameters on the hitting of attained accuracy of estimation is appeared.

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CORRELATION-EXTREME SYSTEM COMBINED SYNTHESIS CONCEPTION FOR A NAVIGATION COMPLEX

In this article the correlative-extreme system combined synthesis conception for a navigation complex is presented. CENS will allow to fly an aircraft to optimum spatial - temporary trajectory.

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A CENTRAL APPROACH IN SOLVING THE TASK OF PARAMETRIC SYNTHESIS OF CONTROL SYSTEM FOR MULTIDIMENSIONAL INTERVALLY SPECIFIED OBJECTS

In this paper the task of parametrical synthesis of closed-loop control systems is solved for multidimensional intervally specified objects. A description of a generalized solution set of an interval matrix equation of Sylvester is brought. For inner estimation of this set a center approach is used.

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ANALYTICAL DESIGNING OF SYSTEM OF OPTIMAL CONTROL FOR PARTICULAR CLASS OF OBJECTS

In this article one of the approaches to problem solving of analytical designing of system of optimal control for particular class of objects realising the concept of the combined synthesizing of controls is stated during functioning system. Its based on a combination of automatized procedures of identification of parameters OC at the incomplete information on its state, reception of estimations of a complete state vector with procedures of synthesizing of controls.

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ROBUST STABILITY OF NONLINEAR SYSTEMS AUTOMATIC CONTROL WITH A NONUNIQUE STATE OF AN EQUILIBRIUM FOR A MAIN CASE WITH ONE NONLINEARITY

There his been developed a methology of study of automatic control system (ACS) robustic dynamic properties. There have been proposed a new frequency criteria of robuste stability for determinid onedimentional non-linear interval ACS with not only one balanse status.

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GROUP LEE FORMULATION CONDITIONS FOR CONTROL SYSTEMS OF INTERVALLY-DEFINED OBJECTS

This report deals with conditions of forming Lie`s group for a set of interval matrixes of Kaucher`s arithmetics.

SECTION "MODELLING IN THE SOCIO-ECONOMIC SYSTEMS"

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SIMULATION MODELS OF ECONOMIC SYSTEM DEVELOPMENT

Offered mathematical model macro economical and system of modeling of modeling information, values other scenario of development of economy of country depending on values of initial conditions and mechanisms of macro economical government regulation.

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ECONOMIC-MATHEMATICAL MODEL IN A TECHNIQUE OF FORMATION OF THE TARIFF ON SERVICES OF TRANSMISSION OF THE ELECTRIC POWER

The new methodical approach on formation of the tariffs on service on transit electric power in application of economic-mathematical models allow to analyze economic situation in a part of prices of enegy producing organization in areas of Kazakhstan and to accept the administrative decision on their regulation.

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OPTIMAL PROBLEM OF NET STRUCTURE

The work devoted to the solution of the problem concerning distribution of resources on nets. An offered approach lets us use specifity of a given problem for building an effective method.

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SOLUTIONS OF CRITERIAL MANAGEMENT PROBLEMS BY AN ACTIVE SYSTEM

Paper considers methods of criterial management problem solving of active system. Problems of criterial management are concluded in the determination of special functions of elements, ensuring maximum criterion system's efficiency at the management open mechanism. The parametric problems of criterial management are solved by methods of " branches and borders" and local optimization.

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MODELLING OF THE POPULATION DEVELOPMENT

In this report describe the mathematical model of the population development dynamics, notions of the stable and steady development of the population, the model system allowed to prognosticate the population number.

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ABOUT OPTIMIZATION AND REGULATION OF THE SUMMARY NATIONAL ACCOUNTS OF INCOME GENERATION

The problems of optimization and regulation of the income generation summary national accounts indices under the condition of SNA in the republic of Kazakhstan are studied. The conditions of the optimum indices of the summary national accounts of income generation and analytical mechanisms of the state regulation of the macroeconomical markets are found.

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ANALYSIS OF THE MARKET OF PRODUCTS ON THE GAME-THEORETIC MODEL BASIS

In this paper attention is focused on the application of game-theoretic methods in the field of economy. The aim of this is to provide the grounds for far from evident decisions made by «PLVZ» in order to strengthen its position at the market.

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SIMULATION OF THE ORGANIZATION-ECONOMIC CONTROL MECHANISM OF THE INFORMATIZATION PROCESS

In the report organizational-economical mechanism of management by the process of informatization is formalized. An approach is offered for simulation of this process based on using the apparatus of fuzzy set theory, active system theory, multicriteria optimization.

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THE LATENCY MODELLING IN INVESTMENTS MASTERING

This paper dedicates to the latency problem in investment's mastering. There are two ways for modeling the investment's lag and they were considered in this work. The problem was solved by Krotov's Theorem [1] about sufficient conditions of optimality and Stability Theory on the finite time interval [2]. In addition, this paper contains comparative analysis between two kind of economic models: with and without investment's lag.

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NATURAL RESOURCES IN ECONOMY OF KAZAKHSTAN

Considering economy as a managerial system, in which regulator is a market, reflected the role of natural resources, related with purposes and criterions of management.

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THE DYNAMIC MODEL OF OPTIMAL DEVELOPMENT MULTIBRANCH ECONOMIC TAKING IN TO CONSIDERATION THE POLLUTION OF THE ENVIRONMENT

Sufficient conditions of the optimality by Krotov were received for the dynamic of the multibranch economy considering the pollution of the environment. It is based on the interbranch balance and the capacity of the branches is describes by the production functions.

SECTION " THE CONCEPT, TECHNOLOGY AND PRACTICE OF DESIGNING OF INFORMATION SYSTEMS"

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A CORPORATE INFORMATION SYSTEM OF AL-FARABI KAZAKH STATE NATIONAL UNIVERSITY

The brief information on corporate information system of university, structure of a computer network, basic problems of administration management, soluble with the help of the given system is submitted.

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DISTRIBUTED INTEGRATED FINANCIAL INFORMATION SYSTEM

The work is devoted to the issues of formation of financial information system in order to provide with adequate information in taking decisions using the wide range of communication and information services.

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CORPORATE INFORMATION NETWORK OF THE HIGHER EDUCATION INSTITUTION

Variants of corporative network creating and problems the developers of the network encounter are presented. An example of network hardware and software and network topology are considered. The optimal variant of network realization in price/productivity correlations.

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CONCEPTUAL APPROACH FOR DESIGNING INFORMATION SYSTEMS OF PUBLIC ADMINISTRATION INSTITUTIONS OF THE REPUBLIC OF KAZAKHSTAN

Activation of reforming of political, economic, administrative structures of the society as a result of evolution of an independent Kazakhstan made the informatization one of top priorities of the country. Issues related to the informatization of public administration bodies are being addressed by many researchers and professionals.

At the first stage of studies conducted at the Academy of Public Service, the objective was to determine the place and role of information technology in the system of public administration of Kazakhstan. An analysis of current studies, upgrading, implementation and operation of information systems by the public administration bodies has demonstrated a lack of uniform methodology of development and implementation of such systems. Every top public administration body utilizes its own informatization project.

Such a process like the informatization of public administration bodies can not be chaotic, but it should be scientifically based and have a clear vision and strategy of development. The modern concept for designing information systems for public administration bodies should include a general methodology of designing information systems and the following evident trends:

Currently there are higher requirements to

- the terms of development and implementation systems and to the quality of their work;

there is an opportunity for an effective and complex utilization of various software, technical tools and available technological solution, which allow to develop, adjust and implement rather quickly new information systems and to upgrade the existent ones;

- a number of managerial processes require the development and implementation of own applications which are more flexible the changing information demands from the side of uses and software and technical configuration of system.

The current unsatisfactory state of infor-matization of public administration bodies is mostly related with the absence of a competent state body responsible for the informatization of public administration bodies, capable to inspect and ask reports on use of funds, to regulate the expenses, especially at purchase of foreign technology, and so on.

Of not less importance is to create a regulatory and legislative basis in the field of informatization.

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ABOUT AN INTEGRATED AUTOMATED BANKING SYSTEM J.S.A.B. (JOINT STOCK AGROINDUSTRIAL BANK)

In the report the experience of choice and introduction of an integrated automated banking system is represented within the framework of one of bank of Republic of Kazakhstan.

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THE OBJECT-ORIENTED APPROACH AT DESIGNING THE BANKING INFORMATION SYSTEM

The information system on an example of the banking information system is described on the basis of the object approach accepted in programming. The information system is represented as a tree, in which each site of a tree represents the object with the properties and methods, and the control of operations in system is made from each top of a tree. The approach reducing complexity of the system simply deciding problems of a control and allocations of access to objects and functions of the system is offered.

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THE CONCEPT OF AN INFORMATION MODEL OF BANK

In the report the new approach to the analysis of banking distinguished from object, traditional by a modification, of the analysis is represented to consideration. Some aspects of construction of an information model of bank are considered.

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THE DEVELOPMENT PROBLEMS OF STUDENT INFORMATION AUTOMATIZED SYSTEMS FOR RESULTS FORECASTING

This work recovers problems of development of an existing automatized systems of higher educational institutions administrating for students' results, scientific organizing, studying process planning and forecasting.

SECTION "INFORMATION TECHNOLOGIES IN MATHEMATICAL MODELLING"

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NEW INFORMATION TECHNOLOGIES IN OIL-AND-GAZ INDUSTRY

In the report presented automatic information system for processing the information flows Oil-and-gaz Industry, conduct of databases and passports of bore holes, buildings of structured cards and profiles of terrain, as well as some packages for deciding of direct and inverse marginal problems of theory to two-phase filtrations.

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THE INFORMATION TECHNOLOGY IN THE MATHEMATICAL SIMULATION OF ETHANE OXIDATION

The results of mathematical simulation of stability of the work of chemical reactor. Two dimensional mathematical model and simplified zero-dimensional model are considered. Qualitative analysis of stability of the stationary regimes oxidation was accomplished on zero-dimensional model and then used for the planning of the computing experiment on initial model. The results of theoretical investigation were compared with experimental data of ethane oxidation noted from paper.

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COMPUTER TOMOGRAPHY FOR PETROLEUM INDUSTRY

In work brought results on deciding direct and inverse problem an seismoexploring and численные results on modeling of inverse problem.

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SIMULATION OF THE DEFLAGRATION TO DETONATION TRANSITION IN A TUBE

The characteristics of the turbulence near the wall as the controlling factor of the whole turbulent combustion in the tube is considered. The predictions are based on numerical solutions of the Favre-averaged, one-dimensional, non-steady set of the conservation equations for individual species, mass, and total energy in the conservative form.

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COMPUTER DESIGN IN MODELLING PROCESSES OF AERODYNAMICS AND HEAT-MASS EXCHANGE

The numerical modelling of processes of transfer in catalytic reactors with a motionless granular layer is considered. The solutions are resulted as the diagrams, at which construction the graphic packages EXCEL-97 (Microsoft), Surfer (Win32) of corporation Golden Software are used.

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NUMERICAL SOLUTION OF THE PROBLEM OF NON-PISTON FORCE OUT OIL THROUGH WATER

In the given article is described problem of modeling of development oil field, as follows non-piston displacing oil by water [1]. Source problem was numerically computed by two ways. For the calculation of pressure in the layer were organized parallel calculations by means of the method of parallel skip.

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USE OF INFORMATION TECHNOLOGIES AT MODELING THE PHYSICAL PHENOMENA

On concrete examples the features and results of modeling of the physical phenomena are stated on the basis of computer system 2x2.

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COMPUTER MODELLING OF THE PROPAGATION AND INTERACTION OF SEVERAL FLAMES

Propagation and interaction of several stoichiometric methane-air flames in a closed vessel is investigated. The hydrodynamic structure of flame generated flows is studied. A qualitative agreement with known data is obtained for various initial flame positions. The results indicate an enhanced flow effect with flame number increasing.

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ABOUT DEFINITION OF A VARIABLE PERMEABILITY OF OIL BED ON ACTUAL DATA

This article is devoted the method of identification of variable permeability of oil bed on actual data and it was realized on PC.

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THE INTERVAL STABILITY OF THE ELEMENTARY IMMUNOLOGICAL MODEL

In the report the results on linearization of mathematical model, allocation of stationary regimes, reception of characteristic quazi-polinoms of delay type in a vicinity of stationary points and research of properties of robust stability of the above-stated family quazi-polinoms are submitted.

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CARTOGRAPHIC AND MATHEMATICAL MODEL OF SOIL PARTICLE TRANSFER

The article is about a program that gives quantitative and qualitative picture of solid particle transfer in any number of iterations for the specified relief and the topsoil density. Analysis of cartographic and mathematical model as a result of the program is described in the article as well.

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NEW APPROACH TO THE NUMERICAL SOLUTION OF THE PROBLEM OF FORECASTING THERMOHYDRODYNAMIC PROCESS IN A POROUS MEDIUM

The information about thermohydrodynamic condition of oil-saturated bed during water injection can be derived from using new approach to the numerical solution of mathematical model. The mathematical model of the studied process is formed with relation to filtrational and thermal flows. Computing algorithm is made in view of process physics and is effective concerning realization on PC.

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SIMULATION OF DYNAMICS OF A TUNNEL IN WATER-SATURATED MEDIUM

In article circular cylindrical tunnel supported by thin shell is considered. Tunnel is founded in water-saturated massif, besides mobile load effects on walls of tunnel. Movement of shell is described by equations of theory of thin shell. Displacements of elastic skeleton and fluid component is represented through potential of volume and shear waves.

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PROGRAM REALIZATION DEFINITION OF INTERACTION FORCE OF WELLS

The petroleum deposits of Kazakhstan have no due processing of the numerous data, which arise from the moment of development oil&gas of a deposit and collect during its development. Between that the realizations of the effective analysis and use of opportunities of computer processing of the information with the help of mathematical methods allow much more easy to watch the numerous factors, which determine efficiency of a developed deposit.

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EXTENSION METHOD FOR ALLOCATION OF RESOURCES IN PARALLEL STRUCTURE SYSTEMS

The work proposes a simple and detailed procedure for solving some optimization problems with possible, but not required near singularity of a constraint matrix. This procedure solves the original problem by a directed transition to the optimal solution from the point corresponding to the optimal solution of a simpler problem with an expanded set of feasible solutions.

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APPLICATION OF DECISION MAKING THEORY FOR FORMING SCIENTIFICALLY-JUSTIED OF THE CURRICULUM SPECIALITY

In work are considered the matters of application of a theory of coming to decisions for forming the curriculum of the speciality. There is shown that the variety and inconsistency of requirements to the curriculum, necessity of the registration of large number of the heterogeneous factors at working out a curriculum of the speciality, boundedness of temporary resources on preparation of the specialists do the problem rather complicated, labour-consuming and badly formalized.The forming of the curriculum is considered as process of coming to decisions on a set of alternatives and restrictions in a class of problems with fuzzy conditions.

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CONSTRUCTION THE MATHEMATICAL MODELS OF BEHAVIOR OF ROBOTIC SYSTEMS BY METHODS OF DISCRETE ANALYSIS

The methods of construction the mathematical models of robotic systems' grouping plan was devised by means of the mathematical apparatus of R-function application. The task of construction the grouping plan was formulated as the optimization task. The algorithm of it's solution was propounded.

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SIMULATION OF THE TERMO-STRESSED OIL LAYER IN THE VICINITY OF A WELL

By using the mathematical models of thermoelastic media the condition of oil collector in vicinities of a bore hole and bore hole system under action of heat flow and pressure at them are simulated. Some results of calculation of temperature, displacements and stress-strain state in the thermoelastic media have been brought.

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PROBLEMS OF CONSTRUCTION OF MODELS ON THE BASIS OF THE THERMODYNAMIC APPROACH

This document outlines problems of creation of mathematical models of continuous manufacturing processes oriented for the management purposes. The mathematical model construction technique is based on implementing the principles of a non-equilibrium thermodynamics.

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AUTOMATIC DIRECTION OF PROCESSES TO CONVEY THE MOTIONS BY TRANSMISSION

For the act of present work includes constructing mechanical self- regulation, to do automatically, irregularly without any stage changes, parameters used in motions in the order of resistance by the movement of working instrument.

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TRAFFIC/MATERIAL CONTROL SYSTEM FOR EXPORT TRANSPORTATIONS

The problems of creation of the control system of motion of transports and outwards by export transportations in Republic of Kazakhstan (RK) are reviewed , basing on satellite communication facilities. Are rotined a relevance of creation of a similar systems and problems arised at it. Are described a structure and principle of operation of a system.

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GROUP METHODS OF CONTROL OF SPECIFICALLY DANGEROUS OBJECTS

Worded problem of operative control of specifically dangerous objects with provision for the level problems conditions-governing an object. Offered so named group methods of control, which coming from problems current condition-control OM will assign methods of deciding a problem of cycle of control, target conditions, controlling actions and etc. Revealed structure and composition of group methods of control.

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ASYNCHRONOUS GENERATORS OF THE WIND POWER PLANTS WITH AN AUTOMATIC STABILIZATION OF FREQUENCY AND VOLTAGE

The cascade of the asynchronized generators for small wind power system is esteemed, which can work at low the frequency of rotation of the arbor wind wheel, providing stability of frequency and voltage output.

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INFORMATIZATION OF TEACHING PROCEDURE IN THE INTERNET ENVIRONMENT OF THE KARAGANDA STATE TECHNICAL UNIVERSITY

This report says about teaching procedure control of the KSTU in the INTRANET environment, using different workstations.

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THE MAIN PRINCIPLES OF REALIZATION OF MKA IN THE AUTOMATED DESIGN SYSTEMS

In the article the structure of program complexes of calculation of construction elements by the finite element method is considered. The automated method of formation of discrete model of objects is described and the work algorithms of pre-processor, processor and postprocessor are formulated.

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THE SYSTEM APPROACH TO AUTOMATION OF METALLURGICAL PROCESSES: EXPERIENCE AND PROBLEMS

The market conditions of managing require acceleration of activities in The savings of resources, increase of quality of production and improvement of an ecology on the basis of use of achievement of modern physics and adopting of automated control systems of technological processes.
In the report is adduced the results of research and change of acoustic methods of the control of a level of slag in the converter, weights - spectrometric methods of the control of a structure and consumptions converters gases, methods and means of the control of temperature of metal etc.
The solution of these problems is considered from system positions which conclude in creation and application of methods of obtaining of the operative information on real-time metallurgical process, account statistical and dynamic characteristics of researched process, account of destabilizing influence of external environment on result of measurement, creation the systems of metrology maintenance and accelerated tests, use of new ways of processing of the measuring information in real-time.
During of research and development is created the complex of techniques, sensors and devices for the control and measurement of a material structure of a blend during of technological process:
- neutron methods for determination of humidity of coke with variable density in bunkers;
- neutron methods for determination of humidity the iron ore concentrate on a surface of a driven conveyor tape;
- radiometric method for determination ashes of hard fuel.
Advantages of listed methods before known consists of correction of results of measure ment on density change of substance, thickness and distance of the sensor from a surface of a controllable material.
Development of a complex of physical methods and sensors has allowed to reach creation of informational-measuring systems (IMS) in iron metallurgy.
Use IMS allows to increase qualities and reliability of the received information, to conduct unification and standartization of electron signals and interface systems.
One from the important questions for construction IMS are the scientific and technical aspects metrological maintenance. On a neutron accelerometer of humidity example the verifying scheme integrating technical means and principles of unit moisture content is considered.
On base IMS and decentralization of automation systems the adaptive control system converter smeltingis created oxygen-converter bay of "Ispat-Karmet" is created and handed in operation.
Created IMS and devices of humidity of loose materials, ashes of hard fuel, complex of local control systems, dosage blend of materials, system of the control of temperature contents of metal in it of carbon etc. is deliver on the enterprises of near and distant foreign countries.

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AUTOMATION OF POLYSILICON MANUFACTURING PROCESS ON THE BASIS OF COMPUTER MONITORING-CONTROL SYSTEM

The paper considered tasks connected with automatic monitoring and control of main technological parameters of the polysilicon cultivation process in reactors of hydrogen restoring on the basis of the specialized software TRACE MODE. Mathematical models (MM) of mains technological parameters regulation are presented.

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OPTIMAL PROCESS CONTROL OF ELECTRICAL PURIFICATION OF GASES WITH FORECASTING OF PERTURBATIONS

In the article the method of process control of electrical purification of gases is offered, which represents procedure consisting from two stages, at the maiden stage which one the purpose of parrying emergency and critical modes and on second - shaping of control actions providing a conclusion of object in area allowable, and then and in area of optimum regimes of operation.

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OPTIMAL CONTROL OF A THERMAL MODE REVERBERATORY SMELTING OF COPPER CONCENTRATES

The problems of optimum control of a thermal mode reverberatory smelting of copper concentrates in metallurgical production are considered. Are given statement of a problem, the mathematical model and is formulated mathematical statement of a task of a problem of optimum control of a thermal mode of the furnace.

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MODELLING OF PROCESS ELECTRICAL SMELTING LEAD CONTAINING DUSTS OF COPPER PRODUCTION

The questions of development of mathematical model of new technology of processing lead containing dust of copper production electrotermics by a way are considered. The offered model is used for simulating researches of technology with the purpose of definition optimum modes of parameters of technological process.

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MODELLING AND OPTIMIZATION OF SOLUTIONS GRANULATION PROCESSSING THE PSEUDO-LIQUEFIED LAYER

The granulation processes of solutions in the pseudo-liquefied layer (PLL) are considered in three aspects: makro - and microkinetics, warm - and weights exchange, and also balance of particles number. Makrokinetics property of similar processes are taken for information when the model with the concentrated parameters is made. The following assumptions are adopted at the description of a microkinetics : the growth rate of granuls does not depend on their size, and depends from a full surface of particles in a layer.

Thus, the mathematical description of process is reduced to a ratio for balance of particles number with account its makro - and microkinetic properties. The mathematical model, known from the scientific literature, was used for research of the physical gear of the phenomena and analysis of process in laboratory conditions. In practice such model cannot be applied, because the information about of kinetic constants of splitting is unknown. Therefore was made the mathematical model which is possible for using in real industrial conditions for assessment of a layers granulometrical structure that determine stability of granulation processes and can't be automatically measure.

The received mathematical model is represent as the following set of equations:

$$\mathit{\Pi}_j = \begin{cases} a_1[1 - a_2(h_{сл} - a_3)](2R_j^{\,2} - a_4 2R_j)\Delta t + a_5\Delta t^2, \\ 0, \quad if \quad j = 3,2,1, \end{cases}$$

$if\ j = 6,5,4$

$$\rho_{j-1} = \rho_j \cdot \frac{\lambda - \Pi_j \cdot \dfrac{(j-1)^3}{j^3}\Delta R}{\lambda - \Pi_{j-1}\Delta R - \Delta R\left[K - \dfrac{3\lambda}{\Delta R(j-1)}\right]},$$

$$\sum_{j=6}^{1} \rho_j = 1, \quad \Delta t = \frac{t_{сл} - t_{кип}}{t_{кип}},$$

Where Π_j - probability of a particle splitting ; $a_1 ... a_5$ - are process parameters; hсл - a layer altitude; tкип - temperature of a solution boiling; Rj - particles radiuses; ρ_j - weight share of a j-th fraction; ΔR- width between radiuses step ; To - constant of a speed unloading; λ - growth rate of particles; tсл - temperature of a pseudo-liquefied layer. On this model was calculated the optimum of technological mode of process that allowed considerably to increase productivity of the PLL furnace.

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THE AUTOMATED MONITORING AND CONTROL SYSTEM OF MAIN PROCESSING OF METALLURGICAL PGV PACKAGE ON BMZ, CORPORATION "KAZAKHMYS"

In the report herein the features of control of a technological package of pool melt (PPM) are given and the base characteristics of the automated monitoring and control system of the metallurgical system designed and put into operation in June, - August 1999 are given. The work on creation, putting into operation of the ASC PMM package, on its support and improvement is step-by-step. Its first stage (mining and putting into operation of the first stage of ASC PMM package) is performed by the experts of corporation "«Kazakhmys", BMIW, joint-stock company "«Sistemotekhnika", Institute Of Metallurgy And Concentration of the Ministry of Science and High Education.

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MONITORING AND CONTROL OF AN INTEGRATED POWER COMPLEX OF PGV AT BALKHASH INTEGRATED MINING-AND-METALLURGICAL WORKS

In the report herein the information on the results of works on creation and putting into operation of the first stage of the automated monitoring and control system of the PMM package on Balkhash mining-and-metallurgical integrated works in June, - August 1999. The experts of corporation "«Kazakhmys", of Balkhash mining-and-metallurgical integrated works (BMIW), joint-stock company "«Sistemotekhnika", Institute Of Metallurgy And Concentration of Ministry of Science and High Education participated in the work.

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SIMULATION OF THE OPERATION OF MINING TRANSPORT SYSTEMS IN CONDITIONS OF THE TRAINS TRAFFICS TRANSFORMATIONS

Expound the fundamental principles of the simulation modeling of open-pit's excavators and trains systems works in the conditions of trains traffics transformations for the moved away factory.

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APPLICATION OF STANDARD SOFTWARE PACKAGES IN DEVELOPMENT OF GAS AND OIL FIELDS

In the given operation applying application packages in development and exploitation of gas and oil fields is esteemed. The specification statement of functionalities of the given application packages is resulted. The indicated software packages usually widely also are intensively used in the automized gathering and information processing about a current state of a field.

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MATHEMATICAL MODELILNG OF INSTALLATION OF "KLAUS 400"

The mathematical modeling and ways of management of complex technological installations on an example of installation 400 methods is considered.

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REDUNDANCY MANAGMENT OF COMPUTER SYSTEM WITH MULTIPLEXES

Thrice-repeated redundancy module system with a multiplexer using is considered. The system positively differs from the similar ones, for example, those installed on the rockets 'Delta-Titan' class. The system is protected by an author's certificate.

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AUTOMATIC CONTROL OF ADAPTINGS OF KEYING UNITS

In the given paper on an example of plane keying units is shown, that the implantation of mechatronical units and usage of combined kinematic chains allows to improve characteristics of keying units.

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CONTROL AUTOMATION BY DYNAMICS OF MOVEMENT OF A LINKAGE

In offered operation the problem is delivered conduct dynamic synthesis of the mechanism on the basis of usage of so-called "continuous" model as against used usually discrete model. For want of it should be taken into account influencings of a continuous modification of parameters of the mechanism on its speaker.

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SOLUTION METHODS OF NETWORK CONFIGURATION SYNTHESIS

The problem of optimization of net structure is surveyed. The methods of solving the problem taking into consideration net structure of it are offered.

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INFORMATION/MONITORING SYSTEM OF THE MOBILE MACHINERY OF MINING OPERATION

The problems of creation of the monitoring system of a mining and transportation of mineral on mines of Republic of Kazakhstan are esteemed, which one concerns to telemetering systems of control of different manufacturing processes in restricted space [1]. Are described a structure and principle of operation of a system.

SECTION "SYSTEM CONCEPTS AND APPLICATIONS TO THE UTILIZATION OF THE EARTH RESOURCES AND ECOLOGY"

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UNDERGROUND CONSTRUCTIONS RELIABILITY ASSESSMENT

In the report made attempt to offer an analytical method of the prognosis of reliability of underground constructions.

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SIMULATION OF EXPLOSION EFFECTS FROM EXTENDED CYLINDRICAL CHARGES

The questions of simulation of explosive affectings from extended cylindrical charges are reviewed. The expressions for fields of offset and stresses from the massed source of a type flat center of expansion are received.

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ANALYSIS OF INTERCONNECTION AND INTERACTION OF INTERNAL AND EXTERNAL FACTORS AND PARAMETERS OF THE "OPENCAST" SYSTEM

The intercouplings of the factors and arguments in system "Opencast" are established, and with objects of an exterior surrounding, the results of decomposition of system on subsystems and members are stated.

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FORMULATION OF COMPUTATIONAL PROCEDURES WITH CONSEQUENT DEFINITION OF EXPERT SYSTEMS FOR AUTOMATED DESIGN OF OPEN MINING OPERATIONS

In the given work the approach to formalization of process of projection of open mining is considered with the purpose of detection of a possibility of simultaneous realization of accounts of separate sections with use of local computing networks.

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SYSTEM ANALYSIS AND SYNTHESIS OF THE ORE EXCAVATION TASK CONTROL PROBLEMS

In operation the results of the systems analysis and synthesis of the tasks of control of mining in the "opencast - factory" system are resulted which functions in the mode of obtaining of maximum value of commodity production from extracted useful mineral. The usage's of various mathematical methods and models realizing algorithms of solutions of these tasks are shown.

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DISTRIBUTED INFORMATION PROCESSING PRINCIPLE APPLIED TO THE PROBLEM OF MINING FIRM DESIGN

The problem of increasing of the Automated Design System Productivity due to using of the principle of parallel information processing during automated design of a career is described in the article.

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APPLICATION OF ORE LOSS AND DILUTION NORMALIZATION METHOD AT VARIOUS STAGES OF MINING OF QUALITY REQUIREMENTS AND DESIGNING OF OPENCASTS

The philosophys of definition both method of application of a normalization of losses and dilution of ore at stages of mining of quality requirements and designing of opencasts are explained in view of arguments of mining method morphometrical of a constitution of panels and value beneficial a component.

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STATISTICAL OPTIMIZATION OF NETWORKS IN QUARRY LOAD FLOWS

Complex question at designing the transport network of opencast with a railway transportation is the installation of necessary capacity for all units of the network. It is fulfilled by means of statistical search of solutions on the simulation model Quarries load streams.

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THE URGENCY OF CREATION OF THE REPUBLICAN NETWORK OF MONITORING AND ERGONOMICS FOR LABOR PROTECTION IN MINING INDUSTRY

The analysis of a state of safety of work of a mining industry has shown necessity of creation of an information network system of monitoring and ergonomics of protection of work at the republican level. The main tasks of this network is: collection, analysis, processing and control of protection of work of mining operations.

SECTION "IMAGE RECOGNITION AND GEO-INFORMATION TECHNOLOGIES"

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ON STABILITY OF GROUP FUZZY CLASSIFICATIONS

Given work is devoted to an investigation of some questions of stability of group fuzzy classification allgorithms. An estimation of stability of algorithms of group fuzzy classifications over reduction of length of initial set of objects is obtained.

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MODERN SITUATION AND PROSPECTS OF DIGITAL CARTOGRAPHY DEVELOPMENT IN THE REPUBLIC OF KAZAKHSTAN

In given item the problems and prospects of development of Cartography and Geodesy branch of Kazakstan are covered. For the decision of cartography and geodesy tasks and satisfaction of growing needs of Republic in cartographic production it is necessary to use digital and geoinformation technologies.

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METHODS OF CREATION OF THE LIST OF CONTOUR POINTS OF SIMPLY CONNECTED REGIONS OF VARIOUS FORMS

Some methods of creation of the list of contour points of symply connected regions of any form are considered. The algorit hm of a construction of the list of contour points of binary images is developed. The analysis of possibilities of considered methods, virtues and shortages is carried out.

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GIS AND REMOTE SENSING METHODS FOR MAPPING AND PROTECTION OF FORESTS OF KAZAKHSTAN

Mapping and taxing of forests with the usage of aerophotographies are well known and used during long time but they are based on hand labour, not automatized and require a lot of work and means. We propose the technology for processing aero- and space images ERMapper 4.1 and ERDAS 8.3.

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LEARNING SYSTEM IN IMAGE RECOGNITION IN COMPOSITION OF GIS TECHNOLOGY

The educational system of grapic symbols recognition with program realization is examined. Algorithm of is based on knowledge about brains functioning and the model of visual path. The system is self-educating and forms the concept about images.

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RECURSIVE GRAMMAR DEVELOPMENT FOR THE ONE CLASS OF CONTEXTUAL LANGUAGES

Introducing of Recurrent Grammar (RG) - the modification of standard grammar formalism. The report shows how to build RG for the class of languages with polynomial recursive structures.

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RECURSIVE GRAMMAR FOR DESCRIPTION AND RECOGNITION OF SOME CLASS OF OBJECTS

The report proposes new approach to extension of standard grammar formalism by introducing the new type of grammar rules and nonterminals. Such rules very similar to recurrent formulas and recurrent rules, so the new grammar was called recurrent grammar. This type of grammars very suitable for recognition and description of some classes of context-sensitive languages.

SECTION "COMPUTER LOGIC AND NEURO-INFORMATION TEGNOLOGIES"

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GENERIC QUERIES OF DATABASES EMBEDDED IN A WEAKLY O-MINIMAL UNIVERSE

One of the problems in Database is to prove that under certain conditions on universe U any locally generic extended query is equivalent over finite state over U to a restricted query. We prove here that for weakly o-minimal universe any locally generic extended query is equivalent over finite Database states to an ordered restricted query.

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ON EQUIVALENCE OF PROGRAMMING LANGUAGE

One of the problems in Database is to characterize indexations of a database class. Also it is proved that equivalence of two arbitrary chosen programming languages is not effectively recognizable.

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USER-ORIENTED TASK SPECIFICATION LANGUAGES

We formalize (give an exact description of) two characteristics of a user: his intellectual resources and intellectual claims. We suggest and study an appropriate language for task specifications.

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SEISMIC FACIES MAPPING: NEW NEURAL NETWORK TECHNOLOGY, METHODOLOGY AND OPTIMIZATION

The paper considers issues of seismic data processing sequence oriented at seismic facies mapping (SFM). The sequence includes two iterative cycles of seismic imaging and SFM with seismic imaging cycle as a part of it. For the optimal seismic imaging the quantitative criterion of the optimal SFM is introduced.

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ELEMENTARY ORDER GENERIC QUERIES OF A DATABASE

One of the problems in Database is to prove that under certain conditions on universe U any locally generic extended query is equivalent over finite state over U to a restricted query.
We introduce new notion (e,<)-genericity and adduce some properties of (e,<)-genericity over a states of a database for a fixed universe.

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INFORMATIVE SYSTEMS OF DATA BASES

Here we present a theorem on existence of an informative system of which elements are relational models of data bases.

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QUERIES OF DATABASES OVER A COUNTABLY CATEGORICAL ORDERED DOMAIN

Here we study the problem of collapse of extended queries to restricted ones over a countable categorical ordered domain of databases.

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ON QUASI O-MINIMAL GROUP DOMAIN OF DATABASES

In it had been proved that if universe U is quasi o-minimal and φ is a locally generic over finite states over U query, then φ is equivalent over finite states over U to a restricted query. We give complete description up to elementarily equivalence of quasi o-minimal ordered groups.

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INTERPRETATION OF TEMPORAL LOGIC OF ACTIONS IN THE LANGUAGE OF THE FIRST ORDER LOGIC

The Caspian Sea is the largest intercontinental reservoir without water flow which demonstrates the unique global evolution on an extent of a huge interval of time. The economies of communities around the Caspian are highly dependent on sea levels. Therefore, development of correct models of the sea level prediction is very important. Existing linear model of outflowless reservoirs and non-linear stochastic models are based on hydrologic balance equation and have a number of limitations [1].

We applied non-linear topological dynamics methods to study the dynamics of the Caspian Sea. According to the general assumption about properties of an unknown dynamical model of the sea level we reconstructed a diffeomorphic copy of its attractor in N-dimensional space from scalar time series [2]. We estimated a correlation dimension of the reconstructed attractor and built input patterns for an artificial neural network.

We used the fully-connected artificial neural network (ANN) "MultiNeuron" developed by Russian scientists [3] as a predictor to make a non-linear prediction of the dynamics [4] of the Caspian Sea. The net was trained on Takens' m -dimensional vectors (m>2v+1) constructed from the instrumental data until 1980 AD and successfully tested on the data from 1980 AD until 1992 AD. The obtained result agreed with original data very well, and promised good prospects for the use of topological dynamics and neural network methods to predict the Caspian Sea levels.

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FRACTALS AND NEURAL NETWORKS FOR PREDICTION OF THE CASPIAN SEA DYNAMICS

In the framework of the Comprehensive Test Ban Treaty(CTBT), development of reliable methods to discriminate between underground nuclear explosions and earthquakes at regional distances (less than 2500 km) is very important. Existing methods of seismic event discrimination are based on the analysis of spectral characteristics of a variety of waves: Pn, Pg, S, Sn, Lg. However, these linear parameters are very sensitive to non-uniformity of the lithosphere and the astenosphere and they depend on the location of the event and the path of a signal propagation. Moreover, modern technologies of nuclear testing complicate distinguishing between nuclear explosions and earthquakes. Necessarity of nuclear explosion identification at the unknown regions creates preconditions to use absolutly new approach to the discrimination problem, based on non-linear nature of seismic events.

Many authors showed the practicability of using Artificial Neural Networks (ANN) for the problem solution. ANN is a modern powerful mathematical tool for solving different tasks in both linear and non-linear statements. Result of ANN running completely depends on a training process, which starts from forming an attribute (feature) space. The problem of the attribute space creation is more art than science. Known examples of Artificial Neural Network (ANN) using for the discrimination problem based on the feature space containing linear parameter. This made ANNs dependent on the station location and/or event localization.

With the aim of creation of seismic signal image as an input pattern for a neural net, the authors have attempted to form the attribute space using Topological Dynamics and Wavelet-Transformation methods. We proposed to build a universal geometrical model of a seismic signal using the canon algorithm of F. Takens to take into account structural features of the lithosphere. In addition, we suggested to use the Discrete Wavelet Transformation (DWT) method to estimate distribution of the seismic signal energy at various frequency ranges, which differ for different types of seismic events. Seismograms of underground nuclear explosions and earthquakes recorded at regional distances were pre-processed for training the fully-connected Artificial Neural Network ' MultiNeuron' developed by Russian scientists.

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1	USA	3
2	Russia	5
3	Kyrgyz Republic	4
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PROCEEDINGS

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CONFERENCE IN THE REPUBLIC OF KAZAKHSTAN

INFORMATION TECHNOLOGIES AND CONTROL

KazITC`99

Dezember 6-10, 1999
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**European Office
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To the participants of International Conference «Information Technologies and Control» ITC-1999

I welcome to the participants of International Conference «Information technologies and control».

Kazakhstan, as a country - the member of international community, actively and sequentially acts for deepening integration processes in the world and in the region. In new socio economic and geopolitical conditions, major development directions of Kazakhstan are integration of the country to the world economy and acceleration of its input rates to world space.

Our country has real conditions for organization and strengthening of mutually advantageous cooperation in scientific and technical sphere. We regard education and science as a main resource for strengthening of an intellectual and economic potential that can do positive influence over economic development of the state. In Kazakhstan the necessary preconditions for construction of modern information space that capable to satisfy information needs of the people and stimulate development of international scientific and business contacts, to boost investment attractiveness of the state have been created.

The support of the modern level of informatization requires generalization of the accumulated experience, scientifically justified strategy of development of priority directions.

The international conference on problems of information technologies and control, which will be carried out in Almaty with involvement of a scientific public of Kazakhstan and the world community countries, will bring significant contribution to this process. The fact of holding such large acts is recognition of progress in domestic science and our efforts for support of stability of the society development.

I am sure, that the international scientific conference doubtlessly will promote solution of actual problems of the modern science and technics and will help to creatie an information space, which corresponds socio economic development needs and national interests of Republic of Kazakhstan.

I wish success to the conference participants and organizers, fruitful, constructive work, close interaction in business, further development of science and practice of information technologies and control.

The President of Academy of sciences
Of Republic of Kazakhstan N.A. Ajtkhozhina

PLENARY PAPERS

Optimal Redundancy Management in Reconfigurable Control Systems Based on Normalized Nonspecificity

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Abstract

In this paper, the notion of normalized nonspecificity is introduced. The nonspecificity mea-sures the uncertainty of the estimated parameters that reflect impairment in a controlled system.
Based on this notion, a quantity called reconfiguration coverage is calculated. It represents the likelihood of success of a control reconfiguration action. This coverage links the overall sys-tem reliability to the achievable and required control, as well as diagnostic performance. The coverage, when calculated on-line, is used for managing the redundancy in the system.

Introduction. Reliability has always been a subjective issue in the analysis and design of fault-tolerant control systems. It is rarely associated with an objective criterion that guides the design. This predicament is due to the fact that standard reliability assessment techniques are not geared toward systems with the type of redundancy that is involved in reconfigurable control. Therefore, it is difficult to establish a functional linkage between reliability and diagnostic/control performance. This paper is intended to establish such a linkage.

One way to achieve fault-tolerance in a controlled system is to reconfigure its control law when the system fails. The method of control reconfiguration becomes feasible and effective in a system if adequate redundancy exists for possible accommodation of few critical but foreseeable failures. The reader is referred to a recent survey paper by Patton (1997) for an outline of the state of the art in the field of fault-tolerant control. Some causes of difficult, common to all fault-tolerant control designs, are the vagueness in the definition of a failure in the context of control performance, the uncertainties in the system and in the exogenous signal models, the limited processing/memory capabilities in carrying out diagnosis, and, above all, the lack of re-liable means of managing redundancy, especially analytic redundancy. For example, the ailerons of an aircraft are primarily for controlling he roll movement when used di"erentially. But they have also a secondary function of iding elevons for controlling the pitch movement, hen used collectively. Therefore, by analytically reconfiguring the control actions of the surfaces, redun-dancy could be effectively provided without added hardware. Unlike the hardware redundancy, analytical redundancy is inherent in the static and dynamic relations among the system variables, and is more difficult to manage. The design of reconfigurable control systems is commonly perceived to involve designs of three separate subsystem modules (Jacobson and Nett 1997): a control subsystem module, a diagnostic subsystem module, and a reconfiguration subsystem module that links the former two.

A schematic diagram of a reconfigurable control system is shown in figure 1. The control module contains a finite number of pre-designed or online-designed control settings. Each control setting, when properly selected under a given impairment condition, is to provide the controlled system with a certain prescribed performance level. The diagnostic module processes the measurements to estimate the current impairment condition. The reconfiguration module decides which control setting should be switched on to accommodate the condition. Note that control reconfiguration need not take place whenever an impairment condition occurs. It is only needed when control performance falls below a prescribed threshold. In that case, a failure is said to have occurred.

An attempt was made by Wu (1997) to link the reconfiguration coverage with a diagnostic resolution and a control performance threshold. The reconfiguration coverage measures the likelihood of success of a reconfiguration action that enters the assessment of the overall system reliability as one of the dominating parameters. The diagnostic resolution is introduced on the basis of a relevant nonspecificity measure.

A measure of nonspecificity, as one type of ncertainty, was first conceived in terms of finite crisp sets by Hartley (1928); it is usually called a Hartley measure. A measure of nonspecificity of convex sets in the n-dimensional Euclidean space was proposed by Klir and Yuan (1995); they call it a Hartley-like measure.

One of the main contributions in this paper is a refinement of the nonspecificity measure, which can be applied to measure and compare uncertainties of various physical quantities of different physical dimensions in a meaningful manner. This is achieved by a normalization process.

As a result, nonspecificity is dimensionless, and has a range between zero and one. Two important measures of reconfigurable control systems are then derived from the normalized nonspecificity.

One measures the performance of the diagnostic module in terms of diagnostic resolution, and one measures the performance of the reconfiguration module in terms of coverage. This coverage allows us to depict in a precise manner how the overall system reliability is related to the performance of the control subsystem module and to the performance of the diagnostic subsystem module. Therefore, it is suitable as a criterion for the management of analytic redundancy.

The paper is organized as follows. Section 2 discusses some background material, including the modeling of a plant in a way suitable for control reconfiguration, and the proper assessment of the control performance. Section 3 introduces the notion of normalized nonspecificity upon which the diagnostic resolution is defined. Section 4 introduces the reconfiguration performance measure in the form of a coverage. The coverage serves not only as a means for incorporating the likelihood of a successful/failed reconfiguration action into the reliability assessment, but also as a device for managing the analytic redundancy. In this regard it is used as a ranking criterion for selecting the most reliable control law. An example is discussed in which the relationship between the level of reconfiguration coverage and the levels of diagnostic resolution and control performance threshold are graphed. The graphs offer a clear view of the alternatives by which the design objectives can be eithe r accomplished or compromised.

2. A fuzzy set description of control performance The purpose of this section is to eliminate the vagueness in the definition of a failure in the context of control performance, and to create a reference framework for redundancy management.

Since the design of both the control module and the diagnostic module in a reconfigurable control system is based on the knowledge of the plant, it is important that a model suitable for the purpose of control reconfiguration be established. By suitable we mean that impairment of critical nature enters the model in an appropriate manner, and available redundancy is fully reflected in the model. In the following discussion, it is assumed that all impairments under consideration enter the plant model in the form of appropriate parameters. Some enter as physical parameters when the model is formed based on the laws of physics. Some enter as coefficients when the model of a prescribed structure is identified through some experimental means. Others enter simply as dimensionless scaling factors to indicate the degree of abnormality of some particular components. Suppose that at a given operating point, the state-space linear model

$$x(t)= Ax(t)+ Bu(t),y(t)= Cx(t),x(0) = x0, (1)$$

simulates the input-output characteristics of a plant, where x, u, and y are n-, m-, and p-dimensional state, input, and output vectors, respectively, and A, B and C are known matrices (which may be time dependent) of appropriate dimensions. As an example, the impairments representing the loss of sensor/actuator e"ectiveness can be characterized by sensor and actuator effectiveness factors. The factors enter the model in the form

$$B = B_0 - B_0\Delta_a,$$
$$C = C_0 - C_0\Delta_S,$$

where

$$\Delta_a = diag\ \{\delta_1,..., \delta_m\},$$
$$and\ \Delta_S = diag\ \{\delta_{m+1},..., \delta_{m+p}\}$$

(Wu 1996). Each δ_i ranges between 0, representing no loss of effectiveness, and 1, representing complete loss of the effec-tiveness in the ith effector (sensor or actuator). In general, we define an impairment parameter space as the Euclidean space of all parameters that change their values as the result of some impairment. The prescribed range of variation of such parameters form a set in the impairment parameter space. Let θ denote a vector in the impairment parameter space of dimension N and Ω denote the set over which θ resides when impairments occur. Without loss of generality, Ω can be regarded as a hyper-rectangle

$$\Omega = \{\theta_{i,min} \leq \theta_i \leq \theta_{i,max},\ i = 1, \ldots, N\}.$$

Denote by Ω_N the normalized impairment parameter domain. It is obtained by scaling each axis of the impairment parameter space by the respective Lebesgue measures of the projections of impairment domain Ω onto that axis.

$$\Omega_N = \{\frac{\theta_i - \theta_{i,min}}{\theta_{i,max} - \theta_{i,min}}, i = 1, \ldots, N \mid \theta \in \Omega\}. \quad (2)$$

Obviously, Ω_N is a unit hypercube which will be used to define the normalized nonspecificity.

In the above example of sensor/actuator impairment, both Ω and Ω_N are m + pth dimensional hyper-rectangles in m + pth dimensional Euclidean spaces. Next, control performance will be defined over the universal set of the impairment domain.

In the schematic diagram shown in figure 1, G(θ) represents a model for the input to output mapping of the plant, including models of actuators and the sensors. The argument θ is made explicit to indicate that the model is dependent on the impairment parameter vector. Vector w contains all external signals, including disturbances, sensor noises and reference signals. Con-trolled output z is an error vector, capturing the design specifications on the system; y is the vector of measured variables; u is the vector of control inputs.

Let Twz (θ) represent the closed-loop input-to-output mapping from w to z. The control design problem under a given impairment condition can be formulated as follows. Select a control setting that maps y to u so that

$$\sup_{\|w\|_{in} \leq 1} \|T_{wz}(\theta^N)\|_{out} \leq \gamma, \quad (3)$$

where the subscripts in and out indicate the norms used for measuring the sizes of the input and the output space signals, respectively, $\gamma > \gamma_{opt}$ is a positive real number representing a prescribed performance level, and γ_{opt} is the optimally achievable performance level. Depending on what the input and output spaces are, design procedures vary and the resulting controllers are different.

Several software packages are available, such as some MATLAB Toolboxes (Balas, et al. 1991), which contain routines for synthesizing such controllers when G is a linear and time-invariant input-output mapping, and both input and output signal spaces are Hilbert spaces of energy bounded signals (L2(0, Ω)). No matter how well a model represents the plant to be controlled, uncertainties due to modeling errors and in the exogenous signals are always present. Such uncertainties can be formalized in plant model G of figure 1 as weighting factors (Doyle, et al. 1989). A good control design achieves the required performance in the face of these uncertainties.

In this case, the controller is said to provide a robust performance. It should be pointed out that the purpose of this paper is not to discuss fuzzy logic control of some model free plant (Mendel 1995), nor to discuss any human-intervened fuzzy supervision (Frank, et al. 1993). The plant to be controlled is reasonably well modeled, and a complete automation is required for control, diagnosis, and reconfiguration.

Suppose that various impairment scenarios require that M different controllers be designed, each guaranteeing that performance level γ be attained under a specific set of impairment conditions (a subset of Ω). Suppose a set of such M controllers has been obtained. Let these controllers be denoted by C1, C2, ..., CM, and let us address the issue of control performance measure. Define an alternative control performance measure

$$\mu_i(\theta) = \frac{1}{\sup_{\|\omega\|_{in} \leq 1} \|T^i_{\omega z}(\theta)\|_{out}} \tag{4}$$

as a function of where the superscript i indicates that controller Ci has been used as the feedback mapping in the performance evaluation. Some software packages (Balas, et al. 1991) can be useful in calculating the pointwise measure for each θ γ Ω. As impairment parameter vector θ moves away from the nominal value at which the design of Ci is carried out, the value of μi(θ) generally decreases. Naturally, M fuzzy sets

$$C_i = \{(\theta, \mu_i(\theta)), i = 1 \ldots M\} \tag{5}$$

on universal set Ω are formed. Each fuzzy set represents linguistically control performance achieved by using controller Ci. Figure 2 illustrates such a situation where three controllers have been designed to cover a one dimensional impairment parameter domain. Without loss of generality, it is assumed that θmax > θmin = 1. Note that fault tolerance can be achieved only if su!cient redundant control authority exists in the system, which is the case in figure 2. This point will be further elaborated shortly.

Let μT denote a prescribed control performance threshold to distinguish the normal from a failed operation for the controlled system, i.e., a failure is declared if

$$\mu i(\theta) < \mu T\,. \tag{6}$$

Whenever this becomes the case, a control reconfiguration is necessary. The essence of control reconfiguration is the management of the control relevant redundancy. The subsequent section will discuss the criteria for making control reconfiguration decisions, and the risk associated with a particular decision.

Referring to figure 2 again, it can be seen that some constraints must be imposed on the control module when the set $\{ Ci \}^{M}_{i=1}$ is constructed.

First, in order to guarantee that the control performance is always kept above the threshold by at least one controller anywhere in the impairment parameter domain, a su!cient overlap must exist among fuzzy sets (4) or (5). In mathematical terms, this condition can be stated as max $_i$

$$\{ \mu i(\theta) \} > \mu T\,, \ \forall\, \theta \ni \Omega. \tag{7}$$

Instead of using the maximum operator in (7), we may use a particular t-conorm associated with the union of fuzzy sets $\{Ci\}^{M}_{i=1}$ (Klir and Wierman 1998). This condition implies that adequate redundancy must exist in a system in order to make fault tolerance possible.

Secondly, since complexity is detrimental to the reliability of a system, the number of con-trollers (M) in the control module ought to be kept to the minimum. This condition implies that each controller ought to be designed to achieve the maximal robustness with respect to the variation in the impairment parameter vector. Suppose $\theta_{i0} \ni \Omega$ is the nominal impairment parameter value at which the design of controller Ci is carried out. Let |Br| denote the Lebesgue measure of a ball centered at "i with radius r in the N dimensional impairment parameter space.

A robust design problem could be formulated as follows.

$$\max_{C_i} r\,,$$

for which

$$\inf_{\theta \in B_r} \frac{1}{\sup_{\|\omega\|_{in} \leq 1} \|T^i_{\omega z}(\theta)\|_{out}} \geq \mu_T$$

Although the past two decades have marked some major development in systematic ap-proaches to robust designs (Green and Limebeer 1995), a focused effort is still very much needed for the development of an iterative search procedure that leads to a set of interactive robust controllers with a well defined overall optimality. Our effort along this direction is under way, but will not be further discussed in this paper. On the other hand, for any existing design of the control module, regardless of the approach and the criterion by which a design is carried out, a control performance evaluation in the form of a set of fuzzy sets can always be obtained.

However, if the result of the control performance evaluation violates one or both constraints mentioned above, some modification must be made in the control module design and/or in the control performance specifications.

Knowing that a successful control reconfiguration action depends on the accurate knowledge of impairment parameter θ, the challenge facing us is to acquire and to represent this knowledge in the presence of uncertainties.

3. Normalized nonspecificity

This section introduces the notion of normalized nonspecificity, which is then applied to provide a measure of the uncertainty in the impairment parameter estimate. The section also discusses how existing deterministic and probabilistic based diagnostic schemes can be retrofitted into the possibilistic formalization under the uncertainty invariance principle (Klir and Wierman 1998).

The past two decades have witnessed much progress in the techniques of fault diagnosis (Frank 1996). Within the category of model-based diagnostic techniques, there are both deterministic and probabilistic approaches, both crisp and fuzzy model-based approaches (Dexter 1995), both analytical and fuzzy-logic approaches (Aubrun, et al. 1993). The emphasis of these developments has been on the prompt and accurate identification of the system condition, in the face of uncertainties. In a control reconfigurable system, the role of the diagnostic module is to provide information to the reconfiguration module on the current condition of the controlled system so that the existing redundancy can be best utilized through control reconfiguration. However, due to limited processing/memory capability and the presence of model/signal uncertainties, conclusions on the system conditions are always based on insu!cient information. One is tempted to directly utilize the available diagnosis techniques and become preoccupied with the concerns regarding such issues as false alarm, missed detection, and false identification. As a consequence, conclusions are drawn prematurely at the output of the diagnostic module, which do not take into consideration the control module involved.

A remedy is to entrust the decision to the reconfiguration module that can combine the characteristics of the control and the diagnostic modules. What is needed from the diagnostic subsystem, in addition to the estimate of the impairment parameter vector, is a description of the uncertainty associated with each estimate in terms of a possibility function. The rationale for the use of possibility functions is that regardless of the diagnostic scheme used, impairment parameter estimates can always be described by fuzzy numbers (more discussion at the end of this section) and these can be given a natural possibilistic interpretation (Klir 1999). In addition, fuzzy sets have been utilized in describing the control performance. The interaction of these two consistent types of fuzzy sets should offer natural steerage toward making reconfiguration decisions. Effort toward the possibilistic diagnosis, though limited at the time, already exists (Kang, et al. 1991). It was observed that a more prudent treatment of uncertainty can result in an improved reliability, and maximum/minimum operations in possibility theory can increase the computational efficiency.

Suppose the identified impairment parameter has been represented by a normal fuzzy set

$$F = \{(\theta, f(\theta)) \mid \theta \in \Omega\},$$

as examplified by a triangular-shape membership function in figure 3. The quantity 1/R in the figure will be discussed when resolution R is formally defined later in the section. (See equation (12).) Set F = $\{\theta \ni \Omega \mid f(\theta) \geq \alpha\}$ for some value $\alpha \ni [0, 1]$ is called the α-cut of F.The fuzzy set bears a possibilistic interpretation (Klir 1999). Since F is normal, the associated possibility distribution, rF , is given in this case by the formula

$$r_F(\theta) = f(\theta)$$

for all θ ∍ Ω. Given now an arbitrary fuzzy set A = {(θ,a(θ)) | θ ∍ Ω } , the possibility measure of A based on possibility distribution rF is given by the formula

$$Pos_F(A) = \sup_{\theta\in\Omega} \min\{a(\theta), f(\theta)\}. \tag{8}$$

The notion of normalized nonspecificity is now introduced for a fuzzy set defined on an N-dimensional Euclidean space (impairment parameter space). Nonspecificity is not the only known uncertainty measure. Within the domain of possibility theory, however, nonspecificity has been shown to dominate the total measure of uncertainty (Klir and Wierman 1998).

The Hartley-like measure of a convex set A in the N dimensional Euclidean space has been shown to take the form

$$HL(A) = \min_{t\in T}\{\log_2[\prod_{i=1}^{N}(1+|A_{it}|) + |A| - \prod_{i=1}^{N}|A_{it}|]\} \tag{9}$$

under some standard uncertainty measure axioms (Klir and Yuan 1995), where T is the set of all unitary transformations on the N-dimensional Euclidean space, and | Ait | is the Lebesgue measure of the projection of set A on to the ith axis of the unitary transformed coordinate system under transformation t. In principle, the logarithm in (9) can be of any base. Base 2 is chosen for the purpose of simplifying a normalization process to be introduced shortly. When the experimental framework is confined to the normalized impairment domain Ω_N as defined in (2), the original Euclidean space is effectively re-scaled along each axis by the Lebesgue measure of the projection of hypercube Ω. Using the Hartley-like measure given in (9), the nonspecificity U(F)of normal fuzzy set F is calculated by the formula

$$U(F) = \int_0^1 HL({}^{\alpha}F)d\alpha, \tag{10}$$

as explained in Klir and Wierman (1998). In the next theorem, the normalized impairment domain Ω_N is used.

Theorem 1.

$$0 \le U(F) \le 1, U(F) = 0$$

if and only if F is a singleton.

Proof. HL(A) is constructed to satisfy the axiomatic requirements (Klir and Wierman 1998) that ∞ > HL(A) ≥ 0 ,where HL(A)= 0 iff A is a singleton in its universal set X,and that HL(A) ≤ HL(B)whenever A ⊆ B where A, B ⊆ X. Therefore HL($^{\alpha}$F) ≥ 0, where HL($^{\alpha}$F)= 0 iff $^{\alpha}$Fis a singleton in Ω_N. In combination with the definition of U(F) given in (10), this implies that U(F) ≥ 0, and that U(F)=0 iff " F is a singleton for any given α.This implies, in turn, that F is a singleton. On the other hand, $^{\alpha}$F ⊆ Ω_N. By the monotonicity of the Hartley-like measure, HL($^{\alpha}$F) ≤ HL(Ω_N). Consequently, U(F) ≤ U(Ω_N). But HL(Ω_N)=1 by the definition given in (9) because Ω_N is a hypercube. Therefore, U(F) ≤ 1.

When Ω_N is one-dimensional, the calculation of the normalized nonspecificity is much simpler. In this case,

$$U(F) = \int_0^1 \log_2(1 + |{}^{\alpha}F|)d\alpha, \tag{11}$$

where $^{\alpha}$F ⊆ Ω_N,and | F | is the Lebesgue measure of $^{\alpha}$F.

We define now a diagnostic resolution R(F) for a specific diagnostic outcome described by fuzzy set F ' Ω_N by the formula

$$R(F) = \frac{1}{2^{U(F)} - 1}, \tag{12}$$

Theorem 2. In a one dimensional impairment parameter situation, diagnostic resolution R(F) satisfies the inequalities

$$1 \leq R(F) \leq \infty \tag{13}$$

In addition, R(F) is equal to the inverse of the core of a crisp set that has the same nonspecificity as fuzzy set F.(See figure 3).

Proof. Since $0 \leq U(F) \leq 1$ by Theorem 1, the definition of R by (12) yields immediately (13).

Suppose there is a crisp set $C \subseteq \Omega_N$ such that $|C_\alpha| = 1/R(F)$ for all $\alpha \ni [0, 1]$. Then its nonspecificity is given by the formula

$$U(C) = \int_0^1 \log_2(1 + \frac{1}{R(F)})d\alpha$$

On the other hand, U(C) and U(F) are the same by assumption. With U(C) replaced by U(F), R(F) of the form (12) is obtained by solving the above equation.

The geometric interpretation of R(F) as it relates to the nonspecificity of F is depicted in figure 3 when $\theta\max - \theta\min = 1$ is assumed. Before normalization, on the other hand, the nonspecificity appears as

$$U(F) = \int_0^1 \log_2(1 + |{}^\alpha F| / |\Omega|)d\alpha \tag{14}$$

In this case, the Lebesgue mesure of the nonspecificity-equivalent crisp set C relates to R(F) through the equation

$$|C| = \frac{|\Omega|}{R(F)}$$

It is important to point out that normalization is absolutely necessary when nonspecificity is to be used in a real world problem. Normalization had not been considered for the definition of nonspecificity prior to this work. By using the one-dimensional case as an example, let us analyze the consequence of employing the non-normalized nonspecificity. This is the case when $|{}^\alpha F| \subseteq \Omega$ in (14) is not divided by the Lebesgue measure of impairment domain $|\Omega|$ .It is noted that the numerical value of $|{}^\alpha F|$ can be made entirely arbitrary, because the unit used for the impairment parameter can be arbitrarily selected. As a result, the numerical value of nonspeci-ficity U(F) is arbitrary. When the unit of impairment parameter " is fixed, the non-normalized nonspecificity can be useful but only in a relative sense. In addition, adding a dimensionless quantity 1 with a quantity with a definite physical dimension ($|{}^\alpha F|$) is a fundamentally incor-rect mathematical operation. When the impairment parameter space is of multiple dimensional, without normalization, one is indeed comparing apples with oranges.

Since most existing diagnostic schemes are either deterministic or probabilistic, the retrofit issue, i.e., the transformation of the diagnostic outcome from its original representation to the possibilistic representation, needs to be discussed.

An estimate from a deterministic diagnostic scheme is represented by a point p in the impairment parameter space with an error bound r. This error bound is typically the radius of a hypersphere surrounding the point. Let B (p, r) denote the set enclosed by the hypersphere. This set can be defined by the characteristic function

$$f(\theta) = \begin{cases} 1, \theta \in B(p,r) \\ 0, \theta \notin B(p,r) \end{cases}$$

Hence, it may be viewed as a special fuzzy set F. The corresponding possibility measure of this fuzzy set is readily obtained by (8).

On the other hand, an estimate from a probabilistic diagnostic scheme is represented by a probability distribution function. The transformation from the probability to possibility formalization is however more involved. The reader is referred to recent papers by Klir (1998) and Harmanec and Klir (1997) for more information. The following example shows how an uncertain-invariant probability-to-possibility transformation is made for an impairment parameter estimate called elevon effectiveness factor that enters an aircraft model. Please see Balas et al (1991) and Wu and Chen (1996) for a description of the 4th order linearized state space model and its modification.

The elevon effectiveness is estimated using an adaptive Kalman estimator (Wu, et al. 1998), and at each given time is described by a computed probability density function.

This density function is then integrated to a discrete probability distribution function, a snap shot of which at t = 4sec is shown in the upper plot of figure 4. Although treatments for both continuous and discrete universal sets are available, our continuous problem is to be treated in the discrete domain for computational efficiency. The lower plot in figure 4 shows the possibility distribution at t = 4sec. The following result is used for carrying out the probability to possibility transformation for the example.

Theorem 3.(Harmanec and Klir 1997) Let H denote the number of distinct values of in the k-tuple $<p1,p2, \cdots ,p_K>$, representing a probability distribution arranged in descending order.

Then there exist H integers, $i_1, ..., i_H \ni \{ 1, ... ,k \}$, such that $p1 = \cdots = pi_1 > pi_{1+1} = \cdots = pi_2 > \cdots > pi_{H-1+1} = \cdots = pi_H$. All possibility distributions $<r_1, \cdots ,r_k>$ consistent with the given probability distribution and containing the same amount of uncertainty are all those possibility distributions that sati sfy

$$r_{iq+1} = \sum_{l=iq+1}^{k} p_l$$

for all q =0, 1, ⋯ ,H ! 1 (with i0 =0) and

$$r_{ij-1} \geq r_j \geq \sum_{l=j}^{k} p_l$$

for $j \ni \{ 1, \cdots ,k \} - \{ iq +1 \mid q =0, 1, \cdots ,H-1 \}$.

The transformation expressed by Theorem 3 remains the same for any multidimensional case, provided that the probabilities and the possibilities involved are ordered as specified. When there are equal probabilities in the distribution, an additional criterion is needed to uniquely determine the corresponding possibility measure. The criterion of maximal nonspecificity (Harmanec and Klir 1997) is adopted in this paper, for one wish to be constrained only as much as necessary in making decisions based on the possibility distribution.

Figure 5 shows the plots of the nonspecificity and the corresponding diagnostic resolution as functions of time. These plots provide a basis for comparing various diagnostic schemes despite the method used for diagnosis. The volatile behavior in these plots is caused by a sudden drop of the elevon control effectiveness at t = 5sec. The impairment parameter estimator recognizes the large uncertainty in the estimate during the transient process.

4. Optimal redundancy management

The focus of our discussion in this section is shifted from the diagnostic module to the reconfiguration module where the decision is made on whether and how a control reconfiguration should take place in order to accommodate a failure. In this regard, the reconfiguration module carries out the task of redundancy management. Optimal redundancy management amounts to selecting in a prescribed class of controllers one and only one that offers the highest reliability.

It is possible to estimate the likelihood of success and the likelihood of unsuccess in a recon-figuration action, which are respectively named coverage, c, and a complementary coverage, Ï c, in the following discussion. More specifically, the coverage indicates the likelihood of fuzzy set (controller) Ci being selected while the actual impairment parameter lies within the interval 4. Optimal redundancy management

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$$c = \frac{\int_0^1 HL(^{\alpha}F')d\alpha}{\int_0^1 HL(^{\alpha}F)d\alpha} = \frac{U(F')}{U(F)},$$

$$\bar{c} = \frac{\int_0^1 HL(^{\alpha}F')d\alpha}{\int_0^1 HL(^{\alpha}F)d\alpha} = \frac{U(F')}{U(F)},$$

where HL(.) denotes the Hartley-like measure defined by (9), and U(.) denotes the nonspecificity defined by (10). Fuzzy set F is subdivided according to whether a particular possible impairment condition is accommodated by controller Ci. The following one-dimensional expressions for the coverage and the complementary coverage may reveal more explicitly their dependence on the partitioned fuzzy sets.

$$c = \frac{\int_0^1 \log_2(1+\left|{}^{\alpha}F^{u}\right|)d\alpha}{\int_0^1 \log_2(1+\left|{}^{\alpha}F\right|)d\alpha},$$

$$\bar{c} = \frac{\int_0^1 \log_2(1+\left|{}^{\alpha}F^{l}\right|)d\alpha}{\int_0^1 \log_2(1+\left|{}^{\alpha}F\right|)d\alpha}$$

These expressions show that the coverage and the complementary coverage depend on the di-agnostic performance, characterized by nonspecificity U(F) which uniquely determines the resolution, as well as the control performance, characterized by threshold μT , which uniquely de-termines subdivisions F u and F l . Therefore it links the performance of individual modules to overall system reliability.

Theorem 4. 0 ≤ c ≤ 1 and 0 ≤ c ≤ 1. In addition, 1-c ≤ c whenever the subadditivity of the Hartley-like measure with respect to set union (19) holds for $^{\alpha}F^{u}$ and $^{\alpha}F^{l}$. The subadditivity always holds when N =1.

Proof. By the monotonicity of the Hartley-like measure (Klir and Wierman 1998), 0 ≤ HL($^{\alpha}F^{u}$) ≤ HL($^{\alpha}$F). Integrating over α ∍ [0, 1] yields 0 ≤ U(F^{u}) ≤ U(F). Therefore, 0 ≤ c ≤ 1 from (15). Similarly, 0 ≤ c ≤ 1, or 0 ≤ 1 - c ≤ 1, by using (16). Assume now that the subadditivity of the Hartley-like measure holds for all α, i.e.,

$$HL({}^{\alpha}F^{u} \cup {}^{\alpha}F^{u}) \leq HL({}^{\alpha}F^{u}) + HL({}^{\alpha}F^{u}), \forall\alpha \qquad (19)$$

It follows from (15) and (16) that

$$c + \bar{c} = \frac{\int_0^1 [HL({}^{\alpha}F^{u}) + HL({}^{\alpha}F^{l})]d\alpha}{\int_0^1 HL({}^{\alpha}F)d\alpha} \geq 1$$

Although the subadditivity may not hold in general, due to the minimum operator in (9), it certainly holds when N = 1 because in this case

$$HL({}^{\alpha}F^{u}) + HL({}^{\alpha}F^{l}) = \log_2(1+\left|{}^{\alpha}F^{u}\right|)(1+\left|{}^{\alpha}F^{l}\right|$$

$$\geq \log_2(1+\left|{}^{\alpha}F^{u}\right| + \left|{}^{\alpha}F^{l}\right|) \geq \log_2(1+\left|{}^{\alpha}F^{u} \cup {}^{\alpha}F^{l}\right|)$$

$$\textit{Therfore} \quad 1-\bar{c} \leq c$$

It is seen that coverage 1 - c is bounded above by coverage c.1 - c and c can be regarded as lower and upper bounds for an interval-valued coverage.

Their difference reflects the amount of information deficiency in the diagnostic outcome.

Suppose there are M possible control settings, each of which is designed to accommodate a particular set of system conditions.

In determining which control setting is most suitable, the coverage defined by (15) can be used as a criterion in the following manner. If, for a diagnostic outcome F, $c_1, \cdots, c_N$ are calculated, and

$$c_K = \max_{i \in \{1 \ldots M\}} \{C_i\}$$

then control setting Ck is selected. This is the essence of optimal redundancy management. As a result, the highest coverage, and, hence, also the highest reliability at the overall system level are achieved. Apparently, a real time computation of coverage values for every candidate control setting is required.

The next example will shed some light on how the computation of the coverage is carried out.

It also shows some quantitative relations of the coverage to the control performance threshold, as well as to the diagnostic resolution. For ease of visualization, a one-dimensional impairment space is considered, as shown in figure 6. Suppose controller Ci is under consideration to see what level of coverage it can provide if it is chosen by the reconfiguration module. Suppose the membership function that represents the performance of this controller has the shape of a triangle.

Its peak Mc represents the level of nominal performance achieved at some value of impairment parameter, and Ic, the Lebesgue measure of its support, gives an indication on performance robustness provided by controller Ci.

The estimated impairment parameter is represented by the normal fuzzy set F, also with a triangular membership function. IF = a_{I0}, the Lebesgue measure of the support of F, is to be varied between 0 and I0 via parameter a $\ni$ [0, 1]. Furthermore, suppose that sufficient analytical redundancy exists so that figure 6 describes the extreme case scenario arg { max f(θ) } = $\ni_0/2$ under which control setting Ci would still be selected. This means that a different controller would have been chosen if arg {max f(θ) } = $\ni_0/2$. In addition, suppose the diagnostic module provides a sufficiently high resolution that 1/IF >Mc/Ic, where Mc > 1 is assumed without loss of generality. Note that most of the assumptions above are for simplifying purposes, and can be relaxed.

For the scenario in figure 6, formulae for computing coverage c and complementary Ï c intro-duced in the previous section take the following forms

$$c=\frac{U(F^{u})}{U(F)}=\begin{cases}1, & b\le \epsilon_0/2-\epsilon_F/2\\ \dfrac{2[1-b+\epsilon_0(1+a)/2]\ln[1-b+\epsilon_0(1+a)/2]-(1+\epsilon_0-2b)\ln(1+\epsilon_0-2b)-\epsilon_0\alpha}{(1+\epsilon_0\alpha)\ln(1+\epsilon_0\alpha)-\epsilon_0\alpha}, & \epsilon_0/2-\epsilon_F/2\le b\le \epsilon_0/2\\ \dfrac{2[1-b+\epsilon_0(1+a)/2]\ln[1-b+\epsilon_0(1+a)/2]+2b-\epsilon_0(1+a)}{(1+\epsilon_0\alpha)\ln(1+\epsilon_0\alpha)-\epsilon_0\alpha}, & \epsilon_0/2<b\le \epsilon_0/2+\epsilon_F/2\\ 0, & b>\epsilon_0/2+\epsilon_F/2\end{cases}$$

$$c=\frac{U(F^{l})}{U(F)}=\begin{cases}1, & b\le \epsilon_0/2-\epsilon_F/2\\ \dfrac{2[1-b+\epsilon_0(1+a)/2]\ln[1-b+\epsilon_0(1+a)/2]+2b-\epsilon_0(1+a)}{(1+\epsilon_0\alpha)\ln(1+\epsilon_0\alpha)-\epsilon_0\alpha}, & \epsilon_0/2-\epsilon_F/2\le b\le \epsilon_0/2\\ \dfrac{2[1-b+\epsilon_0(1+a)/2]\ln[1-b+\epsilon_0(1+a)/2]-(1+\epsilon_0-2b)\ln(1+\epsilon_0-2b)-\epsilon_0\alpha}{(1+\epsilon_0\alpha)\ln(1+\epsilon_0\alpha)-\epsilon_0\alpha}, & \epsilon_0/2<b\le \epsilon_0/2+\epsilon_F/2\\ 0, & b>\epsilon_0/2+\epsilon_F/2\end{cases}$$

Note that the subdivision of F into F u and F l occurs at the point where Ci and μT intersect.
This point is marked by b = μT Ic 2Mc , measured from " =0. Since b is proportional to the control performance threshold μT , it can also be used as an indication of μT . a = IF /I0 is a fraction indicating the support of fuzzy set F relative to its worst case support I0. The nonspecificity and the resolution for this example are

$$U(F)=\frac{(1+\epsilon_0\,\alpha)\ln(1+\epsilon_0\,\alpha)-\epsilon_0\,\alpha}{\ln(2)\epsilon_0\,\alpha},$$

$$R(F)=\frac{e}{(1+\epsilon_0\,\alpha)^{(1+\epsilon_0\alpha)/(\epsilon_0\alpha)}-e}$$

by equations (11) and (12), where e =2.7183. Plots of U(F)and R versus $\ni_F / \ni_0$ are shown in figure 7. It can easily be derived that U(F) $\approx \ni_F$ when $\ni_F << 1$. c and c are now computed as functions of control performance threshold μT , with diagnostic resolution R as a parameter. The fourth plot in figure 8 shows the interval coverage between boundaries c and 1 - c as a function b (μT) with resolution R =4.13 when a = $\ni_F / \ni_0 = 1$, calculated using the above given formulae. It is assumed that the most possible value for θ is at θ = $\ni_0/2 = 0.25$ when $\ni_0 =0.5$, and the peak location of the membership function for F remains as a changes. The change in coverage corresponding to a gradual decrease in the value of a are shown in the third (a =0.65, R =6.30), the second (a =0.35, R =11.58), and the first (a =0.05, R =80.17) plots, respectively. By observing the graphs obtained, the following conclusions can be drawn. The gap between the two bounds on coverage increases with decreasing R (diagnostic resolution), and with increas-ing μT (control performance) at the high coverage end. The value of coverage itself increases with increasing R at high coverage end, and with decreasing μT. All the conclusions are within our expectations. Their significance lies in that a guideline for design iteration is provided in a quantitative manner for meeting a prescribed reliability requirement.

Suppose that coverage c0 =0.99 is required for achieving a certain prescribed reliability. With a relatively high resolution such as shown in the first plot of figure 8 (R = 80), the control performance threshold can be set at b =0.22 or lower. Suppose the diagnostic module designer can afford a resolution only at R =4.13 as shown in the last plot of figure 8. In this case, one must be content with a much lowered control performance at around b =0.022 (10% of the previous case). If this performance level is not acceptable, one can attempt the following: increasing the processing/memory capability of the diagnostic module, or increasing the performance level of the control module at around θ =0.5 without sacrificing elsewhere. The first attempt is aimed at enhancing resolution R within the given decision time, say from R =4 to R = 80, and the second attempt is aimed at raising the allowable level for μT, say from b =0.02 to b =0.2, so that the required coverage level c0 can be achieved.

Conclusions. A method of redundancy management in control reconfigurable systems is presented. Re-dundancy management in such systems amounts to making control reconfiguration decisions. It is assumed that adverse conditions that may cause the failure of the systems are parameterized in the system models in terms of impairment parameters. Our method of decision-making is based on the interaction of two classes of fuzzy sets defined on the bounded universal set in an impairment parameter space. One class of fuzzy sets represents the set of measures of control performance for all control settings. The other class represents the outcome of the impairment parameter estimation. By introducing the notion of normalized nonspecificity measure for the latter class, we are able to meaningfully quantify the performance of the reconfigurable control systems using coverage, which is defined as the likelihood of successful control law reconfigura-tion. On the one hand, the coverage affects the reliability of the overall systems directly.

On the other hand, our definition of the coverage is functionally related to the control performance, as well as to the diagnostic performance. It sets the criterion and provides a means for the integrated design of control reconfigurable fault-tolerant systems. A major theoretic issue that still remains unresolved is the subadditivity of the Hartley-like measure of two bounded sets on a multi-dimensional Euclidean space without imposing the convexity condition on the sets. This has restricted the application of our solution to problems of sequential single-fault scenarios, instead of sequential simultaneous-faults scenarios. Overcoming this restriction may require that a new type of Hartley-like measure be defined.

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Coupled-Wave Analysis of Superimposed Bragg Gratings Based on 3-Beam Holographic Recording and Readout

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Abstract:

When three plane waves of light are used in two separate pairs to record an interference pattern in a holographic material, the two gratings that result may be analyzed by considering them to be superimposed. Beginning with the classic coupled wave formalism, relationships can be obtained for the nature of coupling between the various scattered orders when such a pair of superimposed gratings is illuminated by one, two or three READ beams (assuming Bragg matching relative to the WRITE conditions).

In this paper, the response of the superimposed gratings to one, two and three READ beams is analyzed along the lines of the work by Case [JOSA 65, 724 (1975)]. In particular the amplitude distributions among the scattered orders (typically three), and the resulting scattering efficiency are evaluated for beam splitter, beam combiner, cross-coupled and conjugate cross-coupled modes of operation.

Introduction. An advantage of holographic gratings is their ability to be superimposed. Thus, two or more gratings, each with a different function, may be laid one "on top of" another, resulting in two or more diffracted orders on read-out. This paper considers the properties of thick holographic gratings, superimposed on the same material independently [2, 7, 15]. Considerable work has been done on the subject of thick holographic gratings in the past thirty years [1– 6, 15, 17, 18]. Kogelnik's theory [1] has been applied to a variety of situations [2, 8, 15, 18], with great success, although more recent studies have drawn attention to the cross-gratings created when holographic gratings are superimposed [2, 11, 12, 15]. These cross-gratings can result in spurious beams at the output. In this study, we have applied Kogelnik's theory to a three beam writing scenario, treating the two resultant gratings independently, along the lines of ref. [2].

To complete the analysis, it is assumed that (i) the grating spacings are quite small - to provide a large range of possible Bragg angles for study; (ii) the average refractive index is much larger than the refractive index modulation (of either grating),
Which reduces the amount of internal reflection; (iii) perpendicular polarization is assumed, which simplifies the mathematics; and the absorption coefficient is assumed to be zero, so that the gratings are essentially lossless. As in reference [2], it is assumed that a common beam contributes to the formation of both gratings.

Three Beam Recording

Coupled wave theory may be employed in the investigation of multiply exposed thick holograms [2]. In this paper, we consider only the two gratings written by the interference of the reference beam (S) with the object beams (T and R). If all three beams interfered during exposure, there would be significant coupling between R & T, resulting in a third cross grating. Fig. 1 represents a cell containing two superimposed holographic gratings, each diffracting input light into a different output beam.

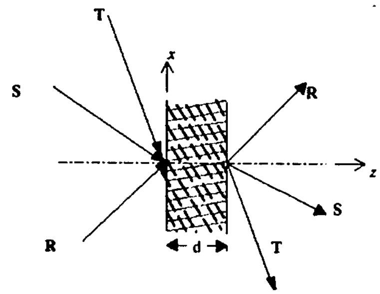
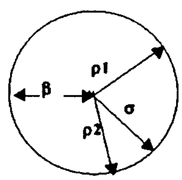


Fig. 1 : The dotted lines represent the grating formed by beams R and S, while the dashed lines represent the grating formed by T and S..



. Figure 2: Dual Grating Wave Vector Diagram. Read-out at Bragg incidence. q is the Bragg angle. b is the wavelength of the light used to write the grating; r1 , s , and r2 are the wave vectors of R, S and T.

Fig. 2 is the wave vector diagram, drawn in k-space, within a circle of radius b, where □ is the wave number of the WRITE beams. Since the wave vectors of the output beams, r1, s, and r2 all have a length of b, Bragg incidence is implied [2].

Coupled Wave Analysis:

The scalar wave equation to be solved for perpendicular polarization is:

$$\nabla^2 E + k^2 E = 0, \qquad (1)$$

where

$$k^2 = \beta^2 + 2\beta\kappa_1 \cos(\vec{K}_1 \cdot \vec{x}) + 2\beta\kappa_2 \cos(\vec{K}_2 \cdot \vec{x}), \qquad (2a)$$

where

$$\kappa_1 = \frac{\pi n_1}{\lambda} \qquad (2b)$$

and

$$\kappa_2 = \frac{\pi n_2}{\lambda}. \qquad (2c)$$

Where n1 and n2 are the refractive index modulations of grating one and grating two, respectively, and K1 and K2 are the grating vectors and k1 and k2 are their coupling coefficients.

Assume there are only three significant electric field components:

$$E = R(z)e^{-j\vec{\rho}_1\cdot\vec{r}} + S(z)e^{-j\vec{\sigma}\cdot\vec{r}} + T(z)e^{-j\vec{\rho}_2\cdot\vec{r}}. \qquad (3)$$

After defining direction cosines and dropping all derivatives of order greater than one (the slowly varying envelope approximation)...

crR' + jk1S = 0, (4a)
csS' + jk1R + jk2T = 0, (4b)
and ctT' + jk2S = 0. (4c)

Note that, from the above equations, it is evident that significant energy exchange occurs only between adjacent beams. Beam S can couple with R or T, but (under the current set of assumptions) R and T cannot interact with one another, except through S. Introducing two new symbols...

$$\alpha_1 = \frac{\kappa_1}{\sqrt{c_r c_s}} \qquad (5a)$$

$$\alpha_2 = \frac{\kappa_2}{\sqrt{c_t c_s}}. \qquad (5b)$$

The simplified coupled wave equations become:

$$R' + j\sqrt{\frac{c_s}{c_r}}\alpha_1 S = 0, \qquad (6a)$$

$$S' + j\sqrt{\frac{c_r}{c_s}}\alpha_1 R + j\sqrt{\frac{c_t}{c_s}}\alpha_2 T = 0, \qquad (6b)$$

$$T' + j\sqrt{\frac{c_s}{c_t}}\alpha_2 S = 0. \qquad (6c)$$

The general form of the solutions of these coupled wave equations is well known and may be expressed as follows:

$$R(z) = r_0 + r_1 e^{\gamma_1 z} + r_2 e^{\gamma_2 z}, \qquad (7a)$$

$$S(z) = s_0 + s_1 e^{\gamma_1 z} + s_2 e^{\gamma_2 z}, \quad \textbf{(7b)}$$

$$T(z) = t_0 + t_1 e^{\gamma_1 z} + t_2 e^{\gamma_2 z}. \quad \textbf{(7c)}$$

The constants ri , si , and ti , in eqs. (7a) – (7c) are dependent on the boundary conditions during read-out. The gi constants may be found by direct substitution of eqs.
(7a) – (7c) into eqs. (6a) – (6c), which yields:

$$\gamma_0 = 0, \quad \textbf{(8a)}$$

$$\gamma_1 = j\sqrt{\alpha_1^2 + \alpha_2^2}, \quad \textbf{(8b)}$$

$$\gamma_2 = -j\sqrt{\alpha_1^2 + \alpha_2^2} \quad . \quad \textbf{(8c)}$$

Case Studies:
Various inputs and combinations of inputs may be employed for use as READ beams, whether the read-out is via the reference wave, one or more of the signal waves, a combination of reference and signal wave, or all the waves that were originally used to write the grating. Expressions for the scattered electric field amplitudes are obtained for each case. From these, the normalized output fields, the intensities and the diffraction efficiency may be determined. Starting with the S beam, each of the beams is presented separately and individually to the input, and the resulting Bragg-matched diffracted orders due to that input are determined. Using this information, outputs due to any combination of inputs may be determined by using superposition to add individual effects - assuming a linear, lossless system. This implies an absorption coefficient of zero, i.e., a pure phase grating. Angular mismatch and wavelength detuning are also considered to be zero.

Case A: S beam illumination (Beam Splitter Mode)
In this case, the boundary conditions will be Rs(0) = Ts(0) = 0, Ss(0) = e j o , at the grating inputs. With the above boundary conditions, the field amplitudes may be shown to be:

$$S_S(z) = e^{j\phi_0} \cos(z\sqrt{\alpha_1^2 + \alpha_2^2}), \quad \textbf{(9a)}$$

$$R_S(z) = \frac{-j\sqrt{\dfrac{c_s}{c_r}}\, e^{j\phi_0}\, \alpha_1 \sin(z\sqrt{\alpha_1^2 + \alpha_2^2})}{\sqrt{\alpha_1^2 + \alpha_2^2}}, \quad \textbf{(9b)}$$

$$T_S(z) = \frac{-j\sqrt{\dfrac{c_s}{c_t}}\, e^{j\phi_0}\, \alpha_2 \sin(z\sqrt{\alpha_1^2 + \alpha_2^2})}{\sqrt{\alpha_1^2 + \alpha_2^2}}. \quad \textbf{(9c)}$$

The energy balance of the beam splitter mode is expressed as:

$$c_r RR^* + c_s SS^* + c_t TT^* = c_s. \quad \textbf{(10a)}$$

Which, after normalization becomes:

$$\tilde{R}\tilde{R}^* + \tilde{S}\tilde{S}^* + \tilde{T}\tilde{T}^* = 1, \quad \textbf{(10b)}$$

$$\tilde{R} = \sqrt{\frac{c_r}{c_s}}\, R, \quad \textbf{(11a)}$$

$$\tilde{S} = S, \quad \textbf{(11b)}$$

$$\tilde{T} = \sqrt{\frac{c_t}{c_s}}\, T. \quad \textbf{(11c)}$$

In Eq. 10a, since the intensity of each wave is multiplied by its direction cosine, this indicates that the coupling between the waves involves power flow in the z direction only. For a grating of thickness d, we next define two new variables, called the grating strengths. These are:

$$v_1 = \alpha_1 d, \quad \textbf{(12a)}$$

$$v_2 = \alpha_2 d. \quad \textbf{(12b)}$$

Using the abov e equations, the normalized field amplitudes at the output of the gratings may be written as:

$$\tilde{R}_S = \frac{-je^{j\phi_1} v_1 \sin\sqrt{v_1^2+v_2^2}}{\sqrt{v_1^2+v_2^2}}, \qquad (13a)$$

$$\tilde{T}_S = \frac{-je^{j\phi_0} v_2 \sin\sqrt{v_1^2+v_2^2}}{\sqrt{v_1^2+v_2^2}}, \qquad (13b)$$

$$\tilde{S}_S = e^{j\phi_0} \cos\sqrt{v_1^2+v_2^2}\,. \qquad (13c)$$

The scattering efficiency is given by:

$$\eta = (R_sR_s^* + T_sT_s^*)/(R_sR_s^* + S_sS_s^* + T_sT_s^*) = R_sR_s^* + T_sT_s^*, \qquad (14a)$$

which, after simplification yields :

$$\eta = \sin^2\sqrt{v_1^2+v_2^2}\,. \qquad (14b)$$

A plot of the beam irradiances at the grating output versus grating strength n1 = n2 = n) is shown in Fig. 3.

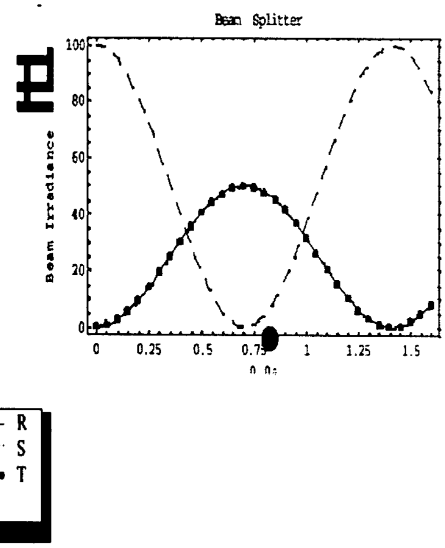


Fig. 3 :Relative beam irradiances for the beam splitter mode with equal grating strengths (n1 = n2 =n) and n0 = p / 2 (the grating strength required to yield 100% efficiency for a single exposure grating)..

In Fig. 3, it is evident that the sum of the three beam irradiances at any given grating strength is a constant, nearly equal to 100% of the input irradiance. When n/no is 0.707, the light is diffracted to each output (R & T) equally, and the efficiency is at a maximum. When n/no is equal to 0 or 1.414, the beam propagates through the grating relatively undiffracted as evidenced by the presence of nearly 100% of the irradiance in the S beam. The half-power points of all three beams (as compared to their individual maxima) occur at n/no □0.35 and at n/no □1.05.

Case B: R beam illumination (Cross-Coupled Mode).

Here, the boundary conditions are: SR(0) = TR(0) = 0, RR = e □f1 .

The field solutions now become:

$$R_R(z)=e^{j\phi_1}\cos(z\sqrt{\alpha_1^2+\alpha_2^2})+\frac{2e^{j\phi_1}\alpha_2^2\sin^2(\frac{1}{2}z\sqrt{\alpha_1^2+\alpha_2^2})}{\alpha_1^2+\alpha_2^2}, \qquad (15a)$$

$$S_R(z)=\frac{-j\sqrt{\frac{c_r}{c_s}}e^{j\phi_1}\alpha_1\sin(z\sqrt{\alpha_1^2+\alpha_2^2})}{\sqrt{\alpha_1^2+\alpha_2^2}}, \qquad (15b)$$

$$T_R(z)=\frac{-2\sqrt{\frac{c_r}{c_t}}e^{j\phi_1}\alpha_1\alpha_2\sin^2(\frac{1}{2}z\sqrt{\alpha_1^2+\alpha_2^2})}{\alpha_1^2+\alpha_2^2}. \qquad (15c)$$

The efficiency may be calculated in a manner similar to the first example.

$$\eta=(S_RS_R^*+T_RT_R^*)/(R_RR_R^*+S_RS_R^*+T_RT_R^*)=S_RS_R^*+T_RT_R^*, \qquad (16a)$$

which leads to

$$\eta=v_1^2\frac{2v_2^2\cos\sqrt{v_1^2+v_2^2}\left(1-\cos\sqrt{v_1^2+v_2^2}\right)+v_1^2\sin^2\sqrt{v_1^2+v_2^2}}{(v_1^2+v_2^2)^2} \qquad (16b)$$

Obviously, the expression above is more complicated than the corresponding result for the beam splitter mode. This is because, in the beam splitter mode, the S beam, which illuminates the grating, couples directly to both the R and T beams. In the cross-.coupled mode, however, the R beam couples to S directly, but couples to T only indirectly, through S. The variations in output intensity for all three beams are shown in Fig. 4.

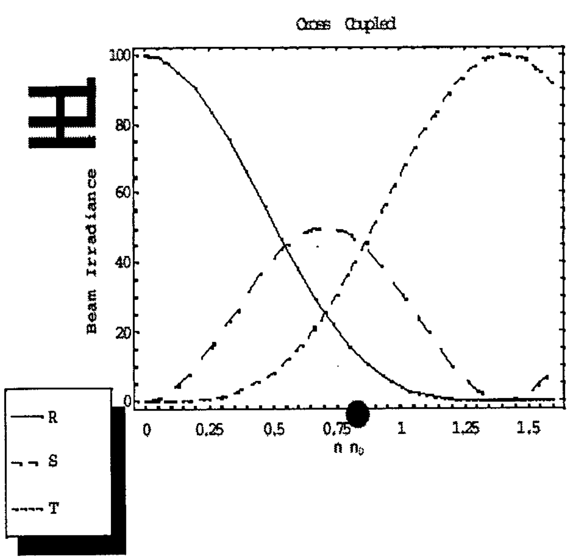


Fig. 4 : Relative beam irradiances for the cross-coupled mode with equal grating strengths(n1 = n2 =n), and n0 = p/ 2 (the grating strength required to yield 100% efficiency for a single exposure grating).

Note that, as in the beam-splitter mode, the sum of the three beam irradiances at any given grating strength is a constant, approximately equal to 100% of the input irradiance. When n/no is equal to 0, the beam propagates through the grating relatively undiffracted, but as the grating strength increases, the power in the R beam output decreases, since the grating is shuttling more power to the diffracted orders. The half- power point of the R beam occurs at n/no □0. 5 and that of the T beam at n/no □0.9. The S beam irradiance curve has two half power points, which occur at n/no □0. 35 and n/no □1.05, similar to the beam-splitter.

Case C: T-beam Illumination (Conjugate Cross-Coupled Mode) Here, the boundary conditions are:

ST(0) = RT(0) = 0, TT(0) = e □f2 ,

Through a method similar to that used above, the diffraction efficiency may be calculated as:

$$\eta=\frac{2v_1^2v_2^2\left[\frac{2v_1^2+v_2^2}{2v_1^2}\sin^2\sqrt{v_1^2+v_2^2}+\cos\sqrt{v_1^2+v_2^2}-1\right]}{(v_1^2+v_2^2)^2}. \qquad (17)$$

The intensity distributions of the three output beams are shown in Fig. 5.

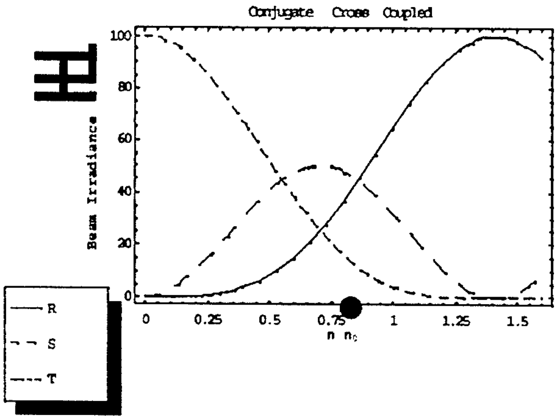


Figure 5 : Conjugate Cross-Coupled Mode Relative beam irradiances for the conjugate cross-coupled mode with equal grating strengths.n0 = p/ 2 (the grating strength required to yield 100% efficiency for a single exposure grating).

The S beam irradiance curve, as in case B, has two half power points, which occur at the now familiar points v/vo ≈ 0. 35 and v/vo ≈ 1.05. In fact, the S beam intensity distribution is identical to that of case B, while the R beam and the T beam have exchanged positions, as compared to the cross-coupled mode.

Case D: R and T beam Illumination (Beam Combiner 1)

The boundary conditions for this case are: $R_{RT}(0) = Ae^{j\Phi 1}$, $S_{RT}(0) = 0$, $T_{RT}(0) = Ce^{j\Phi 2}$.

The efficiency of the beam combiner measures how well R & T couple into S.

$$\eta = \frac{\left|v_1 e^{j\phi_1} + v_2 e^{j\phi_2}\right|^2}{(v_1^2 + v_2^2)} \sin^2(\sqrt{v_1^2 + v_2^2}). \qquad (18a)$$

Expanding Eq. 18a results in the following expression for the efficiency:

$$\eta = \sin\sqrt{v_1^2 + v_2^2} + \frac{2v_1 v_2 \sin^2\sqrt{v_1^2 + v_2^2}}{v_1^2 + v_2^2}\cos(\phi_1 - \phi_2). \qquad (18b)$$

The above equation is a relatively simple result, since it involves the R and T beams coupling directly into the S beam (the converse of the beam-splitter mode), which is their tendency, due to the way the gratings were written (the S beam being common to both interference patterns).

It is worth noting that the efficiency is no longer independent of phase. In all the preceding cases, the output of the grating was considered the result of a single input, thus the phase terms cancelled. In this and the following beam- combiner cases, each final output is defined as the sum of two or more singular outputs, which will result in the presence of phase terms, unless those phases are assumed to be equal.

The intensity distribution is shown in Fig. 6.

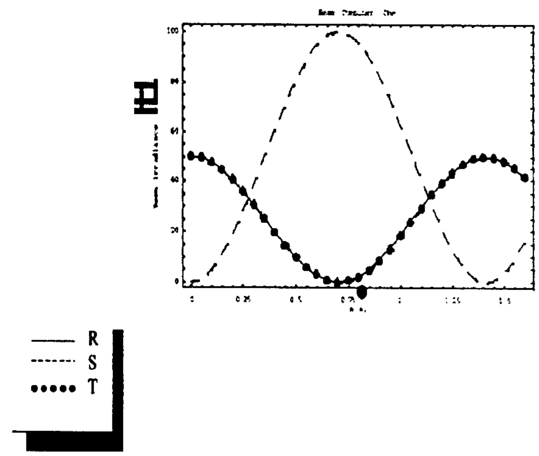


Fig. 6 : Relative beam irradiances for beam combiner 1 with equal phases (f1 = f2) and grating strengths (n1 = n1 = n). Also, n0 = p / 2.In Fig. 6, the sum of the three beam irradiances at any grating strength is a constant, nearly equal to 100% of the input irradiance. The intensity distributions of the R and T output beams lie perfectly one atop the other. When v/vo is 0.707, the light is diffracted almost completely into the S beam, and the efficiency is at a maximum. When v/vo is equal to 0 or 1.414, the beams propagate through the grating relatively undiffracted as evidenced by the presence of 50% of the irradiance in each beam. The half-power points of all three beams occur at v/vo □0.35 and at v/vo ≈ 1.05.

Case E: S and T beam Illumination (Beam Combiner 2) The boundary conditions for this case are: $R_{RT}(0) = 0$, $S_{RT}(0) = Be^{j\Phi 0}$, $TRT(0) = Ce^{j\Phi 2}$, and B = C = 0.707.

$$\eta=\frac{v_1^2\left[2v_2^2\sin^4\left(\frac{1}{2}\sqrt{v_1^2+v_2^2}\right)+(v_1^2+v_2^2)\sin^2\sqrt{v_1^2+v_2^2}\right]}{(v_1^2+v_2^2)^2}-\frac{4v_2v_1^2\sin^3\left(\frac{1}{2}\sqrt{v_1^2+v_2^2}\right)\cos\left(\frac{1}{2}\sqrt{v_1^2+v_2^2}\right)\sin(\phi_0-\phi_2)}{(v_1^2+v_2^2)^{3/2}}\quad (19)$$

The intensity distribution is shown in Fig. 7.

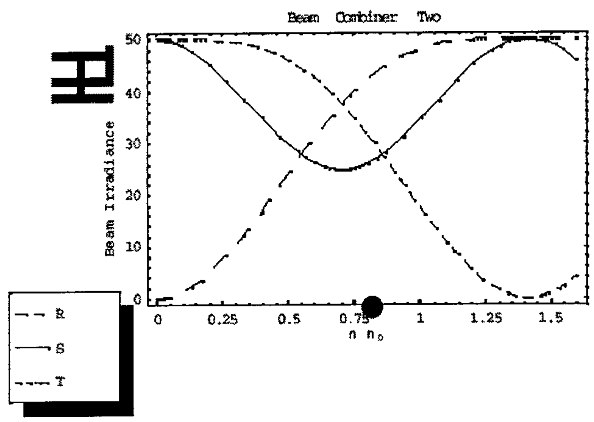


Fig. 7 : Relative beam irradiances for beam combiner 2 with equal phases (f0 = f2) and grating strengths.

Also, n0 = p/ 2.In Fig. 7, the sum of the three beam irradiances at any grating strength is nearly equal to 100% of the input irradiance. When v/vo is equal to 0, the power is divided evenly between the S beam and the T beam. Similarly, when v/vo is equal to 1.414, the power is divided evenly between the S beam and the R beam. This means that, when attempting to achieve a maximum power transfer into R, the S beam is unavoidably at a maximum as well. One can attempt to minimize the intensity of the S beam (by setting v/vo to 0.707), but that results in the remaining light being split between R and T. So the efficiency of this application can never be more than 50%. The half-power points of the R and T beams (as compared to their individual maxima) occur at v/vo ≈0. 5 and at v/vo ≈0.9, respectively, whereas the half-power point of the S beam output occurs at v/vo ≈0.707.

Case F: S and R beam Illumination (Beam Combiner 3)

Boundary Conditions: $R_{RT}(0) = Ae^{j\Phi 1}$, $S_{RT}(0) = Be^{j\Phi 0}$, $T_{RT}(0) = 0$, and A = B = 0.707.

The efficiency is given by:

$$\eta=\frac{v_2^2\left[2v_{12}^2\sin^4\left(\frac{1}{2}\sqrt{v_1^2+v_2^2}\right)+(v_1^2+v_2^2)\sin^2\sqrt{v_1^2+v_2^2}\right]}{(v_1^2+v_2^2)^2}-\frac{4v_2^2v_1\sin^3\left(\frac{1}{2}\sqrt{v_1^2+v_2^2}\right)\cos\left(\frac{1}{2}\sqrt{v_1^2+v_2^2}\right)\sin(\phi_0-\phi_2)}{(v_1^2+v_2^2)^{3/2}}\quad (20)$$

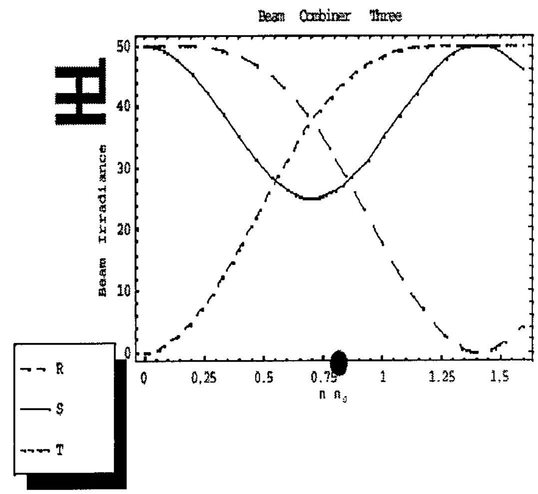


Fig. 8: Relative beam irradiances for beam combiner 3 with equal phases (f0 = f1) and grating strengths (n1 = n2) and n0 = p / 2 (the grating strength required to yield 100% efficiency).Fig. 8 is quite similar to Fig. 7. In fact, the S beam intensity distribution is identical that of case E, while the R and T beam's intensity distributions have exchanged their apparent positions. When v/vo is equal to 0, the power is divided evenly between the S beam and the R beam. When v/vo is equal to 1.414, the power is divided evenly between the S beam and the T beam. The half-power points of the T and R beams (as compared to their individual maxima) occur at v/vo ≈0. 5 and at v/vo ≈0.9, respectively, whereas the half-power point of the S beam output occurs at v/vo ≈0.707, which, as in case E, corresponds to the point at which the S beam's intensity is at a minimum.

Conclusion:

A technique for studying the characteristics of multiplexed holographic gratings was discussed. Specifically, the simplest case of two multiplexed gratings was considered.

These two gratings are each written separately using two beams, one of those two beams being common to both gratings. After the grating has been written, a READ beam or beams may be applied to the input of the grating. Upon read-out, the field amplitudes of both the scattered and unscattered beams were determined, as well as the energy distribution and the efficiency. Using the coupled wave equations, the field amplitudes of the beams anywhere within the grating and at the output were determined. The intensity of each beam may consequently be calculated. Knowing the input intensity, the efficiency was also determined, keeping in mind that the definition of efficiency in many of the cases considered is predicated on the desired function of the grating. The specific function may be that of a beam splitter, for the case of a single input or a beam combiner, when multiple inputs are present.

Multi-Agent Integrated Information Security System for Computer Networks: Architecture and Agent Interaction

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Abstract

This paper presents various aspects of the development of a network-distributed, integrated information security system, configured according to the principles of multi-agent technology. Within the multi-agent framework, the emphasis is placed on the description of architectures and functions of the basic information security agents responsible for particular tasks (intrusion detection, access control, identification and authentication, learning and adaptation to unknown intruder), and meta-agents operating on the host and network levels. Some principle issues of establishing interaction of agents and meta-agents, resulting in agent coordination and cooperative behavior, are described. A review and analysis of modern research efforts and projects in the area of network security assurance, including the efforts and directions of research of the authors, is given.

Keywords: *information security, multi-agent system, architecture, intelligent agent, learning, intrusion detection, access control, authentication*

1. Introduction

Security assurance of the resident information and software of computer networks is one of the crucial problems of modern information technology. The importance of this problem is justified by the ever-increasing value of information, and by potentially devastating consequences of successful attacks on the integrity, confidentiality, and access to facilities and resources of a network, especially in global networks participating in real-time control operations. This problem is highly complex due to the growing size and interconnectivity of a network, high number of users, increasing number of vulnerable targets within the network (communication protocols, operating systems, servers, databases, etc.), and appearance of new types of highly creative, effective, and previously unknown types of attacks.

The information security problem has been in the focus of attention of specialists since the first computer networks were introduced. Presently, it is addressed on the level of hardware and software by development of multi-level systems performing identification, authentication, access control, information encryption, detection of particular types of attacks and damage control [5, 8, 42]. These functions are performed on the software level by independently operating intrusion detection, access control and authentication subsystems, effective against previously known, catalogued types of attacks.

This approach, however, becomes inefficient for modern computer networks whose host computers perform millions of interconnections on a daily basis, interacting with numerous different servers, and are subjected to hundreds of various types of attacks. This approach requires formation of gigantic, partially duplicated, databases and consumes excessive amount of network resources, causing inflexibility of software and hardware facilities of the network. In addition, it does not provide any protection from the distributed attacks and cannot adapt to new types of attacks thus leaving unprotected many entry points of future attacks.

Modern view on the information security problem is that particular protective mechanisms and corresponding software must be integrated within a global system, and distributed between the hosts of the network. The specialized components of such an information security system (ISS) must interact via message exchange to make decisions coordinated within each host and within entire network. They must be able to adapt to the reconfiguration of software and hardware of computer network, to traffic variations within the network, and to learn unknown types of intrusions [3, 9, 15, 16, 26, 35, 36, 37, 40, 45]. One of the most constructive and promising implementations of such ISS is the utilization of the intelligent multi-agent technology. However, most authors apply this technology only to the intrusion detection task and limit the capabilities of particular agents ([13], [22], [24], [37], [40], [45])[1].

In this paper, an integrated ISS is considered. Its architecture is designed on the basis of multi-agent system model [15, 16]. It is supposed that an ISS consists of the multitude of specialized intelligent agents that are distributed over the entire computer network. Each agent performs its own specific task that actually is a component of the entire defense task of ISS. When performing a general defense task, specialized agents interact and cooperate via message exchange initializing each other's resources.

The rest of the paper is organized as follows. In *Section 2*, an outline of the developed architecture of a *Multi-agent Information Security System* is given. *Sections 3*, *4* and *5* present the description of the functions, models and architectures of *Intrusion Detection Agents (IDA)*, *Access Control Agents (ACA)* and *Identification and Authentication Agents (IAA)*.

In *Section 6* the goals and functions of the *host-based meta-agents* and network-based *meta-agent* are specified. The main ontology-based principles of ISS agent interaction and cooperation as well as the distributed knowledge sharing are presented in *Section 7*. *Section 8* describes general principles accepted for the architecture and functions of an *Agent-Based Learning Subsystem (LS)* and *Learning Agents (LA)* that constitute it. The LA represent learning functions of IDA resulting in the ability to distinguish "self" from "non-self" thus detecting known and unknown intruders. *Section 9* presents a short overview of the existing research relevant to the paper scope. *Conclusion o*utlines the paper results and suggests directions of the future efforts.

2. Generalized architecture of multi-agent information security system

A multi-agent ISS is represented as a cooperative community of agents, distributed on the hosts of the network. The agents of the following types are considered (Fig.1) [15, 16]:

(1) *intrusion detection agents* performing their tasks on the basis of available information about normal functioning processes, typical user profiles, possible anomalies, unauthorized access channels and probable scripts of attacks;

(2) *access control agents* providing access to the information and software resources to the appropriate users on the basis of *discretionary access control rules (ACR)*, specifying to each «subject – object» combination the allowed types of operations (read, write, create, etc.). The information flows of various confidentiality levels are supervised by these agents by the realization of *mandatory ACR* preventing unauthorized access to confidential information;

(3) *identification and authentication agents* responsible for the identification of sources of information and confirmation of their authenticity. These agents maintain the conformity between the implemented functional processes and the subjects initiated

[1] See short overview of the related works in *Section 9*.

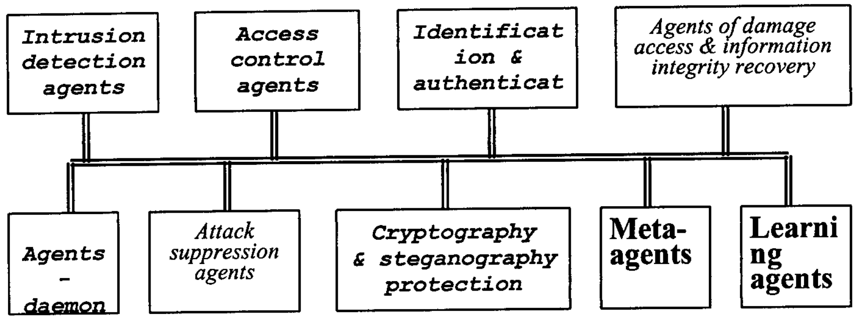

Fig.1. ISS Structure

by these processes;
(4) *attack suppression agents* responsible for «prosecution» and neutralization of the attacking programs (viruses/intruders);
(5) *damage control agents* responsible for assessing the inflicted damage and information recovery;
(6) *cryptography and steganography agents* responsible for the safety (leak-proofing) of the communication channels between the network nodes (hosts, servers);
(7) *learning agents* responsible for the adaptation (learning) of particular ISS agents to computer network reconfiguration and new types of attacks;
(8) *meta-agents* managing information security processes, that results in the coordinated and cooperated behavior of the individual agents and assures the required level of general security according to a global criteria;
(9) *agents-daemons (perception agents or sensors)*, intended for monitoring and preprocessing traffic information within the network.

Let us describe a *common model of an agent-based ISS* functioning as an integrated community of agents, distributed on a set of hosts of a computer network. It is supposed that any *component of a multi-agent ISS architecture, associated with a host*, can consist of one or several copies of the agents of each type. Agents-daemons monitor the information traffic, and analyze its elementary components. For example, each agent-daemon could be attached to a particular input port (protocol). These agents play a role of sensor controls for the multi-agent ISS. The information from daemons transfers to one of the security agents, which handles this information and engages other agents (either directly or through a meta-agent). All agents can exchange messages.

It is supposed that standard (reference) copies of all information and software components (ISC) of a protected information system are available to each host, and the standard configuration of hardware is established. At the initial boot-up, application loading, and during a restoration of damaged information, the *identification and authentication agents* authorize loading only the reference copies of ISC. A user's access to the system is authorized, if and only if the user is registered in the system with the appropriate requisites (rights) *(ID, password* and etc.). The list of allowable resources and the access priority are established for each user according to his/her authority. The access control agents carry out the granting of resources by the realization of *discretionary ACR*. In addition, access control agents supervise the flows of information by the realization of the mandatory ACR reflecting appropriate levels of confidentiality. Individual access control agents cooperate with the purpose of maintaining the conformity with discretionary and mandatory ACR on various hosts.

The *identification and authentication agents* maintain the conformity between functional processes realized and subjects initiated by these processes. While receiving a message from a functional process, these agents determine the identifier of the subject for this process, confirm the identifier and transfer it to access control agents for the application of discretionary ACR.

The *cryptography and steganography protection agents* (CSPA) assure the safe information exchange between the computer network nodes via channels, multiplexed by the authentication agents. In addition, CSPA provide their services to the authentication agents, according to their queries. The *intrusion detection agents* (IDA) monitor all operations within the network. As a result of processing messages formed in the network, IDA can interrupt information processes, inform the security manager, and specify the discretionary ACR. IDA use available audit data for learning via special *learning agents*. IDA cooperate with the *attack suppression agents*, and also with the *agents of damage control and information recovery*. Also, IDA can generate reports to the security manager on the behavior of subjects of the protected information system.

The *meta-agents* carry out the management of information security processes including the **action coordination of particular agents and resolution of conflicts between them.**

3. Intrusion detection agents

According to the generally accepted classification, all intrusion detection tasks may be divided into two groups, i.e. (1)anomaly detection and (2) misuse detection. The former task, for example, may include detection of behavior deviation of a user, accessing the server, from a statistically established "user profile" that could reveal an intrusion. One more example of such a task is the analysis of the network connections or sequences of system calls that could be rated as «normal» or «abnormal» (or "self" or "non-self" in terms of "computer immunology" [13]). Unlike anomaly detection, a misuse detection task implies the identification of the intrusion type. Both tasks are implemented by a number of host-based Intrusion Detection Systems (IDS) of an ISS.

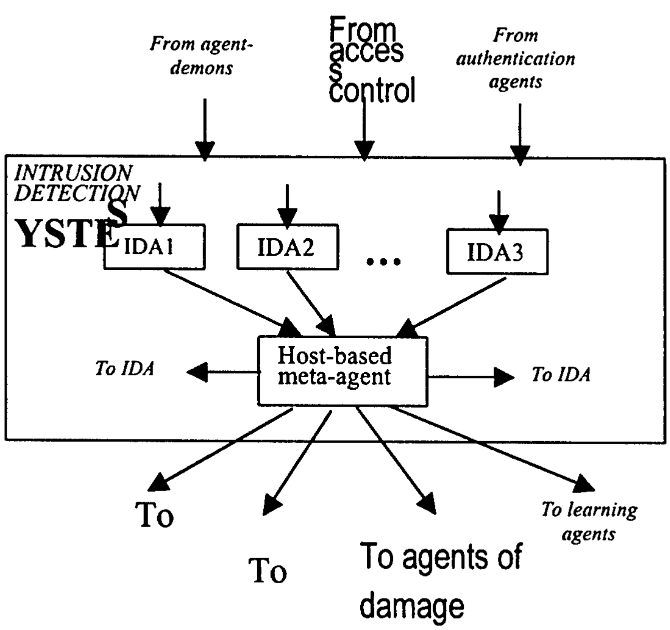

Fig.2. Architecture and interactions of the host-based IDS

Host-based IDS architecture (see Fig.2) comprises a number of the specialized IDA and the meta-agent that, acting in cooperation, perform the intrusion detection task. In addition, host-based IDS are responsible for the search of *unprotected entry points* ("penetration" points) of the host resulting from either unintended or deliberately injected software/ hardware «bugs». One more task of host-based IDS is the monitoring of connections and system calls and gathering of pre-processed statistical data associated with different subjects and objects of the host.

Each IDA of a host-based IDS performs the intrusion detection task within its host, and participates in the detection of the attacks on the entire network within its area of competency. Each IDA makes decisions on the basis of information received from agent-daemons associated with respective entry points (protocol, operating system, software, etc.), the host-based meta-agent and/or received from ACA and IAA. As soon as an IDA detects a suspicious behavior or intrusion at its respective entry point, it forwards an appiopriate message to the host-based meta-agent.

Let us consider an IDA architecture depicted in the Fig.3. The knowledge base and database form the area of the IDA competence and contain models of intruders and other models and information facilitating the intrusion detection within the area of the IDA responsibility, see [11, 20, 21, 28, 32, 40]. An important component of an IDA is an inference engine that performs the classification of the input connections of the host and/or system call as "normal" or "abnormal». Inference engines utilize binary decision trees, like the one of Fig.4, in the following fashion.

Consider an IDA having index *i*, *i=1,2,...,I*, responsible for the detection of attack types that constitute the multitude $\aleph(i)$. Assume $\aleph(i)=\{a1,a4,a7,a14,a15,u\}$, where *a1, a4,...,a15* are the identifiers of «known» intruders and symbol *u* corresponds to an *"unknown"* intruder. Let us map $\aleph(i)$ to the root node of the decision tree of the IDA. Each node of the IDA decision tree is mapped

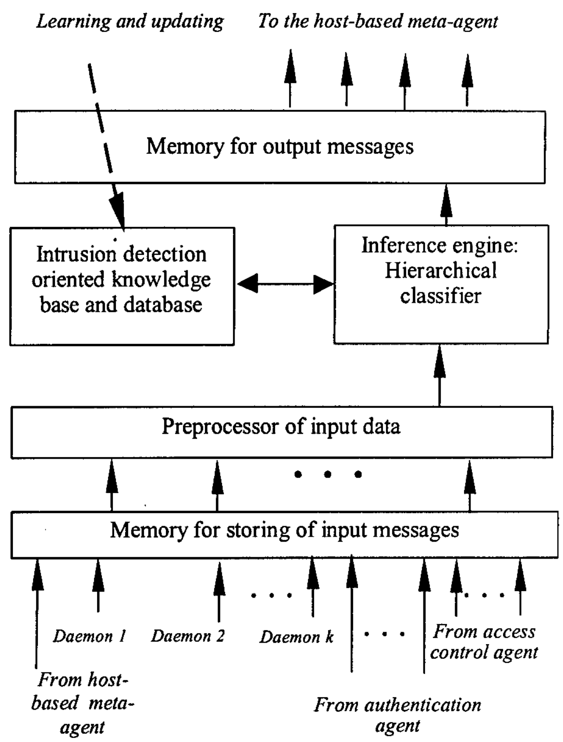

Fig.3. IDA architecture.

by a subset of $\aleph(i,k) \subseteq \aleph(i)$, where *k* is the index of the decision tree node. Therefore, the IDA decision tree constitutes a partially ordered family subset of the set of intruders $\aleph(i)$ corresponding to the IDA area of responsibility.

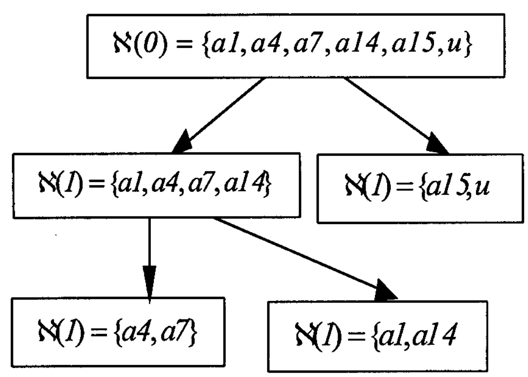

Fig.4. An example of binary decision tree of IDA; *{an}*- type of attacks, *u–"unknown"*

The decision-making procedure corresponds to the step-by-step moving from one node of the decision tree to another to a leaf. Each step of this procedure corresponds to an alternative choice of the subset of intruders (attacks). The choice is made through the inference in the local knowledge base attached to the current node of the decision tree. It should be noted that each local knowledge base is created and updated by an agent-based learning system of the ISS, considered below in *Section 8*. Hence, the knowledge base of each IDA is a tree-ordered set of local knowledge bases. Recall that set $\aleph(i)$ contains an *"unknown"* value that corresponds to the case when inference mechanism of IDA is not able to detect the identifier of an intruder (or the type of attack). The advantages of such structuring of an IDA knowledge base are well known: one *"heavy"* procedure of inference is replaced by a number of *"light"* ones and one "heavy" knowledge base is replaced by a number of "light" ones. In addition, upgrading of such a knowledge base by learning allows for even a much more simple procedure. Output information (decisions) of each IDA is forwarded to the host-based meta-agent responsible for the final decision that determines the consequent behavior and communications with other components of multi-agent ISS.

The entire multitude of the IDA knowledge bases and the knowledge base of its meta-agent form a distributed knowledge base of the Intrusion Detection System of a host.

It is supposed that within the described architecture of multi-agent ISS, an IDS is installed in a fashion that that involves an agent-based learning system to assist in the development of IDS local knowledge bases. If the network is reconfigured by introduction of a new host, its IDS is extended by cloning of the needed agents according to the operating system and protocols (servers) installed on this host. In this case, the learning subsystem of the ISS has to assist in generating the host-based IDS software.

We emphasize that the distributed knowledge base of an ISS is structured according to the part of the ontology of the "computer network security" subject domain that represents the ontology of the domain "types of attacks and defense against them" [15, 16].

4. Access control agents

The *access control agents (ACA)* carry out two basic functions [25, 44]: (1) operate the flows of information with various degrees of confidentiality not allowing the «leaks» of sensitive information through unauthorized access channels; (2) provide user access to information resources in strict conformity with their functional role. The first function is implemented by means of mandatory ACR, and the second one – by discretionary ACR. Therefore, models of a mandatory and discretionary ACR implementation, serving as the basis of the ACA design, should be defined. A *model of mandatory ACR* represents the correspondence between the actual degree of information confidentiality and its internal utilization within the protected information system, and defines the procedures of a mandatory ACR implementation. A *model of discretionary ACR* defines the subjects and objects of discretionary ACR, establishes the relations between various ACR of different depths, and allows deducing a new rule from the existing ones.

Let us describe a *model of a mandatory ACR realization by ACA*. Mandatory ACR are described in terms of the subjects, objects, and hierarchical categories corresponding to a level of clearance of the subject, to the confidentiality level of information in the object, and to the write and read operations [10, 25, 39, 42, 46, 48] as follows:

(a) a subject can read an object, if the hierarchical category of the subject is not less than the classification level of the object;

(b) a subject can write in an object, if the hierarchical category of the subject is not greater, than the classification level of the object.

During the implementation of mandatory ACR, the operation within the protected information system constitutes a set of processes and a set of channels for message exchange. Thus the process-source is considered as the subject, and process-receiver - as the object. To each process, a particular classification level is assigned. This level is understood as a number unambiguously representing the degree of confidentiality at which this process operates. However, because of the following reasons it is impossible to implement such a process interaction when information flow is allowed only from processes of the lowest levels to higher levels and between processes of the same level:

(1) the opportunity to process information of various degrees of confidentiality should be given to each legal user;
(2) the implementation of some functional processes requires that information flows be independent of the levels of confidentiality;
(3) processes of various confidentiality levels may share the same resources.

This inconsistency is removed by the introduction of (fictitious) *trusted processes*, within which information processing of various degrees of confidentiality and creation of information flows in all directions regardless information levels is allowed. Thus, it is possible to propose a model of operation of the information system realizing mandatory ACR by traditional and trusted processes. The ISC development for the trusted processes requires the additional specification and verification work [25, 42]. The hardware and software, realizing trusted processes, should be isolated from remaining ISC as well as ISS components. Therefore, the trusted processes could be viewed as an accessory of the information security process, in spite of the fact that they carry some functional operations. The level corresponding to the highest degree of information confidentiality available to a process is assigned to the trusted process that specifies the confidentiality level of particular messages. Such an approach prevents information flow between usual processes of various levels, that is known to be a common reason of the information confidentiality violations [10, 38], and allows for the multiplexing information flows of various levels through the trusted processes.

Let us describe a *model of discretionary ACR realization by ACA*. First consider the functional processes in the protected information system by the use of subjects. The subjects are determined by active elements (users, tasks, software and hardware components). Subjects are associated with objects (all sorts of resources) and with the messages between the subjects and objects, such as corresponding users' inquiries, calls from application processes to system processes, users' calls to servers, etc. Each subject is viewed as a generator of the messages directed through both the allowed and the unauthorized access channels. A subject has the local object, represented by a data repository and methods of data processing. The subject's choice of the channel for a message transfer depends on the state of its local object.

The message receiver could be an object or a subject. If the message receiver is a subject then the actual receiver is a local object of a subject. If the message receiver is an object, then this object itself becomes a subject and generates requests for processing the obtained message (for example, a user request for an application can initialize a set of processes on hosts and servers). The messages received by objects, as well as the messages transmitted by subjects, could be directed through both the allowed and the unauthorized access channels. All system objects encapsulate data and methods of message processing, and fall under the concept of object of the object-oriented approach. The user perceives the application menu as an object, sees the menu options as methods of the object, and dispatches the messages, initializing methods of the object by making selections via the menu.

For each subject, discretionary ACR determine the allowed channels by using the attributes specifying classes of the receivers and classes of the message types. The receivers-subjects are marked by the identifiers of their local objects. Discretionary ACR operate in the fashion determined by the last channel and the object (i.e. the message receiver that is not a subject). For the objects, that initiate the subjects, discretionary ACR define the allowed classes and the sequences of channels. For example, messages intended only for text files can initiate text processing applications. For a program, the allowed sequence of the chosen channels reflects the program specification; for a user, it reflects the requested operation procedure.

In the process of subject initiation, discretionary ACR are used to generate a detailed message consistent with the channel obtained by the subject's local object. For example, messages directed at one class of files initiate the text processing application corresponding to this task, while messages directed at another class of files reflect another task. Since the choice of the message generation channel is made only on the basis of the state of the subject's local object, any *unauthorized access to information* is treated as a mismatch between the real state of the local object and the state that is predefined by discretionary ACR. An example of such a mismatch is an occurrence of logical conditions permitting execution of a prohibited sequence of operators.

Discretionary ACR can be determined as a set of rules defining discretionary ACR for the specific subjects and objects and their classes. This allows to deduce some rules and to establish a correspondence between the ACR of various depths. Traditionally, discretionary ACR are realized on the basis of access matrixes, subjects' token profiles, objects access lists or as a combination of these methods. The ACR implementation is possible also by the assignment of access categories to the subjects and objects. These categories allow to establish the token profiles and the access lists.

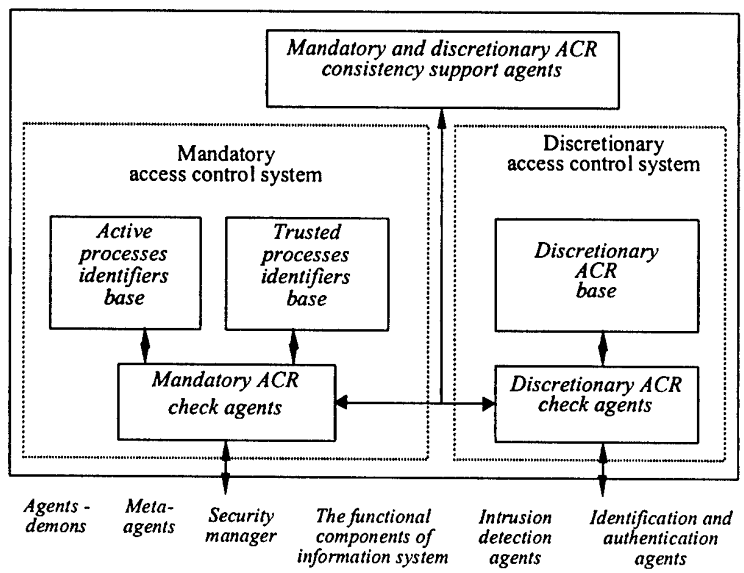

Fig.5. Architecture of Access Control Subsystem

An access control subsystem of an ISS (Fig.5) consists of mandatory and discretionary access control subsystems, including the mandatory and discretionary ACR check agents, and the mandatory and discretionary ACR consistency support agents. The *mandatory ACR check agents* assure the conformity of significant events (such as process initiation, completion of processes, and message transfer) with mandatory ACR. The check is based on the internal representation of the information processes as the *trusted and active process identifier bases*, whose logical structure represents a matrix of correspondence between the process identifier and the process level. The *discretionary ACR check agents* inspect the correspondence of the messages from subjects to objects on the basis of the *discretionary ACR base.* The base represents multilevel data structure. The rules of the specific depth of the access control correspond to each level of this structure. The *mandatory and discretionary ACR consistency support agents* inspect every mismatch between discretionary and mandatory ACR each time discretionary ACR are introduced by the security manager.

5. Identification and authentication agents

The *identification and authentication agents (IAA)*, as well as the mandatory access control agents, consider the protected information system as processes, channels and messages, but for quite different purposes. IAA should provide correspondence between an internal representation of information in the discretionary access control subsystem and in the intrusion detection subsystem. In other words, IAA enforce the correspondence between the functional components of the information system (its subjects and objects) and actual processes of information transmission and processing.

IAA are created on the basis of the following *authentication model*. For the authentication, the services provided by the cryptography protection agents include: calculation of hash functions and implementation of the asymmetric cryptography channel. The *hash function* allows for generation of the message authentication code (MAC), which is unique for each message. *The asymmetric cryptography channel* assumes that the message source has couple of keys: a private key known only to a source, and an open key known to all receivers. An open key can decrypt the message enciphered by a private key. Let us consider the *generalized algorithm of authentication of the message source and receiver* [1, 14, 25, and 47] used in IAA.

1. Source authentication (operation of source agents) includes: (a) calculation of the MAC of the transmitted message; (b) calculation of the message digital signature by encoding the calculated MAC on the basis of the private key of the source; (c) transferring the message and its digital signature.

2. Receiver authentication (operation of receiver agents): (a) calculation of the MAC of the message; (b) obtaining the MAC calculated by a source agents on the basis of the digital signature decryption and the source open key; (c) matching the codes and making a decision on the source authenticity and the identity of the obtained message.

For the contamination protection of the messages this algorithm is supplemented by the transmission of a time mark or the inquiry-answer procedure containing a random number generated by the receiver agents that is sent back to source agents and returned in the message. This algorithm is used for assignment of safe channels to the functional processes and also for the definition of the subjects-principals (to which discretionary ACR should be applied) for each process. The principals are the *carriers of the responsibility (CR)* for realizable functional processes. A set of CR could exist for one process, and one CR could be responsible for a set of processes. For example, for a text editing process, the list of CR includes the users inputting the editor commands, the editor application interpreting these commands, the operating system loading the editor application and processing system calls. The set of processes on various hosts could reflect the interests of one user, which is a CR for all these processes. A CR for each process is defined by the mapping of executable functional processes on the set of CR by authentication of the subjects (including users) and authentication of the messages.

The *subject authentication* implies that IAA (before initialization of the process by the subject) provide a conclusion that the subject is a CR. The right of process implementation is given to the subject in the case of a positive result of authentication. The authentication function is included in the processes of initial boot-up, loading of programs, and each user entry in the system. At the initial boot-up, the correspondence of the configuration of all hosts and servers to the one that is set for the operation implementation is checked. Thus the authentication data is formed. This data consists of the description of the system hardware configuration, MAC of the operating system and standard applications. The *verification of users' authenticity* can be accomplished by the use of smarts-cards [1] by the similar scheme (as a smart card contains in the memory a user's private key and personal identifier and has the processor for asymmetric encoding).

At subjects' authentication, besides establishment of the correspondence of the subject to CR, the authority transmission of one CR to another is implemented. When the user «authenticates himself» at a host, he in fact delegates to a host the right to generate messages on his behalf. The sequence of subsystems of the information system can be involved in the process of processing messages from the user, each of which delegates to the subsequent system the right to operate on user's behalf, spreading the authority to represent an original message source. If a subject can be authentified repeatedly at such delegation of authority, the authentication results are saved as certificates for future interactions. These certificates attest the right of one CR to represent others. For example, a repeated successful authentication of a user accessing the server allows for avoiding authentication. Instead, the host «shows» the certificate «signed» by a smart card at an entrance of the user in the system, proving that the host can appear as a representative of the user. Such a certificate could be given to each active functional process.

The presence of a process certificate results in a confirmation of the right of this process to perform operations on behalf of the CR, described in the certificate.

The *message authentication* includes not only the detection of the immediate message source but also the restoring the entire chain of CR, responsible for the message generation. For each couple of interacting processes implemented at various hosts, the «process – process» channel is created by multiplexing the channels between hosts. Thus for the obtained message, the identifier of the process generated this message is determined. Then, the CR names representing the process are selected from the process certificates.

The *identification and authentication subsystem* (Fig.6) consists of a set of IAA. The *agents of loading* permit initiation of the functional processes from the preset software components. The *certificate creation agents* form the certificate for each process using the *base of certificates*.

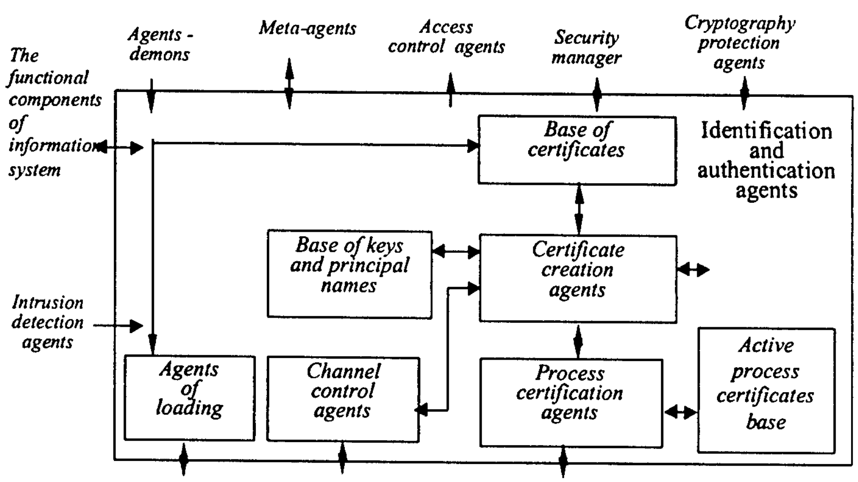

Fig.6. Architecture of Identification and Authentication Subsystem

The *process certification agents* write the process certificate in the *active process certificates base*. At each process to process call, the certification agent determines the responsible principals' names, using the certificate of the process, and transmits these names to discretionary access control agents.

The principals in a authentication subsystem are represented by an open key from a couple of keys of asymmetric encoding. The *database of keys and principal names* is used for the verification of the correspondence between the key and the logical name of the principal. The authentication agents cooperate by exchange of process certificates. If a process transfers the message to a process on another host, then the authentication agent of the other host inquires about the message certificate for the source verification. For messaging between processes of various hosts, the *channel control agents* create the «process-process» channels by multiplexing the cryptography channel between the hosts.

6. Host-based meta-agents

When necessary, the behavior of host-based IDA is coordinated by the host-based meta-agent. Interaction and cooperation within the entire network is achieved within the community of host-based meta-agents, learning agents and the network-based meta-agent. The last interaction and cooperation is necessary for the detection and elimination of network attacks. Therefore, the management of the host-based IDA behavior, participation in the detection of network attacks and management of the host-based IDA learning and reconfiguring are the basic functions of the host-based meta-agent. All interactions are realized in the message exchange mode. Output messages of the host-based meta-agent are self-initiated or are responses to input messages. The latter may be generated by the host or the network administrator, as well as by the host-based IDA, ACA, IAA, learning agents and the network-based meta-agent. Let us list the main input messages to a host-based meta-agent that initiate its performance.

1. Messages about detected and/or identified *intrusions outside* of the network or about *suspicious operations* of users *inside* one - originated from the host-based IDA, ACA and IAA.

2. Messages about an *intruder of unknown type* – originated from host-based IDA.

3. Messages that proceed from attack suppression agent: about result of *anti-intruder operation*.

4. Messages about *intrusions or suspicious operations* at the network inputs or

5. inside the network – originated from the network-based meta-agent.

Messages about *updating* the knowledge base of an IDA, *generation* of new IDA or about *reconfiguration* of the host-based IDS – originated from learning agents. The major output messages of a host-based meta-agent are the following responses to the above input messages:

- In response to message 1: Intrusion detection data processing and initialization of the respective scenario of computation and interaction, i.e. *1.* Task specification of the attack suppression agents to *eliminate the intruder*; it should contain information about the intruder: for example, number of the port, protocol, system calls sequence, names of directories and damaged files, etc.

2. Task specification of the *damage assess and information integrity recovery agents:* names of directories and damaged files.

3. Forwarding the intrusion related *information to the network-based meta-agent.*

- *In response to message 2:*

4. Task specification of the agent-based *Learning Subsystem*: registration of the new type of attack, updating the knowledge base of the respective IDA or generation of a new agent and reconfiguration of the host-based IDS.

- *In response to message 4 :*

5.Queries to the host-based IDA for the audit data, for the decision on possible presence of intrusion . In response to message 5:

6. Insertion of a new IDA and recon figuration of the host-based IDS. Thus, while coordinating activity of a host-based ISS, the meta-agent must manage all inner processes of interactions and operations. It must provide a flexible distribution of security-related operations among agents, for example, among ACA and IAA to provide the needed level of probability of perfect decision under constrained resources of the network. In particular, it must minimize resources needed to detect access control violations, for example, via the increase of the level of access control for less time-consuming functional processes.

7. Common knowledge of ISS agents

In order to perform the global task of information security in a distributed and cooperative fashion, agents of a multi-agent ISS to must communicate by message exchange. Message exchange surmises that agents are able in some sense to "understand" each other. Mutual agent understanding implies that each agent

(1) «knows» the agent(s) that should be addressed to request help, if his functionality and/or information are not sufficient for dealing with a problem within his scope of responsibility,

(2) «knows» the agent(s) to whom the result of the performed task must be directed, and

(3)agent's messages must be represented in a form and in terms that are understood to addressees.

These aspects as are summarized as the presence of a *common context* or *divided knowledge* in a multi-agent system. Note that these requirements are typical for any distributed knowledge base of a multi-agent system, in which each agent has the knowledge not only about itself but also about the knowledge of other agents and the models of their operation (that is a common requirement to multi-agent systems in which the agents cooperate for solving mutual problems).

One of the most promising approaches to model the distributed agents' knowledge, beliefs and common ground of multi-agent-system as a whole is the utilization of domain *ontology* [18, 19]. The ontology characterizes domain knowledge, disregarding particular structures of knowledge representation, inference algorithms or heuristics, i.e. the factors introduced at the problem formalization and program implementation. Like any other domain, ontology of the information security domain is a description of the partially ordered concepts of this domain and the relationships over these concepts, which should be used by the appropriate security agents.

Except for the partial order-type relationships, subject domain relationships obtained as a result of the domain investigation by the experts, are superimposed on the nodes of this structure. These are various sort limitations, rules, and quantitative and qualitative relations, linking concepts of information security. This ontology determines a subset of concepts, which are used by various ISS agents for cooperative solution of the set of problems without the necessity of using the whole subject domain ontology by each agent. A part of the developed fragments of the information security domain ontology is depicted in Fig.7. It is a part of the ontology that is associated with tasks of IDA, ACA and IAA.

The specialisation of ISS agent is reflected by a subset of nodes of the ontology that represents the knowledge of the respective agent. Some nodes of the ontology can be common for more than one agent. Usually, only one of these agents has the detailed description of the node. This agent is the «owner» of the appropriate component of knowledge base. At the same time, there is a part of an ontological knowledge base that is common for all agents, including the meta-agent. This part of knowledge plays the role of a common context, i.e. the common knowledge of the multi-agent ISS.

8. Learning and meta-learning

Agent-based Learning System assures the learning ability and adaptability of an ISS which are its most critical features. The learning ability is the ability of an ISS to use its experience (for example, audit data) for off-line and on-line learning for detecting an intrusion at an entry point of a network. The adaptability of an ISS is its ability to detect attacks of unknown type and to learn to identify and distinguish them from other types of unknown attacks.

IDS learning is a relatively new and very difficult task within the intrusion detection scope. This task is being researched during several last years [6, 29, 30, and 31]. Elsewhere accepted opinion is that mining of audit data is the only way to learn to detect intrusions. Audit data is perceived by agent-daemons at the input of each protocol in real-

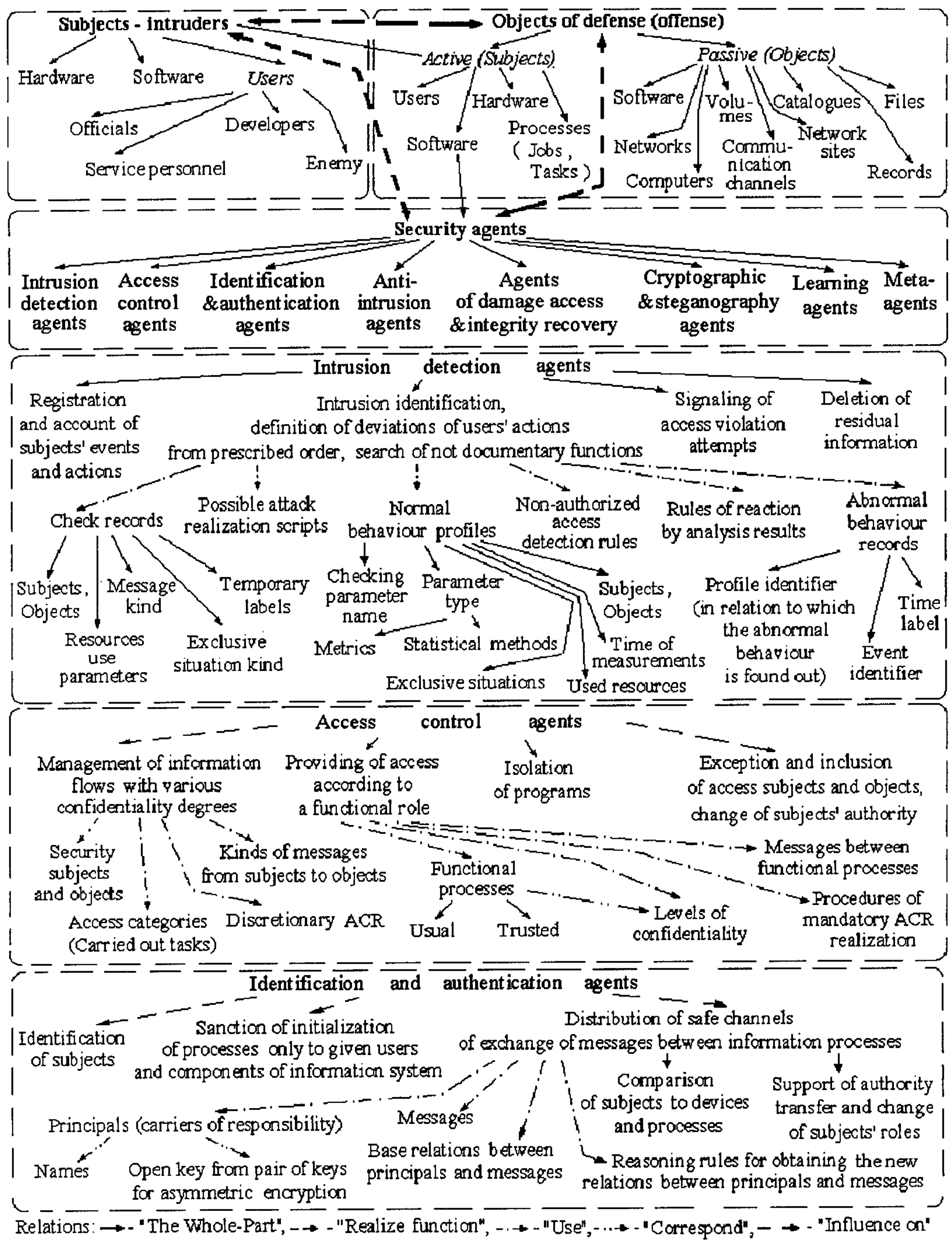

Fig.7. Fragment of the top level ontology of information security domain

time and gathered in the audit database. As a rule, audit data may be preprocessed in such a way that each record is represented as a sequence of time-stamped symbols of arbitrary length. Each symbol is a code of some operation (at the level of network protocol, say, TCP/IP protocol, at the level of system calls of the operation system or a server, etc.). Some metrics of audit data may be real-valued, for example, "duration of an action".

Data Mining and Knowledge Discovery from Data (KDD) techniques make available a fruitful mathematical basis to solve the tasks of learning to detect intrusions [2, 7, 29, 30, 31, 33, 34]. It is well known that audit data possess specific properties that restrict the efficiency and applicability of Data Mining and KDD algorithms for intrusion detection learning. Existing research, experience and numerical experiments indicate that intrusion detection learning is supported by the classes of algorithms listed below [30]:

- *Classification*: it converts each record of the audit data into a category of a predefined class ("normal", "abnormal", "category of attacks", "unknown", etc.). These algorithms define a classifier in the form of *rules* and *decision tree*, possibly, with assigned a measure of uncertainty [7, 17]. The classifier is constructed via a learning algorithm applied to a sufficient number of gathered and interpreted (for example, as "normal" and "abnormal") audit records.
- *Link analysis:* it aims at finding relationships between fields in the audit database records. These relations form a basis allowing for the specification of user profiles in terms of *association rules* [2].
- *Sequence analysis:* it is used to develop a model of time-based sequential event patterns that frequently occur together. The basis of sequential analysis is the search of frequent episodes [33, 34].

A learning technology applicable to intrusion detection is formed as a combination of the above algorithms. The *general scheme of the commonly accepted learning technology* is relatively standard. *First*, the link and sequence analyses are used for the extraction of useful patterns (association rules and frequent episodes) from preprocessed audit data. *Then*, on the basis of these patterns a rule-based classification algorithm is formulated. Because of the specifics of audit data, the first step does not have a standard implementation technique within the intrusion detection task and all known approaches need to be considered. In contrast, the last task could be solved by implementing a standard tool. Within the JAM Project [29, 30, and 31] for these purpose the RIPPER algorithm is used [7].

In any case, implementation of any learning technology for intrusion detection is a very complex task. Indeed, audit data gathered from a server for one day may contain more than one million records of different length. Consequently, providing both accuracy and appropriate computational complexity of the learning procedure and the resultant classifier constitutes a formidable task. These aspects are in the focus of the authors of the JAM Project. To provide the required accuracy and efficiency, they proposed a so-called "meta-classification" approach. Conceptually, this approach uses several simple ("light") interacting learners instead of the one complex ('heavy") learner [29, 30, 31]. Practically, meta-classification intersects with approach that was proposed in the late 70th and known as a "collective of decision makers" [38]. Nevertheless, in the JAN Project this idea is developed in a new way and seems very fruitful.

In brief, the essence of the idea is as follows. The learning system is provided by a number of simple classification algorithms capable of learning using its own training and testing data. These algorithms are called "base classifiers". They may be very simple and computationally efficient but, as a rule, not very accurate. After learning, these classifiers are tested on a new audit data, and each testing record is submitted to all base classifiers. While performing classification of the same interpreted audit record, each base classifier makes its own decision about category of input record. Decisions of all base classifiers are joined in a new record that is supplemented by the correct interpretation. These records form data for training a meta-classifier. In the same way base classifiers and the meta-classifier interact during solving the intrusion detection task.

The advantages of intrusion detection utilizing meta-classification are manifold. The approach results in much more efficient and accurate classifiers. It makes possible to add new base classifiers, new learning techniques and new audit learning and testing data to update the intrusion detection system. Meta-classifiers may be structured hierarchically

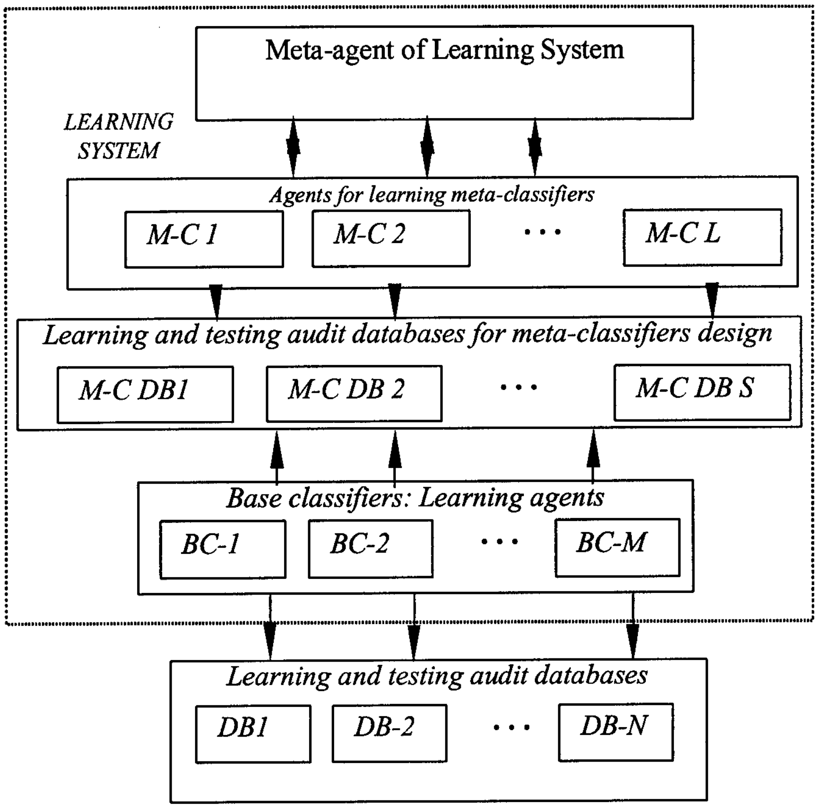

Fig.8. Architecture of Agent-based Learning System

that allowing for constructing multi-level intrusion detection agents following the IDS architecture proposed in the *Section 3*. This idea seems fruitful for the development of the agent-based distributed intrusion detection systems that is the subject of this paper.

Yet the most outstanding advantage of the meta-classification approach is that it is naturally applicable to learning to detect network attacks. Indeed, each IDS can use its own audit data associated with different entry points of the computer network. For example, one of them is receiving and processing *IP*-packets audit data to detect attack on network protocol, other IDS is analyzing the *login* and *password* to detect eventual attack on the host, one more IDS performs the processing of the server input (WWW, FTP, etc.). A meta-classifier combines evidences of a number of host-based IDS and forms the global policy of a network defense system. According to the agent-based architecture proposed in this paper, the learning task is assigned to the Learning System that is responsible for learning of IDA independently on every host they are based. Its architecture is depicted in Fig.8.

The upper layer of the architecture coincides with the meta-agent of Learning System. It manages learning within the entire network via communication to host-based agents and network-based agent. It exchanges messages with the above meta-agents and makes decisions on the necessity of updating the knowledge base of an intrusion detection agent, on generating a new IDA, on cloning a new host-based IDS, etc. To solve the above tasks, it manages the operation of Learning Agents (see Fig.8) that are responsible for the installation of IDA, updating their knowledge bases, etc. The meta-agent of the Learning system manages the multitude of base classifiers and meta-classifiers implemented as specialized agents interacting within the Learning System.

The success of the development of the entire

ISS depends critically on the efficiency and accuracy of the Learning System. It is common understanding that the latter play one of the most important roles within the ISS. In turn, success of a Learning System development depends on whether an audit data are representative and of required size.

9.Related work

Many of the existing and proposed ISS use a monolithic architecture and do not consider a task of integrated security of a computer network. Recently there were a number of publications and projects exploiting the idea of distributed ISS, see [40, GrIDS project], [22, the NADIR system], [45, Cooperative Security Manager], [37, EMERALD project], [35, Bro system], [24, Network Flight Recorder (NFR)]. In the paper [13] the metaphor of immune system to develop a widely distributed program to intrusion detection problem solving is exploited.

There exist few papers, for example, [3, 9, 32, 45] that consider an agent-based approach for an ISS design. They mostly considers only the intrusion detection task. It must be noticed that all cited papers represent a very simplified vision of agents, their architecture and cooperative behavior.

In [3, 9] a so-called AAFID (Autonomous Agents For Intrusion Detection) architecture of an intrusion detection system is proposed. It utilizes the notion of the low level agent that mainly coincides the traditionally used notion of "daemon" A "daemon" is a program that is attached, say, to a port "to inspect the content of network packets and to perform operations based on this information" [9]. AAFID ISS itself can be distributed over a number of hosts in a network and may contain a great number of such agents. Each daemon monitors a small aspect of the entire network traffic in order to recognize a case of "probably suspicious behavior" (not known IP address of an input packet, an attempt to write information on a hard disk, etc.). Each agent is "measuring" an attribute of the input traffic and compares its value against some assigned "threshold". A "suspicious behavior" corresponds to the case when measured value does not fit within the threshold. Agents cooperate by sending information to a host-based transceiver that is intended for intrusion detection on the basis of entire amount of information obtained by the host-based system. An agent may also perform a simple function (such as a linear threshold function) whose arguments are generated by a group of agents. A hierarchical structure (host-based and network-based agents→host-based transceivers→network-based monitor) is imposed over a multi-agent system. Since agents may be located on or migrate to different hosts, the approach utilizes advantages of the host-based and the network-based ISS.

A multi-agent system ("Cooperating Security Manager"–CSM) for intrusion detection is proposed in the [45]. It is more close to the modern concept of multi-agent system. CSM runs on each computer connected to a network and aimed at cooperative detection of probable intrusions. Its architecture include sensors that analyze users activity and input queries to the system in order to recognize abnormal system usage patterns. The entire system contains a number of host-based sensors that cooperate via information exchange that, in turn, makes it possible to detect attacks on the host as well as on the network as a whole. For example, several agents based on different hosts detect the sequential attempts of entries having incorrect login, password and the same IP address of the source. While an individual agent is unable to detect this attack, analyzed as a whole this information reveals a certain feature of the attack on the network. This is a good example of a agent cooperation. Unfortunately, the proposed approach is based on relatively poor agents' functionality, architecture and the form of cooperation.

One more example of the intrusion detection and agent learning-related research is presented in the framework of JAM ("Java Agent Model") Project [29, 30, 31]. The IDS architecture itself is out of the mainstream of the Project. Instead, it focuses on IDA learning in order to provide extensibility and adaptability of IDS. The main idea of this project is to use audit data as the source of knowledge about normal and intrusion activities. Audit data describes each network connection or the host session. The authors use audit data generated expressly for learning and testing IDSs within *"DARPA Intrusion Detection Evaluation Program"*. They adapted known approaches and developed a number of new ones that make it possible to extract an extensive set of features and to apply data mining programs to learn rules and to capture the behavior of normal and intrusion activities. The idea of the meta-classifier proposed by authors is very fruitful because it allows for providing efficiency of learning procedure for large-scale audit data. A number of concepts proposed within the JAM Project, such as the idea of using a set of simple so-called "base classifiers" and top level procedure (meta-classifier) that makes decision on the basis of decisions made by base classifiers, is exploited in our work. In addition, we propose to use each base classifier as a node of decision tree having each own (local) knowledge base and responsible for the detection of a subset of attack types including *"unknown"* types.

All referred above papers possess the following restrictions:

- They consider only one of the information security related tasks, i.e. intrusion detection task and ignore other ones.
- They do not pay the needed attention to the agent cooperation and multi-agent system architecture.

In our paper, the mentioned above shortcomings are in the focus of the research.

It is obvious that to evaluate and to compare approaches, algorithms and resulting ISS it is important to use the same batch of audit data. To make possible development, evaluation and comparison of ISS, DARPA launched a special program that is entitled *"DARPA Intrusion Detection Evaluation Program"*. In the framework of this program, the audit database of great size is made available for all developers of ISS in the USA. In December 1999, DARPA intends to organize a competition of different ISS developed in the USA on the basis of DARPA audit database. It is clear that participating of ISS in competitions like one organized by DARPA is the best way to get real-life assessment of any developed algorithm and ISS as a whole.

10. Conclusion and perspectives

In this paper an agent-based architecture of an integrated ISS intended for computer networks is proposed. Architectures of specialized agents constituting multi-agent ISS are developed as well. The main features of the proposed approach are as follows:

- An ISS constructed according the proposed architecture is expected to be extendible, adaptive and efficient. ISS is considered as a number of cooperating host-based and network-based specialized agents and meta-agents. They solve, jointly, the entire multitude of tasks of information security, such as (1) access control; (2) identification and authentication; (3) intrusion detection; (4) pursuing, identifying and rendering harmless the attacker; (5) assessing the damage of non-authorized access and information integrity recovery; (6) assurance of channel safety on the basis of steganography and steganoanalysis (7) learning and adaptation to new types of attacks.
- message interpretation is based on the use of ontology of information security domain. The latter is considered as the framework for distributed common knowledge and agent's individual knowledge development and representation. In addition, the use of ontology forms the model of the common ground needed to reach agents' mutual understanding during the message exchange process.

The main paper results include:

(1) Development of an agent-based architecture of an ISS that aims at integrated defense of computer network.

(2) Development of the framework for common knowledge representation on the basis of ontology of information security domain associated with the multitude of information security tasks.

(3) Development of architectures of

particular intelligent agents, task distribution between them and general framework of agents' cooperation. A software prototype of ISS that implements the basic ideas of the paper is under development. The hardware part of the ISS model includes local computer network that has access to Internet. The software part based on LINUX and Windows NT and is developing within JAVA and Visual C++ environment. In the future, it is planned to develop the "learning by feedback" methods in more detail and to assure such ISS properties as real-time extensibility and adaptability. The latter would allow an ISS to withstand new kinds of network attacks and variability of computer network structure and platforms. It is recognized that any successful information security technology cannot be implemented in a fixed system, therefore, providing an ISS with powerful dynamic and adaptive learning capabilities has a high priority on the authors' list.

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Generalized Model of Accelerated Science Development

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The model of accelerated (exponential) science development described by simplest exponential equation (1) is well known and is actively used in knowledge engineering

$$\frac{dI}{dt} = kI, \quad I(t_0) = I_0, \; t \ge t_0 = 0 \quad (1)$$

with the solution

$$I(t) = I_0 e^{kt}, \quad (2)$$

where I - informative parameter, characterising the development of science;

k - constant;

t - time.

Advantages and restrictions of this model are considered in this paper. Disadvantages of this model when applied to describing real processes in science under political and social and economic crises are also discussed. The author proposes parametric model, which more adequately reflects the development process of science. The model is built based on double-sector economic and mathematical model of the information society and could be represented in a form of the following differential equation:

$$\frac{dI}{dt} kI + C, \; I(t_0) = I_0, t \ge t_0 = 0 \quad (3)$$

with the solution

$$I(t) = I_0 e^{kt} - \frac{C}{K}(1 - e^{kt}), \quad (4)$$

where

$$k = k_1 \psi^{\alpha} L^{\beta} - \lambda,$$

ψ - main funds (financing allocated for science);

L - number of people engaged in science,

λ - parameter characterising knowledge ageing;

k_1, α, β - parameters of the model;

C - extra system parameter, taking into account the intensity of information exchange with the environment (the process of "brain drain", the natural reduction of scientists number, misinformation, etc.).

The paper gives analysis of possible trajectories of science development depending on ψ, L, λ and C parameters, reveals trajectories and conditions of science degradation. The statistic data corroborating the model (3) adequacy to real negative processes in development of the Russia science during the last decade are presented. These data are: the number of people engaged in research and development, financing allocated for science from the federal budget, indices of publishing and patenting activities, the number of defended doctors and candidates theses.

Possible strategies of post-crisis science development are discussed in the conclusion.

(The entire paper is not available)

Instability and Development Stabilization of Market Mechanisms of Economic

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Resume.

On mathematical model of economic system is showed the diversity of types of price levels on goods market, which varies from simple equilibrium points to plural periodic or chaotic attractors. Therefore is proposed an approach for forming functions of surplus demand and supply from class structure-stable reflections, which allows to utmostly increase the sphere of robust stability of equilibrium trajectories of development of economic system.

Keywords: *Economic system., good market, price level, chaos, attractor, bifurcation ,stability, robust, catastrophe theory.*

Introduction. In development of economics in deferent countries are known the periods of erases, during which market mechanisms became unstable. Instabilities of market mechanisms are directly determined by conducted monetary, fiscal, investment policies and external economic activity of state. Their strike scientific analysis should be based on accurate mathematical description of process of functioning of economic system in whole. Possibility of research on mathematical models of conditions of loosing stability of equilibrium conditions of market mechanisms appeaved thanks to development of theory of open nonlinear dynamic systems with managing and/or disturbing influences in shape of exchange of energy, substance and information.

In resent years was received a number of important results such as strange attractors (D.Ruel, F.Takens 1971),chaos in determinist systems (T.Lee, D.Yorhe,1975) Feigenbaum's universalism (M.J. Feigenbaum, 1978), was developed a qualitative theory of dynamic systems (R.Thom, AAmold and others) and theory of selg-organisation (H.Prigojin, C.Nicolis, Haken and others), where is mathematically based and showed on the example of processes in physics, chemistry a nd biology an outcome in non-linear dynamic systems complex behavior in particularly the diversity of types of behavior, which vary from simple changing equilibrium points to plural periodic or chaotic.

Consider good market. Demand on market is determined by volume of money M(t), and supply by volume of goods on market. The change of price levels on market is characterized by very rapid process, and changes of functions of demand M(t) and supply $\bar{y}(t)$ on the market, on the contrary by very slow process (in comparison with distinctive time of change of price levels), let's P_n denote price levels on good market in step n. Suppose that state n guided by price level P_{n-1} plan to issue money into handling $P_{n-1}M(t)$, and producers planissue and selling of goods on internal market in volume of P^ y(t) .Note that the model of price making (1)

$$P_n = \frac{P_{n-1}M(t)}{P_{n-1}\bar{y}(t)} \qquad (1)$$

is discrete analogy of model of changing price levels [1].

$$\frac{dP}{dt} = \frac{1}{T}\frac{M(t) - p\bar{Y}(t)}{p\bar{Y}(t)}p, \qquad (2)$$

where T is a parameter which has

measurement time and characterizing speed of reaction of price levels to difference of demand and supply.

Let function of demand and supply on good market be determine from the solutions of the simplest differential equations.

$$\frac{dx(t)}{dt} = \Phi^1(t) - \mu P_{n-1}x(t), \qquad (3)$$

$$y(t) = x(t)/b \qquad (4)$$

$$\frac{dM(t)}{dt} = P_{n-1}M(t) - \theta P_{n-1}\bar{y}(t) - \delta P_{n-1}\bar{y}(t) -$$
$$- D_1^k(t) - \Phi_1^{\zeta}(t) - H^{\zeta(t)} - Q(t) \qquad (5)$$

$$\Phi^1(t) = D_1^k(t) + \Phi_1^{\zeta}(t) + S(t) - Q(t) \qquad (6)$$

$$\bar{y}(t) = y(t) + \mathrm{Im}(t) - Ex(t) \qquad (7)$$

$$\frac{dQ(t)}{dt} = Q^{\zeta}(t) + P_{n-1}(Ex(t) - \mathrm{Im}(t) +$$
$$+ \Phi_1^{\zeta}(t) - H^{\zeta} - Q(t) \qquad (8)$$

where x(t) - volume of basic funds in economics, Φ^1(t) - volume of investments into production area of economics, μ - coefficient of depreciation of basic funds, M(t) - volume of money in economics, y(t) - volume of output in economics GDP, θ - speed of handling money in turnaround of incomes, S(t) - saving within economic system, $D_1^k(t)$ - straight foreign investments into production field of economics, $\Phi_1^{\zeta}(t)$ - credits received by state from outside. Ex(t) and Im(t) - accordingly volume of export and import in economics, Q(t) -currency savings in country, Q^{ζ} (t) - gold reserves of the state and H^{ζ} (t) - flows of payments of state for canceling before obtained foreign credits, b - share of fund capacity in GDP, δ -coefficient of issuing money.

Especial interested submit the regime of exponential grows of economics. For it note that:

$$\Phi^1(t) = \gamma P_{n-1}x(t), \quad \mathrm{Im(t)} = \mathrm{k}^1 y(t),$$
$$Ex(t) = k^E y(t) \qquad (9)$$

where γ - continuous rate of growth of investments into economics; k' and k^E - accordingly share of import and export in GDP.

Function of demand and supply on market for economics developing on regime of exponential growth with rate are determined by solving of equations (3) and (5) taking into consideration (4), (6), (7), (8), (9) and look as follows:

$$x(t) = x_0 \ell^{P_{n-1}(\gamma-\mu)t},$$
$$\mathrm{y(t)} = \frac{\mathrm{x}_0}{\mathrm{b}} \ell^{P_{n-1}(\gamma-\mu)t}, \qquad (10)$$
$$\bar{y}(t) = \frac{x_0(1+k^1-k^E)}{b} \ell^{P_{n-1}(\gamma-\mu)t}$$

where xo and Mo - accordingly origin value of volume of basic funds and money. Putting (10) and (11) in expression (1) we get

$$P_n = -\frac{(\theta+\delta)(1+k^I-k^E)+\gamma b}{\theta(\gamma-\mu-1)(1+k^I-k^E)}$$
$$\left[1-\left(1+\frac{M_0 b(\gamma-\mu-1)}{x_0(\theta+\delta)(1+k^I-k^E)+\gamma b}\right) \ell^{-P_{n-1}(\gamma-\mu-1)t}\right], \qquad (12)$$

$$\beta = \frac{(\theta+\delta)(1+k^I-k^E)+\gamma b}{\theta(\gamma-\mu-1)(1+k^I-k^E)},$$
$$x_n = \ell^{-P_n t},$$
$$\lambda = 1+\frac{M_0 b(\gamma-\mu-1)}{x_0(\theta+\delta)(1+k^I-k^E)+\gamma b},$$
$$\alpha = \gamma-\mu-1$$

Then from (12) get

$$x_n = \ell^{\beta t(1-\lambda x_{n-1}^{\alpha})}, \qquad (13)$$

Reflection (13) determines discrete dynamic system, in which slow time t is a parameter.

I n more detail in theory of dynamic system is studied asymptotic behavior of systems trajectories with a=2. Dynamic system (13) with <x=2 astonish with unimaginable diversity of behavior types [1,3], varying from simple equilibrium points to plural periodic or chaotic decisions. It corresponds to ignite sequence of bifurcation with certain values of parameter $g=\lambda\beta t: g_1<g_2<\ldots\ldots<g_n<\ldots\ldots$ each of them carries to cycles of higher sequence with period doubling with every consecutive bifurcation values of gn accumulate near some particular value goo, after this there appear with orbits with «infinitive periods», that is with brightly expressed chaotic behavior.

So that, we are convinced that good markets is characterized by complies behavior and unsuitability of stationary conditions of price levels are directly determined by correlation of such parameters as: rate of economics growth, and coefficient of equipment depreciation in economics, initial meanings of basic funds volume and money in economics, share of fund capacity coefficient in GDP, speed of money handling in turnaround of incomes, coefficient of money issue, share of export and import in GDP, etc.

Note that market works in conditions of uncertainty for theory and practice of management of market mechanisms, the most urgent can be an approach for managing goods market, providing stability of desirable (given) equilibrium conditions of market wide range of changes of economic system parameters.

Basic idea is that on goods market deviation of price levels from desirable (giving) value changed according to law given in stricture-stability shape of reflections [4] which provides property of robust stability of desirable trajectories of price levels development under any change of uncertain parameters of economics system.

Let's suppose, that is desirable change of price levels P,(t) on goods market, which corresponds to equilibrium, every value of equilibrium price levels $P_S(t)$ correspond to money M(t) and commodity supply in volume P_S (t) $\bar{y}(t)$. Then equilibrium price level on open and unequilibrium developing market in real conditions never stay permanent, instant values of price levels P(t) on commodity market do not coincide with equilibrium value $P_S(t)$ it represents some near value.

$$P(t)=P_S(t)+x(t) \qquad (14)$$

Value ofx(t) is deviation from equilibrium value of price level.

Thus, suppose, the market in whole will continuously deviate from desirable condition $P_S(t)$.

Market will answer to such deviations differently, depending on stability or unstability of equilibrium market conditions $P_S(t)$. Equilibrium conditions of market P,(t) in general case is a particular solution of the equation (2).

There is a need to provide to goods market such development by trajectory of market equilibrium, so that stability was provided under any change the general parameter k of economic system.

However a similar problem can be put, if consider supply and demand are given on the market and come from conditions of the maximum largest robust stability of market development then it is possible to make functions of demand and supply like $f(x,k) = -x^2 + k$.

Then equations of dynamics of price levels with respect to deviation ofx can be written down:

$$\frac{dx}{dt} = \frac{1}{T}(-x^3 + kx), \qquad (15)$$

Here right hand part of equation (15) represents single parametrical structure-stability reflection from catastrophes' theory.

Equation (15) has permanent onditions $x_S^1 \geq 0$ and $x_S^{2,3} = \pm\sqrt{k}$. Worthy to note, permanent conditions $x^1_S = 0$ equation (15) corresponds to equilibrium price level on the market $P_S(t)$.

Solution x\ S 0 exists under k < 0 and from it branch of solutions $x_S^{2,3} = \pm\sqrt{k}$ under k>0 that is point k≥0 where bifurcation occurs.

It arrears that conditions $x_S^1 \geq 0$ (P(t) = P s(t)) are global asymptotically stable under k<0 and ustable under k>0 and conditions of system $x_S^{2,3} = \pm\sqrt{k}$ appear under bifurcation of system (15) in point k≥0 also will be asymptotically stable. In other words commodity market gets properties of robust stability in maximum wide sphere of change of general parameter of economic system KI price level is stabilized on equilibrium level $P_S(t)$. Cheching of these utterances was conducted on basis ofLyapunov's first method.

Conclusion. Research of price level stability on the commodity market is based on single measured points reflection methods. For this the model of economic system in continues time, is carried to model with discrete time determined only by recurrent correlation with relation of price levels on the commodity market.

It is showed that given discrete reflection corresponds to infinite sequma of bifurcation under certain values of parameters each of them brings to stable cycles of higher sequence with period doubling under every consequent bifurcation, turning into conditions with brightly expressed chaotic behavior.

Regularities of a dynamic approach of price of price levels on the market to sphere of chaotic behavior (strange attractor) are coordinated with results of Fiegenbaum's universalism law. Parameters of bifurcation are directly determined by rate of economic growth, deprecation of basic fund, money growth, credits, export and import volume, initial values of basic funds volume and money in economic, etc.

There is proposed an approach to an election of function of surplus demand and supply from class of structure-sable reflections, which allows maximum increase sphere of robust stability of equilibrium trajectories of economic system development, that is allowing asymptotic stability of equilibrium price levels on goods market at any change of uncertain and regulated parameters of economic system.

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Methods of Control Systems Design with a Potential for Robust Stability

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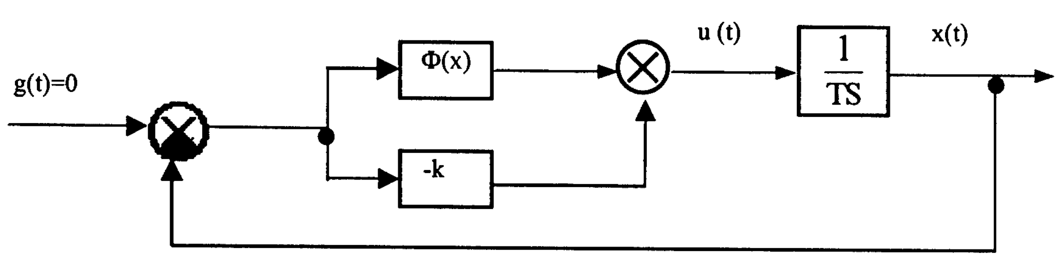
Resume.
The offered approach, to the choice of control laws for objects with uncertain parameters in a class of structurally stable reflections from the theories of catastrophes, allows to build systems of control by a highly boosted potential of robust stability.
Keywords: *robust stubility, structurally stable reflections, systems of control, catastrophes.*

Introduction. The problem of robust stability is one of the most acute in the theory of control and presents high practical interest. In the general setting it comprises pointing at the limits of change of system parameters, under which the stability is preserved. Apparently, all these limitations are defined by the fields of stability on indefinite object parameters and setting initial parameters of the device control panel (regulator). Well-known methods [1-5] of building control systems with indefinite parameters are basically devoted to determining the fields of robust stability of the system with a set structure with linear rules (laws) of control or passive nonlinear (relay) characteristics and do not permit to design control systems with sufficiently wide field of robust stability in the conditions of uncertainty of managed object parameters and drift of its characteristics within the vast limits. To date, there are no scientific thesis on elaboration and exploration of control systems with sufficiently wide field of robust stability.

This very article is devoted to up-to-date problems of building of robust stable control system of linear dynamic objects with uncertain parameters with the approach to the choice of control rules(laws) in the class of structurally-stable reflections from the theory of catastrophes [6,7], permitting to critically increase potential of control system robust stability.

The increase of robust stability potential can be viewed on the example of building control system for astatic objects of the first and second order. System of control preserves the qualities of stability at the wide range of object and regulator parameters' alteration. Exploring of the system robust stability is based on the ideas of linear approximation and first method of A.M. Lyapunov.

Here is Automated Control System (AMS) of the first order with nonlinear regulator is viewed (Picture 1). The object of research is an integrating chain with constant of integration T.



Picture 1

where $\Phi(x) = -x^3$
The law of control is chosen in the form of one-parameter structurally stable reflection

$$u(t)=-x^3+kx \qquad (1)$$

Equation of the system status relating initial variable X is written in the following form

$$\frac{dx}{dt} = \frac{1}{T}(-x^3 + kx) \qquad (2)$$

System (2) with nonlinear law of control (1) has set condition of system $x_s^1 = 0$ when k(k<0) is negative, and when k(k>0) is positive it has two set conditions: $x_s^2 = \sqrt{k}$ and $x_s^3 = -\sqrt{k}$. This pair of set system conditions is merged with x_s^1, when $k=0$ and is branching off when k>0, i.e. in the point $k=0$ occurs bifurcation.
In case of the simple model which is viewed here, the problem of stability exploration is rather trivial, because equation (2) allows exact integration.
It turned out, that condition x_s^1 is asymptotically stable when k<0 and is unstable when k>0, and conditions x_s^2 and x_s^3 are also asymptotically stable. In other words, the branches of the settled conditions x_s^2 and x_s^3 appear as a result of bifurcation at that very moment, when condition $x_s^1 = 0$ loses it's stability, although these branches themselves are stable.
Actually, this relation between overcritical branching is not at all casual. According to one of the common results of the theory of catastrophes [6-7] at nonlinear function overcritical branches are stable and undercritical are not. Then we can see, that set conditions of the system (2) ingeniously defined by the coefficient of the intensifier k, independently from constant of integration, and nonlinear control law (1) gives stability to a system at any change of parameter k in allowed limits..
2.Let us view nonlinear ASC of the second order presented at the picture (Picture 2)

The control law is chosen in the form of the one-parameter structurally stable reflections

$$u_1 = -x_1^3 + kx_1, \quad u_2 = -x_1^3 + kx + x_{21},$$

To structural scheme ASC presented at the picture 2 corresponds the equations of condition

$$\begin{cases} \dfrac{dx_1}{dt} = \dfrac{1}{T_1}(-x_1^3 + kx_1 + x_2) \\ \dfrac{dx_2}{dt} = \dfrac{1}{T_2}(-x_1^3 + kx_1) \end{cases} \qquad (3)$$

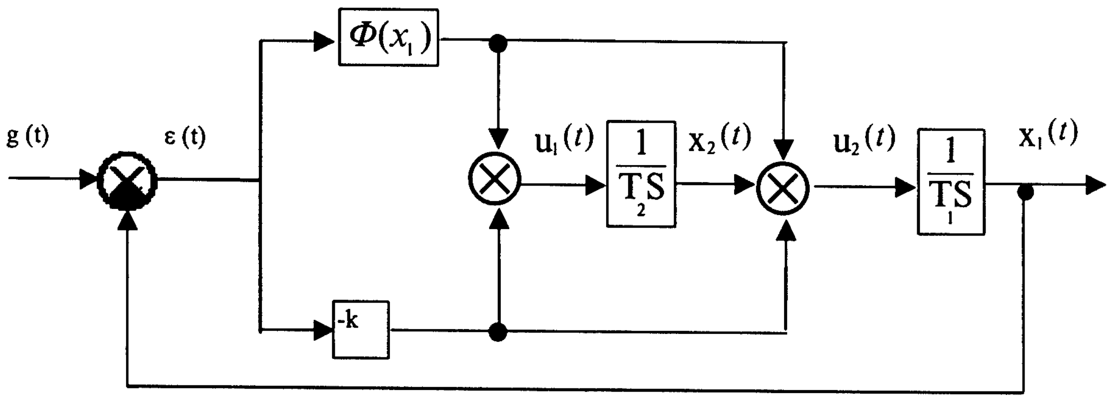
System has a standard condition $x_{1s}^1 = x_{2s} = 0$ and $x_{1s}^{2,3} = \pm\sqrt{k}, x_{2s} = 0$.
Stationary conditions $x_{1s}^{2,3} = \pm\sqrt{k}, x_{2s} = 0$ merge with $x_{1s}^1 = x_{2s} = 0$ at the coefficient of strengthening k=0 and branch off only at k>0. Investigation of the system stability shows that for stability of stationary condition $x_{1s}^1 = x_{2s} = 0$ it is necessary and enough, that coefficient of strengthening k always takes the meanings less than zero (k<0), and for stability of the condition $x_{1s}^{2,3} = \pm\sqrt{k}, x_{2s} = 0$ it is necessary and enough, that coefficient of strengthening k always takes the meanings bigger than (k>0)
3.ASC for astatic object of the second order, the laws of control of which are chosen into the class of structurally stable reflections in the form of three-parameter structurally stable
reflections

$$u = -x_1^3 - x_2^3 - k_1x_1x_2 + k_2x_2 + k_3x_1,$$

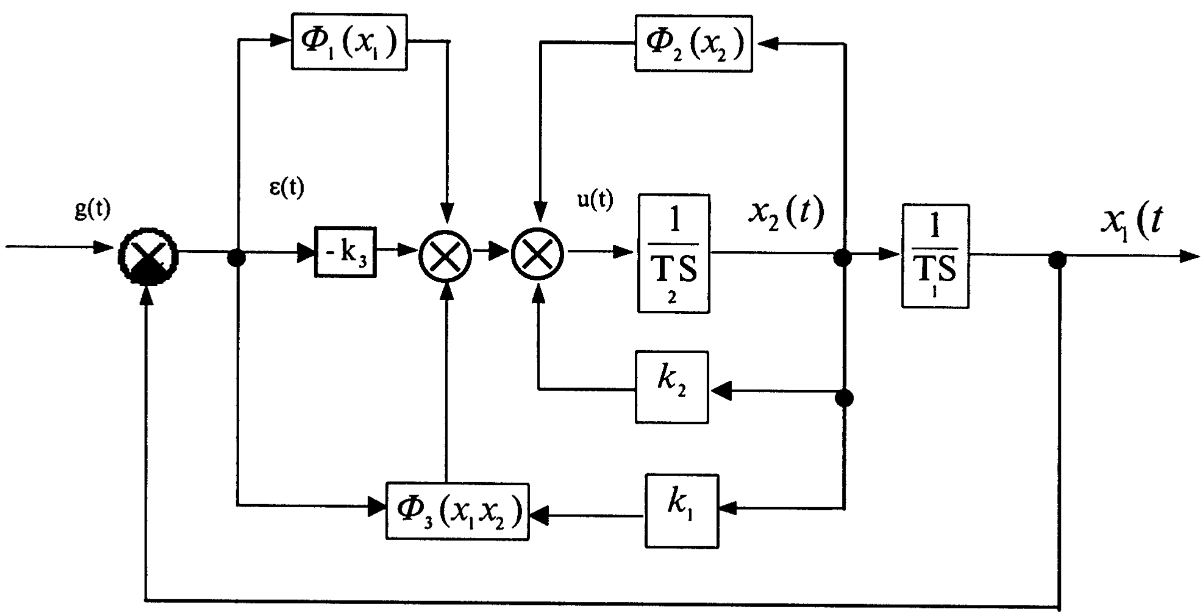
presented at picture 3
where

$$\Phi_1(x_1) = -x^3, \Phi_2(x_2) = -x_2^3, \Phi_3(x_1, x_2) = -\kappa_1 x_1$$

The equation of the system condition relating variables x1 and x2 are written in the form



Picture 2



Picture 3

The stationary conditions of the system are $x^1_{1s} = x_{2s} = 0$ and $x^{2,3}_{1s} = \pm\sqrt{k}, x_{2s} = 0$ stationary conditions $x^{2,3}_{1s} = \pm\sqrt{k}, x_{2s} = 0$ fuse with $x^1_{1s} = x_{2s} = 0$ at the meaning of the coefficient $k_3=0$ and branch off only at $k_3>0$.

We elaborate the stability of these system stationary conditions on the basis of the idea of the first method of A.M.Lyapunov.

The analysis shows, that conditions $x^1_{1s} = x_{2s} = 0$ are asymptotically stable at $k_2<0$and $k_3<0$ and get unstable at $k_2>0$ and $k_3>0$. But settled conditions $x^{2,3}_{1s} = \pm\sqrt{k}, x_{2s} = 0$, appearing at $k_3>0$ will be also asymptotically stable on fulfilling the conditions:

$x^{2,3}_{1s} = \sqrt{k}, x_{2s} = 0$
is stable at $k_1>0$, $k_2>0$, $k_3>0$
and $k_2 - k_1\sqrt{k_3} < 0$, $x^3_{1s} = -\sqrt{k_3}, x_{2s} = 0$
is stable at $k_1<0$, $k_2>0$, $k_3>0$
and $k_2 + k_1\sqrt{k_3} < 0$.

4. Let us examine the problem of free movements stability research by the law of control. They are chosen as a form of two-parameterial structurally stabled reflections presented at picture 4. The object of a control is an integrated row whith constant of integrating T.

where $\Phi_1(x) = -x^4, \Phi_2(x) = -x^2$. The control law we can write in the form of two-parameterial structurally stabled reflections.

$$U(t) = -x^4 + k_1x^2 + k_2x$$

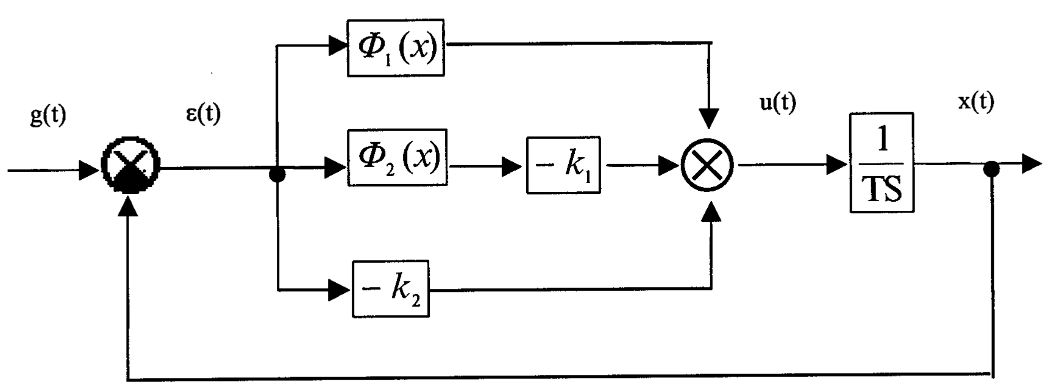
Equation of system state with regard to the outing variable x is written in the form

$$\frac{dx}{dt} = \frac{1}{T}(-x^4 + k_1x^2 + k_2x) \qquad (5)$$

Equations (5) have stable stational conditions $x_{1s} = 0$, when $k_1 < 0$ and $k_2 < 0$. The rest immovable points now are defined by the canonical form of a cube equation in general form

$$-x_s^3 = k_1x_s + k_2 = 0 \qquad (6)$$

As it is know from elementary algebra such equation (6) can have to three real answers (solutions) when $4k_1^3 + 27k_2^2 > 0$. More of that there is a fusing of three answers while the parameters change. And there is an only real answer, when $4k_1^3 + 27k_2^2 > 0$.



Picture 4

The sphere of three real roots existence ends in the point (the beginning of coordinates in the parametrical space), in which the dependence of k_1 on k_2 has a peculiarity in the form of a point [6,7]. Stationary condition dependence of x_3 on k_2 when k_1 is fixed has a curve of hysterecysis cycle and it is conditioned by a plurality of answers in an according sphere of the parameter meanings k_2. More of that, two of the branches turn out stable simultaneously. The field of bi-stability ends in two critical points, in the area of those there is a changing of a new stable stationary condition.

Thus the conditions of stability of systems with the law of control in the class of structurally stable reflections show, that

- a system with linear law of control for astotical objects of the first order is stable only with in the limited area and gets robustly-stable in the maximum wide area of changes of object parameters and set parameters of the regulators;
- a system with linear law of control for astotical objects of the second order, unstable at any meaning of parameters, gets not only robustly-stable, but does not have any limitson changes of indefinite object parameters and sets parameters of the regulators, at which the stability is preserved.

Conclusion. The offered approach, to the choice of control laws for linear dynamic objects in a class of structurally stable reflections from the theories of catastrophes, allows to build ASC by a highly boosted potential of robust stability.

The synthesized system of control preserves the meanings of stability in the extremely wide range of changing indefinite object parameters and installed parameters of a control devise.

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The Controllability of Integro-Differential Equations with Phase Restrictions

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Annotations.

The new approach to the problem of controllability of integro- differential equations under the phase coordinates and controll value restrictions is proposed. The necessary and sufficient conditions of controllability are obtained and the method of the solution construction for boundary problems is developed.

Key words: *controllability, integro-differential equations, minimige sequrence, and functional gradient, strongly convex functionals, bicompact sets.*

Introduction: The mathematical models of many phenomenons in natural sciences and automatic systems for different purpose are boundary problems integro- differential equations. The problems of controllabity and time-optimal control of ordinary differential equations are developed in [1]. The general theory of controllability and optimal controll can be find in [2,3].
The results obtained in [1], [2,3] extend to integro- differential equations.

Problem statement. Let us observe the system

$$\dot{x} = A(t)x + B(t)f(x,u,t) + D(t)\int_{t_0}^{t_1} K(t,\tau,\upsilon(\tau),x(\tau))d\tau + \mu(t), \quad t \in I = [t_0, t_1] \qquad (1)$$

with boundary conditions

$$(x(t_0), x(t_1)) \in S \subset R^{2n}, \qquad (2)$$

under the phase restrictions

$$\omega(t) \le F(x(t),t) \le \varphi(t), \ t \in I, \qquad (3)$$

where $A(t)$, $B(t)$, $D(t)$ are matrixes with piecewise-continuous elements of $n \times n, n \times r, n \times m$ dimensionality, respectively, $\mu(t), t \in I$ is the vector-functions with piecewise-continuous elements, S is a given convex closed set, $F(x,t)$ is S-dimensional continuous vector-function by the totality control variables vector-functions, where

$$u(t) = (u_1(t), \ldots u_{r_1}(t)), \upsilon(t) = (\upsilon_1(t), \ldots u_{m_1}(t)), \ t \in I$$

$$u(t) \in U = \left\{u(\cdot) \in L_2(I, R^{r_1}) \,\middle|\, \alpha_i(t) \le u_i(t) \le \beta_i(t), i = \overline{1, r_1}, t \in I\right\}, \qquad (4)$$

$$\upsilon(t) \in V = \left\{\upsilon(\cdot) \in L_2(I, R^{m_1}) \,\middle|\, \gamma_i(t) \le \upsilon_i(t) \le \delta_i(t), i = \overline{1, m_1}, t \in I\right\}, \qquad (5)$$

$f(x,u,t)$ is r-dimensional vector-function, $K(t,\tau,\upsilon,x)$ is m-dimensional vector-function,
Suppose that the functions $f(x,u,t)$, $K(t,\tau,\upsilon,x)$ are measurable and satisfy the conditions

$$|f(x,u,t)| \le c_0\left(|x| + |u|^2\right) + c_1(t),$$
$$x \in R^n, \quad u \in R^{r_1}, \quad t \in I,$$
$$|f(x,u,t) - f(y,u,t)| \le l_1(t)|x-y|, l_1(t),$$
$$c_1(t) \in L_1\left(I, R^1\right),$$
$$|K(t,\tau,\upsilon,x)| \le c_2\left(|x| + |\upsilon|^2\right) + c_3(t,\tau),$$
$$c_3(t,\tau) \in L_1\left(Q, R^1\right),$$
$$|K(t,\tau,\upsilon,x) - K(t,\tau,\upsilon,y)| \le l_2(t,\tau)|x-y|,$$
$$l_2(t,\tau) \in L_1\left(Q, R^1\right),$$

where $Q = \{(t,\tau) \mid t_0 \le t, \ \tau \le t_1\}$. Under these conditions, the system (1) have a only solution $x(t) = x(t;t_0,x_0,u,\upsilon) \in AC(I,R^n)$ passing through $x_0 \in R^n$.

<u>Problem 1</u>. To define the necessary and sufficcient conditions of the boundary problem (1)-(5) solution existence (controllability).

<u>Problem 2</u>. To define the problem (1)-(5) solution. In particular, the formulation of the problem may be interpreted as following: the rocket is starting from the given area S_0 for defeating the target, which is located in area S_1, $x(t_0) \in S_0$, $x(t_1) \in S_1$, the set $S = S_0 \cup S_1$. For each moment t, $t \in [t_0, t_1]$ rocket trajectory $x(t)$, $t \in I$ must be situated in the given area of phase space. It is necessary to find the rocket motion control algorithm $u(t) \in U$, $\upsilon(t) \in V$, which which ensures the target destruction.

The equation of rocket motion is (1).

<u>The principe of immersion:</u>

The basis of suggested approach to the solving the problem 1,2 is a principle of immersion , wich allows to reduce the initial boundary problem (1)-(5) to the eqvivalent problem without boundary restrictions.

Let as consider control system

$$\begin{aligned} &\dot{y} = A(t)y + E(t)w(t) + \mu(t), \\ &y(t_0) = x(t_0) = x_0, \ y(t_1) = x(t_1) = x_1 \end{aligned}, \ t \in I \qquad (6)$$

$$w(\cdot) \in L_2\left(I, R^{n_1}\right), \ n_1 = r + m, \qquad (7)$$

where $E(t) = (B(t), D(t))$.

Let the matrix (Kalman matrix)

$$W(t_0,t_1) = \int_{t_0}^{t_1} \Phi(t_0,t)E(t)E^*(t)\Phi^*(t_0,t)dt,$$

where

$\Phi(t,\tau) = \theta(t)\theta^{-1}(\tau)$, $\theta(t)$ - fundamental matrix of solution the linear homogenerous system $\dot{\xi} = A(t)\xi$.

<u>Theorem 1.</u> Suppose the matrix $W(t_0,t_1)$ is positively determined. Then the control $w(\cdot) \in L_2\left(I, R^{n_1}\right)$ change over the trajectory of system (6) from any initial state $x_0 \in R^n$ to any desirable final state $x_1 \in R^n$ if and only if

$$w(t) \in W =$$
$$= \left\{ w(\cdot) \in L_2\left(I, R^{n_1}\right) \middle| \begin{array}{l} w(t) = v(t) + \lambda_1(t,x_0,x_1) + \\ + N_1(t)z(t,v), \end{array} \right.$$
$$\forall v, v(\cdot) \in L_2\left(I, R^{n_1}\right), \ t \in I \Big\}, \qquad (8)$$

where $\lambda_1(t,x_0,x_1)$, $N_1(t)$, $t \in I$ are defined vector-function and matrix in correspondence, and function $z(t) = z(t,v)$, $t \in I$ - is a solution of differential equation

$$\begin{aligned} &\dot{z} = A(t)z + E(t)v(t), \\ &z(t_0) = 0, \ t \in I, \ v(\cdot) \in L_2\left(I, R^{n_1}\right) \end{aligned} \qquad (9)$$

The solution of differential equation (6) corresponding to control $w(t) \in W$ is defined by formula

$$y(t) =$$
$$= z(t) + \lambda_2(t,x_0,x_1) + N_2(t)z(t_1,v), \ t \in I, \qquad (10)$$

where $\lambda_2(t,x_0,x_1)$, $N_2(t)$ - are defined vector-function and matrix. The proof of the theorem received from the results of work [].

Let

$$v(t)=(v_1(t),v_2(t)),\lambda_1(t,x_0,x_1)=$$
$$=(\lambda_{11}(t,x_0,x_1),\lambda_{12}(t,x_0,x_1)),$$
$$N_1^*(t)=(N_{11}(t),N_{12}(t))^*,$$

where $(^*)$- the symbol of transposition

Lemma 1. Let the matrix $W(t_0,t_1)$ positively determined. Then boundary problem (1)-(5) is equivalence to the following problem

$$v_1(t)+\lambda_{11}(t,x_0,x_1)+N_{11}(t)z(t_1,v)= = f(y(t),u(t),t),\quad t\in I, \tag{11}$$

$$v_2(t)+\lambda_{12}(t,x_0,x_1)+N_{12}(t)z(t_1,v)= = \int_{t_0}^{t_1}K(t,\tau,\upsilon(\tau),y(\tau))d\tau, \tag{12}$$

$$\dot z(t)=A(t)z+B(t)v_1(t)+D(t)v_2(t),\quad z(t_0)=0,\quad t\in I, \tag{13}$$

$$v_1(\cdot)\in L_2(I,R^r),\ v_2(\cdot)\in L_2(I,R^m),\ u(t)\in U,\ \upsilon(t)\in V,\ (x_0,x_1)\in S, \tag{14}$$

$$\omega(t)\le F(y(t),t)\le\varphi(t),\quad t\in I. \tag{15}$$

The conversion from the problem (1)-(5) to the problem (11)-(15) is a principle of immersion.

The necessary and sufficient condition of solvability:

The conversion from initial problem (1)-(5) to the problem (11)-(15) is allow to use the methods of the extremal problems theory for solving the problem 1,2.

Lets introduce the set

$$W_1=\left\{\begin{array}{l}\eta(\cdot)\in L_2(I,R^S)/\,\omega_i(t)\le\eta_i(t)\le\varphi_i(t),\\ i=\overline{1,S},\quad t\in I\end{array}\right\},$$

where

$$\omega(t)=(\omega_{Б1}(t),\dots,\omega_S(t)),$$
$$\varphi(t)=(\varphi_{Б1}(t),\dots,\varphi_S(t)),\quad t\in I$$

are given continuous functions.

Let us observe the problem of optimal control: minimize the functional

Theorem 2. Let the matrix $W(t_0,t_1)$

$$J(v_1,v_2,u,\upsilon,\eta,x_0,x_1)=$$
$$=\int_{t_0}^{t_1}\left\{\begin{array}{l}|v_1(t)+\lambda_{11}(t,x_0,x_1)+N_{11}(t)z(t_1,v)-\\ -f(y(t),u(t),t)|^2+\\ +|v_2(t)+\lambda_{12}(t,x_0,x_1)+N_{12}(t)z(t_1,v)-\\ -\int_{t_0}^{t_1}K(t,\tau,\upsilon(\tau),y(\tau))d\tau|^2+\\ +|\eta(t)-F(y(t),t)|\end{array}\right\}dt=$$
$$=\int_{t_0}^{t_1}F_0\left(\begin{array}{l}v_1,v_2,u,\eta,\\ x_0,x_1,z(t),z(t_1)\end{array}\right),\int_{t_0}^{t_1}K\left(\begin{array}{l}t,\tau,\upsilon(\tau),\\ y(\tau),d\tau,t\end{array}\right)dt\to\inf \tag{16}$$

under conditions

$$\dot z=A(t)z+B(t)v_1(t)+ + D(t)v_2(t),\quad z(t_0)=0,\quad t\in I, \tag{17}$$

$$v_1(\cdot)\in L_2(I,R^r),\ v_2(\cdot)\in L_2(I,R^m), \tag{18}$$

$$u(t)\in U,\quad \upsilon(t)\in V,\quad \eta(t)\in W_1,\quad (x_0,x_1)\in S, \tag{19}$$

where the function $y(t),t\in I$ is defined in (10)positively determined. For the problem (1)-(5) to have the solution it is necessary and sufficient that

$$J(v_1^*,v_2^*,u_*,\upsilon_*,\eta_*,x_0^*,x_1^*)=0,$$

where

$$(v_1^*,v_2^*,u_*,\upsilon_*,\eta_*,x_0^*,x_1^*)\in L_2(I,R^r)\times L_2(I,R^m)\times U\times V\times W_1\times S=X$$

is the optimal solution of problem (16)-(19).

Minimize sequences. As it follows from the theorem 2, for the construction the solution of problem (1) - (5) it is necessary to construction sequences

$\{v_1^n\},\ \{v_2^n\},\ \{u_n\},\ \{\upsilon_n\},\ \{\eta_n\},\ \{x_0^n\},\ \{x_1^n$

for which

$$\lim_{n\to\infty}J(v_1^n,v_2^n,u_n,\upsilon_n,\eta_n,x_0^n,x_1^n)=$$
$$=J_*=\inf_{\mu\in X}J(\mu)=J(\mu_*)=0,$$

where $\mu=(v_1,v_2,u,\upsilon,\eta,x_0,x_1)\in X$,

$$\mu_n=(v_1^n,v_2^n,u_n,\upsilon_n,\eta_n,x_0^n,x_1^n)\in X,$$
$$\mu_*=(v_1^*,v_2^*,u_*,\upsilon_*,\eta_*,x_0^*,x_1^*)\in X.$$

Theorem 3. Let the matrix $W(t_0,t_1)$ positively determined, the function $F_0(\cdot)$

is defined and continious by the totality of its arguments together with the partial derivatives

$$\frac{\partial F_0}{\partial v_1}, \frac{\partial F_0}{\partial v_2}, \frac{\partial F_0}{\partial u}, \frac{\partial F_0}{\partial \upsilon},$$
$$\frac{\partial F_0}{\partial \eta}, \frac{\partial F_0}{\partial x_0}, \frac{\partial F_0}{\partial x_1}, \frac{\partial F_0}{\partial z}, \frac{\partial F_0}{\partial z(t_1)},$$

and they satisfy the Lipshits conditions.

Then under condition (17) - (19) the functional (16) is differentiated, and its gradient $J'(\mu)=$
$(J_1'(\mu), J_2'(\mu), J_3'(\mu), J_4'(\mu), J_5'(\mu), J_6'(\mu), J_7'(\mu)) \in Y$
$= L_2(I, R^r) \times$
$\times L_2(I, R^m) \times L_2(I, R^{r_1}) \times L_2(I, R^{m_1}) \times$
$\times L_2(I, R^S) \times R^n \times R^n$

is calculated in any point by formula:

$$J_1'(\mu) = \partial F_0 / \partial v_1 - B^*(t)\psi(t),$$
$$J_2'(\mu) = \partial F_0 / \partial v_2 - D^*(t)\psi(t),$$
$$J_3'(\mu) = \partial F_0 / \partial u, \quad J_4'(\mu) = \partial F_0 / \partial \upsilon,$$
$$J_5'(\mu) = \partial F_0 / \partial \eta,$$
$$J_6'(\mu) = \int_{t_0}^{t_1} \frac{\partial F_0}{\partial x_0} dt, \quad J_7'(\mu) = \int_{t_0}^{t_1} \frac{\partial F_0}{\partial x_1} dt, \qquad (20)$$

where $z(t) = z(t, v)$, $t \in I$ - is the solution of differential equation (17) when $v_1 = v_1(t)$, $v_2 = v_2(t)$, $t \in I$, and the function (t), $t \in I$ - is the solution of a conjugate system:

$$\cdot = \frac{\partial F_0}{\partial z} - A^*(t)\psi, \quad \psi(t_1) = -\int_{t_0}^{t_1} \frac{\partial F_0}{\partial z(t_1)} dt. \qquad (21)$$

Besides, the gradient $J'(\mu)$, $\mu \in X$ satisfies the Lipshitz condition

$\|J'(\mu_1) - J'(\mu_2)\| \le l \|\mu_1 - \mu_2\|$, $l = const > 0$,

Lets construct the sequences $\{\mu_n\} \subset X$ by the following rule

$$v_1^{n+1} = v_1^n - \alpha_n J_{1Б}'(\mu_n),$$
$$v_2^{n+1} = v_2^n - \alpha_n J_{2Б}'(\mu_n),$$
$$u_{n+1} = P[u_n - \alpha_n J_{3Б}'(\mu_n)],$$
$$\upsilon_{n+1} = P_V[\upsilon_n - \alpha_n J_{4Б}'(\mu_n)],$$
$$\eta_{n+1} = P_{W_1}[\eta_n - \alpha_n J_{5Б}'(\mu_n)],$$
$$x_0^{n+1} = P_S[x_0^n - \alpha_n J_{6Б}'(\mu_n)],$$
$$x_1^{n+1} = P_S[x_1^n - \alpha_n J_{7Б}'(\mu_n)],$$
$$n = 0,1,2,\ldots,$$
$$0 < \alpha_n \le \frac{2}{l + 2\varepsilon}, \quad \varepsilon > 0. \qquad (22)$$

<u>Theorem 4.</u> Let all conditions of the theorem 3 be fullfiled, sequences $\{\mu_n\}$ be defined by formula (22). Then:

1) the numerical sequence $\{J(\mu_n)\}$ decreases strictly and $\|\mu_{n+1} - \mu_n\| \to 0$ when $n \to \infty$
2) if the functional (16) under the condition (17)-(19) is convex and the set $\Lambda = \{\mu \in X \,|\, J(\mu) \le J(\mu_0)$ is bounded, then sequences (22) are minimizing, i.e. $\lim_{n \to \infty} J(\mu_n) = J_* = \inf_{\mu \in X} J(\mu) = J(\mu_*)$, $\mu_* \in X$, $\mu_n \xrightarrow{сл} \mu_*$

when $n \to \infty$.

The evalution of the convergence rate is

$$0 \le J(\mu_n) - J(\mu_*) \le \frac{c_1}{n},$$
$$c_1 = const > 0, \quad n = 1,2,\ldots;$$

3) if
$$J(\mu_*) = 0,$$
then
$$x_*(t) = y_*(t) = z(t, v_1^*, v_2^*) + \lambda_2(t, x_0^*, x_1^*) + N_2(t) z(t_1, v^*),$$ $t \in I$ - is the solution of the problem (1)-(5).

In a number of cases it is efficient to consider the following problem:

Minimize the functional

4) which satisfy the condition
$$2\varepsilon_k - l = \kappa_k > 0.$$

$$J_k(v_1,v_2,u,\upsilon,\eta,x_0,x_1)=$$
$$=\int_{t_0}^{t_1}F_0dt+\varepsilon_k\left\{\int_{t_0}^{t_1}\left[|v_1|^2+|v_2|^2+|u|^2+|\upsilon|^2+|\eta|^2\right]dt+\right.$$
$$\left.+|x_0|^2+|x_1|^2\right\}\to\inf \tag{23}$$

under conditions (17)-(19), where $\varepsilon_k>0,\ \varepsilon_k\to+0$ when $k\to\infty$.

Therem 5. Let all conditions of the theorem 3 be fullfilled. Then

1) the boundary problem (1)-(5) have a solution if and only if $\lim_{k\to\infty}J_k(\mu_k^*)=0$, where $\mu_k^*=(v_{1k}^*,v_{2k}^*,u_k^*,\upsilon_k^*,\eta_k^*,x_{0k}^*,x_{1k}^*)\in X$ - is optimal solution of the problem (23), (17)-(19);

2) the functional (23) under conditions (17)-(19) is differentiated continuously for any $\varepsilon_k>0$, and its gradient $J_k'=(J_{k1}',J_{k2}',J_{k3}',J_{k4}',J_{k5}',J_{k6}',J_{k7}')\in Y$ in any point $\mu_k=(v_{k1},v_{k2},u_k,\upsilon_k,\eta_k,x_{0k},x_{1k})\in X$ is calculated by formula

$$J_{k1}'(\mu_k)=\partial F_0/\partial v_1+2\varepsilon_k v_{1k}-B^*(t)\psi(t),$$
$$J_{k2}'(\mu_k)=\partial F_0/\partial v_2+2\varepsilon_k v_{2k}-D^*(t)\psi(t),$$
$$J_{k3}'(\mu_k)=\partial F_0/\partial u+2\varepsilon_k u_k,$$
$$J_{k4}'(\mu_k)=\partial F_0/\partial \upsilon+2\varepsilon_k \upsilon_k,$$
$$J_{k5}'(\mu_k)=\partial F_0/\partial \eta+2\varepsilon_k \eta_k,\quad J_{k6}'(\mu_k)=$$
$$=\int_{t_0}^{t_1}(\partial F_0/\partial x_0)dt+2\varepsilon_k x_{0k},$$
$$J_{k7}'(\mu_k)=\int_{t_0}^{t_1}(\partial F_0/\partial x_1)dt+2\varepsilon_k x_{1k}, \tag{24}$$

where $(t),\ t\in I$ - is a solution of a conjugate system (21);

3) the gradient $J_k'(\mu_k),\ \mu_k\in X$ satisfies the Lipshitz condition, i.e.

$$\|J_k'(\mu_k^1)-J_k'(\mu_k^2)\|\le l_1\|\mu_k^1-\mu_k^2\|, \tag{25}$$
$$\forall\mu_k^1,\mu_k^2\in X.$$

the functional (23) under condition (17) - (19) is strongly convex for any $\varepsilon_k>0$,

On the base of (24), (25) we construct the sequences $\{\mu_k^n$

$$\mu_k^{n+1}=P_X[\mu_k^n-\alpha_n J_k'(\mu_k^n)],$$
$$n=0,1,2,...,\quad 0<\alpha_n\le l|(l_1+2\varepsilon),\quad \varepsilon>0. \tag{26}$$

Theorem 6. Let all conditions of the theorem 5 be fulfilled, sequences $\{\mu_k^n\}$ be defined by formula (26) for $\varepsilon_k>0$. Then

1) the numerical sequence $\{J_k(\mu_k^n)$ decreases strictly and $\|\mu_k^{n+1}-\mu_k^n\|\to 0$ when $n\to\infty$ for any $\varepsilon_k>0$;

2) The set $\Lambda_k=\{\mu\in X\,|J_k(\mu)\le J_k(\mu_k^0)$ is a bicompact for all $\varepsilon_k>0$ which satisfy condition $\kappa_k=2\varepsilon_k-l>0$;

3) if $\kappa_k>0$, then sequences (26) converge the unique point $\mu_k^*\in X$, where $\mu_k^*\in X$ - is the optimal solution of problem (23), (17)-(19),i.e.

$$\lim_{n\to\infty}J_k(\mu_k^n)=\lim_{N\in X}J_k(\mu)=J_k(\mu_k^*),$$
$$\{\mu_k^n\}\subset\Lambda_k.$$

The evaluation of the convergence rate is

$$0\le J_k(\mu_k^n)-J_k(\mu_k^*)\le\frac{c_1}{n}, \tag{26}$$
$$c_1=const>0,$$
$$\|\mu_k^n-\mu_k^*\|\le\frac{c_2}{n},\quad c_2=const>0, \tag{27}$$
$$n=1,2,....$$

Lemma 2 Let all conditions of the theorem 5 be fulfilled, the value $\kappa_k>0$, sequences $\{\mu_k^n\}\subset X$ be defined by formula (26), where the value α_n is chosen from condition $0<\alpha_n<2\kappa_k|l_1^2,\ \kappa_k\le l_1$.Then the evaluation of the convergence rate of

$$\|\mu_k^n-\mu_k^*\|\le\|\mu_k^0-\mu_k^*\|\theta^n(\alpha_n), \tag{28}$$
$$n=0,1,2,...,$$

where $\theta(\alpha_n)=(1-2x_k\alpha_n+\alpha_n^2l_1^2)^{1/2}$, $0<\theta(\alpha_n)<1$

is valid.

Let

$y_{nk}(t) = z(t, v_{1k}^n, v_{2k}^n) + \lambda_2(t, x_{0k}^n, x_{1k}^n) +$
$+ N_2(t) z(t_1, v_{1k}^n, v_{2k}^n), \quad t \in I,$
$y_{*k}(t) = z(t, v_{1k}^*, v_{2k}^*) + \lambda_2(t, x_{0k}^*, x_{1k}^*) +$
$+ N_2(t) z(t_1, v_{1k}^*, v_{2k}^*), \quad t \in I,$
Lets note $\Delta y_{nk}(t) = y_{nk}(t) - y_{*k}(t), \ t \in I.$

Theorem 7. Let all condition of theorem 5 be fullfiled, the value $\kappa_k > 0$, then:

1) in a case $0 < \alpha_n \le 2/(l_1 + 2\varepsilon), \ \varepsilon > 0$, the evalution

$$\|\Delta y_{nk}\|_C = \max_{t_0 \le t \le t_1} |y_{nk}(t) - y_{*k}(t)| \le c_3 / \sqrt{n}, \quad c_3 = const > 0, \quad n = 1,2,..., \tag{29}$$

is valid

2) in case $0 < \alpha_n < 2\kappa_k / l_1^2$, the evaluation

$$\|\Delta y_{nk}\|_C \le c_4 \theta^n(\alpha_n), \ c_4 = const > 0, \quad n = 0,1,2.... \tag{30}$$

is valid.

Note that the evaluations (29),(30) follows from inequalities (26)-(28).

Conclusion. On the basis of obtained results the algorithm of constructing the problem of controllability are suggested a) $\varepsilon_k > 0$ is chosen from condition $\kappa_k > 0$. The sequences $\{\mu_k^n\} \subset X$ constructed, which converge to point $\mu_k^* \in X$ .If $J(\mu_k^*) = 0$, then the solution of the initial problem (1)-(5) can be found. The evaluation of the distant $y_{nk}(t), t \in I$ from $x_*(t) = y_{*k}(t), t \in I$ is defined by formula (29) (or 30) ; b) if the value of $J(\mu_k^*) > 0$, then $\varepsilon_{k+1} < \varepsilon_k$ is chosen and sequences $\{\mu_{k+1}^n\} \subset X$ constructed for the functional $J_{k+1}(\mu$ and so on.; c) If $\varepsilon_k \to 0$ when $k \to \infty$ and $\lim_{k \to \infty} J_k(\mu) = J(\mu)$, then the point $\mu_* \in X$ will be found. If $J(\mu_*) = 0$, then the solution of problem (1)-(5) is constructed, opposite case, when $J(\mu_*) > 0$ the solution of initial problem not exit.

In particular, when matrix $D(t) \equiv 0, \ t \in I$ above obtained results are true for the solution the problem of controllability of ordinary differential equations with phase coordinates.

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Representations of Boolean Functions by Formulas of Special Types in Various Bases (Existence Conditions, etc.)

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Resume.

One of *the problems of Boolean functions theory and its Application is the necessity of the representing of functions by specially given forms. In this paper the operator approach is proposed for polynomial expansions of the Boolean functions. The operator approach allows to introduce a new class of polynomial expansions and polynomial canonical forms. The certain estimates for complexity of polynomial normal forms were obtained. The criterion of existence of representation of functions by real-one formulas in certain bases, among them, consisting of all Boolean functions of 2 variables was found. New methods of minimization of Boolean functions in classes of polynomial normal forms and binary therms were proposed.*

Keywords: *Boolean functions, complexity, minimization, canonical forms, therm, formula, basis, real-once therm.*

Introduction. Our research is broken into three parts. The methodological part aims at introducing new types of Boolean functions expansions and determining conditions under which these expansions exist. Special attention is devoted polynomial and real-once representations. It also aims at introducing new classes of canonical forms of representing Boolean functions. The analytic part presents a comparative analysis and classification of the various forms of representations of Boolean functions. It also presents estimates of complexity of these representations. The algorithmic part comprises algorithm development for searching Boolean functions representations by various forms of minimizing algorithms for representing by these formulas. It is also supposed to develop automatic system based on obtained algorithms for finding representations and minimizing Boolean functions.

The methodological approach. In this paper the operator approach is proposed for polynomial expansions of the Boolean functions. The operator approach makes it possible to introduce a new class of polynomial expansions and polynomial canonical forms . We got the formulas for calculation of coefficients of expansions without using inverse matrix .

Among other operators, we use a mixed operator for polynomial expansions, which is defined as follows [1].

The mapping $\psi\colon \mathrm{E}_2^n \to \mathrm{E}_3^n$ is said to be alternative embedding if $\phi\psi$ is identical mapping on the set E_2^n, where $\phi : \mathrm{E}_3^n \to \mathrm{E}_2^n$ is a mapping induced by the following: $0 \to 0$, $1 \to 1$, $2 \to 0$. The operator, which mixes p and d or p and t or d and t operators, is defined by induction on alternative embedding ψ:

$$pd_{x_1}^1 f(x_1, y) = f(x_1, y),$$
$$pd_{x_1}^0 f(x_1, y) = f(\overline{x}_1, y),$$
$$pd_{x_1}^2 f(x_1, y) = f'_{x_1}(x_1, y),$$
$$pt_{x_1}^1 f(x_1, y) = f'_{x_1}(x_1, y),$$

$$pt_{x_1}^{0} f(x_1, y) = f(\overline{x}_1, y),\ pt_{x_1}^{2} f(x_1, y) = f(x_1, y),$$
$$dt_{x_1}^{1} f(x_1, y) = f(\overline{x}_1, y),$$
$$dt_{x_1}^{0} f(x_1, y) = f(x_1, y),\ dt_{x_1}^{2} f(x_1, y) = f'_{x_1}(x_1, y),$$
$$q_{x_1,\dots,x_n}^{\tau_1,\dots,\tau_n} f(x_1,\dots,x_n, y) = q_{x_n}^{\tau_n}(q_{x_1,\dots,x_{n-1}}^{\tau_1,\dots,\tau_{n-1}} f(x_1,\dots,x_n, y)),$$

where $q \in \{pd, pt, dt\}$.

We investigated the following polynomial expansions:

$$f(x,z) \doteq \sum_{\tau}\sum_{\sigma} \beta_{\sigma\tau} t_x^{\tau} g(x, f^{\gamma}(\sigma, y))$$

different mixed operators *t*, i.e. we described a class of functions *g(x,y)* for which such expansions exist. The expansions of Boolean functions in terms of all variables give us new canonical forms of representations.

The bases $\{\vee,\&,\neg,0,1\}\cup\{g\}$ are the most interesting for investigations of existence of real-once realization, where g is a quasireal-once function on the $\{\vee,\&,\neg,0,1\}$ set, i.e. g is not realized by a real-once formula, but its any subfunction is realized .

The criterion of existence of representation of functions by real-once formulas in certain bases, among them, consisting of all Boolean functions of 2 variables has been obtained. We have developed the algorithm without scanning for finding the real-once representations of Boolean functions by formulas in any basis consisting of functions of 2 variables .

The analytic approach.The certain estimates for complexity of polynomial normal forms were obtained. In particular, we have found the exact value of a Shannon function for polynomial normal forms in a class of symmetrical Boolean functions [2] and for polarized Zhegalkin polynomial.

The algorithmic approach. A new methods for minimization of the Boolean functions in classes of polynomial normal forms and binary terms have been developed [3]. These methods are based on expansion of the Boolean functions with respect to one variable, due to which a minimal form can be obtained. This method allowed us to develop the approximate algorithm of the minimization of Boolean functions which was the basis of automatic system "Automatic synthesis of partial finite automata on PLA with memory" .

Conclusions. Results described above are of practical importance.

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Synthesis of Adaptive Functional Optimal Control Systems (Strong Adaptive Systems)

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The problem of construction of adaptive control systems has already more than thirty-years history and extensive literature. One of the first fundamental works in this area was work of A.A. Feldbaum. In a basis of the theory, advanced by him, (called then "the theory of dual control systems") the hypothesis that all uncertain quantities and processes considered at the solving of optimal control synthesis problem have stochastic (in mathematical sense of this word) a nature with the known statistical characteristics was set. This direction of the theory of adaptive control systems had the rather numerous followers. At the end of seventieth and in the beginning of the eightieth years in connection with intensive investigation of methods of guaranteed estimates obtaining in identification problems and development of the general control theory in conditions of unstochastic uncertainty also development of a new direction in the theory of adaptive control systems intensively began. Most full to the present time the methods of synthesis of a special class of adaptive control systems (specific lost optimal or weak adaptive control systems) are developed. In general statement the synthesis problem for adaptive control systems which are optimal in functional sense or strong adaptive control systems, as far as it is known under the literature, now is not still solved.

I this report the solving of strong adaptive control systems synthesis problem for following classes of objects is considered: 1) objects without memory, 2) dynamic objects.

(The entire paper is not available)

Different Methods for Solving Unstructured Convection-Diffusion Problems

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In the present work there are discussed possibilities to solve problems of mathematical physics on unstructured grids. The emphasis is on approximation of the convection/diffusion equation as the most important application. The main attention is given to constructing difference schemes on triangular grids (as the most general unstructured grids). Approximations on the grids designed via the Delaunay triangulation are highlighted as the most optimal.

The basis for constructing discrete analogs is the balance method (integro-interpolation approach) which in publications in English is referred to as *the finite volume method.* Positive features of this approach are very attractive in case of unstructured grids. For the Delaunay triangulation we have Voronoi cells as control volumes.

In constructing difference schemes for hydrodynamics problems or conve* -live heat/mass transfer the emphasis is on monotone schemes, i.e. scheme;-' satisfying tlie maximum principle. In the present study there are considered monotone schemes Jui unstructured grids designed via the Delanay triangulation using the iniegro-interpolation method where Voronoi cell arc employed as control volumes. Monotone schemes for convection/diffusion problems are developed on the basis of the regularization principle for difference, schemes. Nonlinear unconditionally monotone difference schemes arc-constructed for the time-dependent transport equation.

(The entire paper is not available)

Geoinformation Technology Application to the Analysis of Ecological Problems of Kazakhstan

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With independence the Republic of Kazakhstan received from the former Soviet Union the large complex of ecological problems. These problems, caused by wide-scale and unreasonable human activity, are complicated by high sensibility of the nature to external effects. Although local effects can cause the processes of lands desertification and degradation.

The cycle of works carried out at the Space Research Institute on creation of geoinformation systems (GIS) for local territories under high anthropogenic stress verify this fact.

It should be noted that geoinformation systems show high effectiveness at analysis and control of ecological processes, especially at nature protection measures. GIS is not only the base of cartographic data, but is also the tool for expert analysis of territories development projects. GIS of such kind, unifying territorial processes monitoring and modelling, are presented in this paper.

GIS of Almaty urban pollution is the most comprehensive one. Here there are integrated into unit chain:

• procedures for cartographic and semantic information input, storage, processing and visualization;

• atmospheric sounding with the aim of vertical distribution of wind and inversion layers which are used by the mathematical models in on-line regime;

• the package of mathematical models for pollutant transfer and diffusion, meteorological elements objective analysis, inversion layer dynamics and others;

• interface between the system and the user.

As result the system for short-term prognosis of urban pollution which can be involve into the ecological monitoring system has been engineered.

One of consequences of the ecological crisis in the Aral Sea region are the dust-salt storms from the Sea's dry bottom. On the base of geoinformation technologies there has been worked out the system of space monitoring and modelling of aerosol large-scale output from the territories near the Aral Sea. There have been developed:

• technique for AVHRR/NOAA space images processing to reveal dust-salt storms sources;

• technique for dust and salt plumes identification with the usage of ER Mapper software;

• numerical non-stationary spatial model of particles turbulent diffusion
with the usage of data about dust-salt storms sources under Arc Info
software (using GRID algebra).

The nuclear programs especially strong effected the territory of Semipalatinsk nuclear test site. The works conducted in this direction resulted in:

• creation of geoinformation system on test site territory, intended for current radio-ecological situation analysis with the usage of mathematical modelling methods and remote sensing data;

• analysis of the number ofradio-nuclides migration mathematical models;

• development of the territory digital elevation model;

• working out of the model for radio-nuclides transfer by the ground water;

• realization of the modeling block in the package of models for dose calculation and radio-nuclides transfer by ground waters.

Besides mentioned GIS there are carried out a number of projects on monitoring of agricultural lands and other territories in Kazakhstan. All these works are fulfilled on the base of conceptual agreements allowing to sum them into unified geoinformation system - the "Kazakhstan" GIS.

(The entire paper is not available)

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SECTION
"CONTROLLABILITY AND OPTIMALITY OF DYNAMIC SYSTEMS"

The Method of Generalized Lagrange Multipliers in Optimal Control Problems

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Resume.
In the work the optimal control problems prescribed by operator relations in the Banach spaces are considered. The development of the absolute minimum theory based on the V.F.Krotov lemma is given.

Key words: *the Lagrange multipliers; optimal control; optimality conditions.*

Introduction. The generalized V.F.Krotov lemma is given. The sufficient optimality conditions for the control problems prescriebed by operator relations in the Banach spaces are stated.

Let $K=\{k|k=1,2,...\}, S=\{s|s=1,2,...\}$ be index sets. We assume that the families of the sets $\{\ D_k, k\in K\ \}, v_k \in D_k$ are given. The functional $J_k: D_k\to R$ on D_k is given.

Lemma 1. Let the problems $\{<<D_k, J_k>>, k \in K\}$ satisfy to the conditions:1^0. for all $k\in K: J_k(v)\geq J_{k+1}(v), v \in D_k$;$2^0$. there are the integers $p,q\in K$ and the sequence $\{v_s, s\in S\}\subset D_p$ such that $p<q$ and $\lim\limits_{s\to\infty} = i_q = \inf_{D_q} J_q$. Then $\{v_s, s\in S\}$ is minimizing for the problems $\{<<D_k, J_k>>, k= p, p+1,..., q\}$ and any minimizing sequence for $<<D_k, J_k>>$ satisfies to the condition 2^0 and is also minimizing for family of problems $\{<<D_k, J_k>>, k= p, p+1,..., q\}$. Let Y_1, Y_2, U_1 be the Banach spaces, Y_1 be reflexive, continuously and densely embedding in Y_2. $Y=Y_1^n$, $U=U_r$ with elements $y=\{y_1,...,y_n\}$ and $u=\{u_1,...,u_r\}$ correspondingly, $\{y, u\}$ be the pair state-control. Let

Let P be the closed convex cone with non-empty interior [2]. Assume that this cone consists of the non-negative elements from Y_2, that is, $P=\{z\in Y_2/z\geq 0\}$ and the abjoint cone $P^*=\{z^*\in Y_2/<z, z^*>\geq 0$ for $\forall z\in P\}$.
We suppose that the pair state-control satisfies to the following functional constraints:

$$A_i(y,u)=O_{Y_2}, i=1,...,l_1, A_i(y,u)\geq O_{Y_2},\quad i=l_1+1,...,l. \tag{2}$$

We designate a set of pairs (y,u) which satisfy (1), (2) as D_l and assume $D_l\neq\emptyset$. Functional $J_l(y,u)$ is defined in D_l.

Problem. To find a solution of the minimization problem $<<D_l, J_l>>$.

Let

$$D_2=\{y,u|(1)\}, J_2(y,u)=J_1(y,u)-\\ -\sum_{i=1}^{l}<\lambda i(y), Ai(y,u)>, \tag{3}$$

where

$\lambda_i: Y\to Y_2, i=1,...,l_1,\ \lambda_i: Y\to P^*,$
$i=l_1+1,...,l,$

are nonlinear operators.

Theorem 1. Let there are

a). operators $\lambda_i, i=1,...,l$;

b). sequence $\{\ y_s, u_s, s\in S\ \}\subset D_l$ such that

$$\lim_{s\to\infty} J_l(y_s,u_s) = i_2 = \inf_{D_2} J_2 \qquad (4)$$

Then $\{y_s,u_s,s\in S\}\subset D_l$ is minimizing for $<< D_l, J_l >>$, and any minimizing sequence for the problem $<< D_l, J_l >>$ satisfies to the condition (4).

Theorem 2. Let there are a) operators $\lambda_i, i = 1,...,l$; b) the pair $\{\bar{y},\bar{u}\}\in D_l$ such that

$$J_l(\bar{y},\bar{u}) = i_2 = \inf_{D_2} J_2 . \qquad (5)$$

Then the pair $\{\bar{y},\bar{u}\}\in D_l$ is the minimum for $<< D_l, J_l >>$, and any minimum for the problem $<< D_l, J_l >>$ satisfies to the condition (5). The proofs of the theorems 1, 2 follow from lemma 1 and [3,4,5]. We consider the successive improvement algorithm for the approximated solution of the problem $<< D_l, J_l >>$ according to theorems 1, 2. Assume that $l = l_l$, that is, the inequalities from (2) are absent. The proposed algorithm consists from the following basic steps:

1^0. give the initial approximation of the control u_0;

2^0. define the state set y on the control u_0

$$Y^0 = \{y | y \in Y(1),(2)\}; \qquad (6)$$

3^0. solve the minimization problem for the functional $J_l(y,u_0)$ an the set Y^0 (6), that is, we find either the element $y_0 = \arg\inf_{y\in Y^0} J_l(y,u_0)$ or the sequence $\{y_{0s}\}\subset Y^0$ such that $\lim_{s\to\infty} J_l(y_{0s},u_0) = \inf_{y\in Y^0} J_l(y,u_0)$; in the last case we take the element of the sequence $\{y_{0s}\}$ which ensures a required exactness instead of element y_0;

4^0. find the operators $\lambda_i^{(l)}(y), i = 1,...,l_l$ from the condition

$$H(y_0,\tilde{u}^{(l)}(y_0)) = \sup_{y\in Y_c} H(y,\tilde{u}^{(l)}(y),\lambda^{(l)}),$$

Where

$$J_1(y_{s-1},u_{s-1}) = \inf_{y\in Ys-1} J_1(y,\tilde{u}^{(s-1)}(y)) =$$
$$= J_1(y_{s-1},\tilde{u}^{(s-1)}(y_{s-1})) =$$
$$= J_1(y_{s-1},\tilde{u}^{(s-1)}(y_{s-1})) -$$
$$- \sum_{i=1}^{l_1} < \lambda_i^{(s)}(y_{s-1}), A_i(y_{s-1},\tilde{u}^{(s-1)}(y_{s-1})) > =$$
$$= H(y_{s-1},\tilde{u}^{(s-1)}(y_{s-1}),$$
$$\lambda^{(s)}(y_{s-1})) \ge \inf_{u\in U_c(y_{s-1})} H(y_{s-1},u,\lambda^{(s)}(y_{s-1}))$$

we obtain (10) . From (10) and (7) we shall have the inequality (8) and the equality (9). This finishes the proof of theorem 3. The step 4^0 is main, which define the iterations of above proposed algorithm. The realization of this step can be various, some of them are investigated in [1]

Conclusions: The given results are applied to various control problems in technics, chemical technologie and so on.

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On the Problem of Space Vehicle Soft Landing at the Target Point on Planet Surface

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Keywords: optimal descent of space vehicle, maximum principle, quasilinearization method, linear-quadratic problem of optimal control.

We consider the time-optimal problem of space vehicle (SV) soft landing at the target point on planet surface. We assume that lander engine's thrust G is a fixed value and SV motion is controlled by rotation of thrust direction. SV motion equations [1] may be represented as

$$\dot{s} = v, \quad \dot{h} = w,$$

$$\dot{w} = \frac{v^2}{R+h} - g(h) - \frac{F(h,V)w}{mV} + \frac{G\sin\theta}{m},$$

$$\dot{v} = \frac{wv}{R+h} - \frac{F(h,V)v}{mV} + \frac{G\cos\theta}{m}, \qquad (1)$$

where s is a SV coordinate in relation to the target point, h is an altitude over the planet surface, w is a vertical component of the SV velocity, v is a horizontal component of the SV velocity, θ is an angle included between $\vec{v}$ and $\vec{G}$, R is the planet radius, $g(h)$ is a gravitational acceleration, $F(h,V)$ is an air drag, V is a SV velocity, m is a SV mass.

We try of solution of the time-optimal control problem on differential constraints (1), initial conditions $h(t_0) = h_0$, $w(t_0) = w_0$, $v(t_0) = v_0$ and final conditions $s(t_*) = 0$, $h(t_*) = 0$, $w(t_*) = 0$, $v(t_*) = 0$.

This problem may be solved using maximum principle of Pontryagin and quasilinearization method [2], where at each step of iterative process the analytical method of solution of linear-quadratic optimal control problem for systems with fixed endpoints of trajectories is applied [3, 4].

The concrete example that confirms an efficiency of suggested method is considered. A contolled SV, which begins descent with initial velocity 6 *km/s* from height of 45 *km* and distance of 40,8 *km*, can accomplish soft landing nearly at the target point on the planet surface (a range deviation is less than 6 *sm*).

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On Necessary Conditions of Optimality for Burger's Control Problem

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Resume

It is considered the optimal control problem of system governed by one-dimensional Burgers's equation. It was taken a necessary condition of optimality due to the Bellman's approach which the optimal control and adjoined state must satisfy.

Keywords. *Burgers's equation, optimal control.*

Introduction. The problem we consider is a nonlinear distributed control problem governed by one-dimentional Burgers's equation. Of course the main point of an application is to construct an optimal control. It is known, that the tool used to construct the optimal control is the Pontryagin maximum principle, a set of necessary conditions which an optimal control must satisfy.
The objective of this paper is to derive the some necessary condition that is connection between optimal control and adjoined state by dynamic programming method.

Let $\Omega=[0,l]$- set from R^1, $Q = \Omega\times[s,T]$, $0\le s\le t\le T<\infty$.

Assume that z- state, $v\in L^2(Q)$- control of system, governed by equation

$$z_t - \nu z_{xx} + zz_x = v \qquad (1)$$
$$z(t,0)=0, z(t,l)=0, \quad z(s,x)=y^s(x)$$

Here $y^s(x)$ is given, ν - constantly viscous coefficient.
Subject to (1) - (2) find $u\in L^2(Q)$ that minimizes the cost functional

$$J(v) = \int_Q [h(y(x,t)) + g(v(x,t))]\,dxdt\ , \qquad (2)$$

where h and g is positive given functions, g s convexity, semi-continuos

$$\forall v\in U:\ g(v)\ge a\|v\|_U^2 + b, \text{ where } a,b\in R,$$
$$\forall z\in H:\ h(z)\ge (c,z)+d, \text{where } d\in R,\ c\in H.$$

This optimal control problem was studied in [1] at the point of view constructing the computing method finding that optimal control to get "desirable " state of the system with only difference in problem treat that a control were realized on the border.
It is known, to compute this problem resort to methods of minimization of LaGrange cost functional which were made on the basis of equations and initial - boundary conditions. However, in its turn, also well known that most minimization methods suppose using the Gradient of cost functional (the like calls as gradient-down methods).
But finding out obvious form of the gradient of cost functional presents some difficulty.
In [1] was shown how to get obvious discreet form of cost functionless gradient for considerable optimal control problem at once. Authors propose to solve that problem by one of down-methods(for example, a method of adjoined gradients). In that case researcher has two connections between the state- control pair and state - adjoined state pair. Usually, for adjoined state p(t,x) by using Euler's 1-st order necessary conditions [2] is taken the equation:

$$p' + \nu p_{xx} + zp_x + \nabla_z h(z) = 0 \qquad (3)$$

It is that connection between p(t,x) and z(t,x).
The need of the connection between adjoined state and optimal control does'nt mentioned in [1], although on the our view point this moment of investigation of considered problem must'nt be missed.
Thus, our further treat wiil be devoted to get that connection. In [2] and other research works of J.-L. Lions that connection calls quazi-variational inequality(or equality in depend on the form of restrict to control function) and its deduce closely connected with minimization theory of convexity functionals , taking process of first two connections by Euler's 1-st order necessary conditions.
In this paper we present the bring of that connection by Bellman's approach [3].
At first consider a function:

$$R(\tau, y^\tau) = G - V\ ,$$

where

$$V(\tau, y^\tau) = \int_\tau^T [h_1(z(r)) + g_1(u(r))] dr$$

here u - optimal control,

$$h_1(z(t)) = \int_0^l h(z(t,x))\,dx\ ,\ g_1(v(t)) = = \int_0^l g(v(t,x))\,dx\ ;$$

$$G(\tau, y(\tau, s, y^s)) = = \inf_v \{ \int_\tau^T [h_1(z(r;\tau, y(\tau, s, y^s))) + g_1(v(r))] dr \}\ ,$$

here y(.) -optimal trajectory: $y(\tau, s, y^s) = y^\tau$.
From definition of J and V we have, that

$$J(u,y,s,y^s) = V(s,y^s)|_{z=y} = G(s,y^s)$$

It means that the function $R(\tau, y^{\tau})$ reaches its maximum on the optimal trajectory and max R=0.
We have next statement[3]:
Statement 1. The function $G(t, y^t)$ is a solution of equation:

$$G_t - (G_z, \nu z_{xx} + zz_x) + \inf\{(G_z, v) + g(v)\} + + h(z) = 0 \qquad (4)$$

$$G(T,.) = 0$$

Further, from [3] also we can take:

$$\inf_v \{(p,v) + g(v)\} = (p,u) + g(u) \quad (5)$$

That is the search connection between optimal pair (p,u).

Conclusion. Usually the above taken relation is deduced from necessary condition of extremum. We attempt to show the opportunity taking of that by Bellman's principle. The technique of this paper is also can be applying to the control problem governed by parabolic nonlinear equations.

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On the Inverse Stochastic Circuit's Problem

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Resume

One of the inverse problems of dynamics - the circuit's problem by given properties of motion into the class of stochastic differential Ito's equations of second order is considered. The necessary and sufficient conditions of the existence of given integral manifold of the building system of stochastic equations are received.

Keywords: *the inverse problem of circuit, stochastic Ito equation, integral manifold.*

Introduction. At the present have been formulated possible statements of the inverse problems of mechanical systems' dynamics (problems of forces' and moments' definition by given properties of motion) and developed common methods of their problems' solution, mainly, in a class of ODE (ordinarry differential equations)[1-4]. In addition, it turns out that if the given properties of mechanical systems' motion can be analytically represented as first or particular integral of corresponding equations of motion, so in general, the inverse problems of dynamics' solution is reduced to the construction of differential equations by their given integrals and to the definition later on using them reseaching forces and moments, parameters and constraints, which are necessary to realize mechanical systems' motion by preliminary given properties. Howere, the initial problem for solution of inverse problem of dynamics is the problem which is posed by N..P. Erugin [5]. It is necessary to mark, that one from common methods of a solution of inverse problem of dynamics in a class ODE (quasi-inversion's method) is offered in work [3].

Importance of a research of inverse problem of dynamics in a class of stochastic differential Ito equations it is explained as broad application in mathematical modelling of these equations, as lack of common methods of solution of inverse problems of dynamics in the presence of random disturbances.

Below the solution by one from an inverse problems of dynamics - stochastic circuit's problem is reduced in a class of stochastic differential second order's equations of Ito's type.

The solution of fundamental, according to A.S. Galiullin [1], inverse problem in probable statement is received in the work of the author [6].

Statement of the inverse circuit's problem of dynamics in the presence of random disturbances. The different inverse problems of dynamics into the class of the ordinary differential equations are investigated in [1-3]. The concept of the inverse circuit's problem into the class of stochastic differential Ito's equations of second order can be formulated as follow.

Let us give stochastic differential equation of Ito's type

$$\ddot{x} = f_1(x,\dot{x},u,\dot{u},t) + \sigma_1(x,\dot{x},u,\dot{u},t)\dot{\xi} \quad (1)$$

and it is required to reconstruct the circuiting equation

$$\ddot{x} = f_2(x,\dot{x},u,\dot{u},t) + \sigma_2(x,\dot{x},u,\dot{u},t)\dot{\xi} \quad (2)$$

by given particular integrals

$$\Lambda(t):\lambda(x,\dot{x},u,\dot{u},t) = 0, \lambda \in R^m, \lambda \in C^{12121}_{x\dot{x}u\dot{u}t} \quad (3)$$

Or else, it is required to define a vector-function f_2 and matrix σ_2 by given f_1, σ_1 and λ, so that the set (3) was integrated for a joint system of equations (1), (2).

It is here $x \in R^n, u \in R^r, \xi \in R^k$ and σ_1, σ_2 are the matrixs of dimensionality accordingly $(n \times k)$ and $(r \times k)$; $\{\zeta_1(t,\omega),\ldots,\zeta_k(t,\omega)\}$ is the system of independent Wiener random process [7], given on some probable space (Ω, U, P).

Let us suppose that vector-functions f_1, f_2 and matrixs σ_1, σ_2 are continuous on t and lipschitzian on $x, u, \dot{x}, \dot{u}$ in a domain

$$U_H(\Lambda) = \{z = (x^T, \dot{x}^T, u^T, \dot{u}^T)^T : \rho \qquad (z, \Lambda(t)) < H, H > 0 \quad (4)$$

that ensures in (4) existence and uniqueness up to stochastic equivalence of a solution $z(t)$ of the system of equations (1), (2) with initial condition $z(t_0) = z_0$, being continuous with probability 1 strict Markov process [7].

The indicated problem in case of a lack of random disturbances $(\sigma_1 \equiv \sigma_2 \equiv 0)$ is investigated enough completely in works [1-4].

In the present work a quasi-inversion's method of R. G.. Muharliamov [3] is applied in the problem of circuit of stochastic differential equations second of Ito's type.

It is made for a solution of the posed problem according to a rule of stochastic Ito's derivation the equation of perturbed driving

$$\begin{aligned}\dot{\lambda} = {} & \frac{\partial \lambda}{\partial t} + \frac{\partial \lambda}{\partial x}\dot{x} + \\ & + \frac{\partial \lambda}{\partial \dot{x}} f_1 + \frac{\partial \lambda}{\partial u}\dot{u} + \\ & + \frac{\partial \lambda}{\partial \dot{u}} f_2 + \frac{1}{2}\left[\frac{\partial^2 \lambda}{\partial \dot{x}^2} : \sigma_1 \sigma_1^T\right] + \\ & + \frac{1}{2}\left[\frac{\partial^2 \lambda}{\partial \dot{u}^2} : \sigma_2 \sigma_2^T\right] + \left(\frac{\partial \lambda}{\partial x}\sigma_1 + \frac{\partial \lambda}{\partial u}\sigma_2\right)\dot{\xi}\end{aligned} \quad (5)$$

where $\dfrac{\partial^2 \lambda}{\partial \dot{x}^2} : D$ is, following [7], the vector, elements of which are the tracks of matrixs' products of flexions of corresponding elements $\lambda_\mu(x, \dot{x}, t)$ of a vector $\lambda(x, \dot{x}, t)$ to the components $\dot{x}$ on a matrix D

$$\frac{\partial^2 \lambda}{\partial \dot{x}^2} : D = \begin{bmatrix} tr\left(\dfrac{\partial^2 \lambda_1}{\partial \dot{x}^2} D\right) \\ \vdots \\ tr\left(\dfrac{\partial^2 \lambda_m}{\partial \dot{x}^2} D\right) \end{bmatrix}$$

Let's enter any functions of N. P. Erugin [5]: m¬dimensional vector- function A and $(m \times k)$ - dimensionala matrix B , possessing a property $A(0, x, \dot{x}, u, \dot{u}, t) \equiv 0, B(0, x, \dot{x}, u, \dot{u}, t) \equiv 0$, thus has a place

$$\dot{\lambda} = A(\lambda, x, \dot{x}, u, \dot{u}, t) + B(\lambda, x, \dot{x}, u, \dot{u}, t)\dot{\xi}, \quad (6)$$

From here, comparing the equations (5) and (6) we come to relations

$$\begin{cases} \dfrac{\partial \lambda}{\partial \dot{u}} f_2 = A - \dfrac{\partial \lambda}{\partial t} - \dfrac{\partial \lambda}{\partial x}\dot{x} - \dfrac{\partial \lambda}{\partial \dot{x}} f_1 - \\ - \dfrac{\partial \lambda}{\partial u}\dot{u} - \dfrac{1}{2}\left(\left[\dfrac{\partial^2 \lambda}{\partial \dot{x}^2} : \sigma_1 \sigma_1^T\right] + \left[\dfrac{\partial^2 \lambda}{\partial \dot{u}^2} : \sigma_2 \sigma_2^T\right]\right), \\ \dfrac{\partial \lambda}{\partial \dot{u}}\sigma_2 = B - \dfrac{\partial \lambda}{\partial \dot{x}}\sigma_1, \end{cases} \quad (7)$$

from which it is necessary to define a vector-function f_2 and matrix σ_2. For a solvability of the problem it is required Lemma [3]. The set of all solutions of a linear system

$$\begin{aligned} & Hv = g, H = (h_{\mu k}), v = (v_k), g = (g_\mu), \\ & \mu = \overline{1,m}; k = \overline{1,n}, m \le n, \end{aligned} \quad (8)$$

where the matrix H has a rank equal m, is determined by expression

$$v = sv^\tau + v^\nu, \quad (9)$$

here s - any scalar value,

$$v^{\tau} = [HC] = [h_1 \ldots h_m c_{m+1} \ldots c_{n-1}] = \begin{vmatrix} e_1 & \ldots & e_n \\ h_{11} & \ldots & h_{1n} \\ \ldots & \ldots & \ldots \\ h_{m1} & \ldots & h_{mn} \\ c_{m+1,1} & \ldots & c_{m+1,n} \\ \ldots & \ldots & \ldots \\ c_{n-1,1} & \ldots & c_{n-1,n} \end{vmatrix}$$

is a vector product of vectors $h_\mu = \left(h_{\mu k}\right)$ and any vectors $c_\rho = \left(c_{\rho k}\right)$, $\rho = \overline{m+1, n-1}$; e_k – single basis vectors of space R^n, $v^\tau = \left(v_k^\tau\right)$, where

$$v_k^\tau = \begin{vmatrix} 0 & \ldots & 1 & \ldots & 0 \\ h_{11} & \ldots & h_{1k} & \ldots & h_{1n} \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ h_{m1} & \ldots & h_{mk} & \ldots & h_{mn} \\ c_{m+1,1} & \ldots & c_{m+1,k} & \ldots & c_{m+1,n} \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ c_{n-1,1} & \ldots & c_{n-1,k} & \ldots & c_{n-1,n} \end{vmatrix}, \quad v^\nu = H^+ g$$

$H^+ = H^T\left(HH^T\right)^{-1}$, H^T – matrix transposed to H.

By designating through $\widetilde{B} = B - \frac{\partial \lambda}{\partial \dot{x}}\sigma_1$, according to the formula (9) of lemma from relations (7) we shall define unknown vector-function f_2 and matrix σ_2 as

$$f_2 = s_1\left[\frac{\partial \lambda}{\partial \dot{x}} C\right] + \left(\frac{\partial \lambda}{\partial \dot{x}}\right)^+ b_1, \qquad (10)$$

$$\sigma_{2i} = s_2\left[\frac{\partial \lambda}{\partial \dot{x}} C\right] + \left(\frac{\partial \lambda}{\partial \dot{x}}\right)^+ \widetilde{B}_i, i = \overline{1,k}, \qquad (11)$$

where $\sigma_{2i} = \left(\sigma_{21i}, \sigma_{22i}, \ldots, \sigma_{2ni}\right)^T$ - the i- column of a matrix $\sigma_2 = \left(\sigma_{2\nu j}\right)$, $(\nu = \overline{1,n}$, $j = \overline{1,k})$; $\widetilde{B}_i = \left(\widetilde{B}_{1i}, \widetilde{B}_{2i}, \ldots, \widetilde{B}_{ri,}\right)^T$ - the i-column of a matrix $\widetilde{B} = \left(\widetilde{B}_{\mu l}\right)$, $(\mu = \overline{1,r}, l = \overline{1,k})$,

$$b_1 = A - \frac{\partial \lambda}{\partial t} - \frac{\partial \lambda}{\partial x}\dot{x} - \frac{\partial \lambda}{\partial \dot{x}} f_1 - \frac{\partial \lambda}{\partial u}\dot{u} - \frac{1}{2}\left(\left[\frac{\partial^2 \lambda}{\partial \dot{x}^2} : \sigma_1\sigma_1^T\right] + \left[\frac{\partial^2 \lambda}{\partial \dot{u}^2} : \sigma_2\sigma_2^T\right]\right),$$

$$\left[\frac{\partial \lambda}{\partial \dot{x}} C\right] = \begin{vmatrix} e_1 & \ldots & e_n \\ \frac{\partial \lambda_1}{\partial \dot{x}_1} & \ldots & \frac{\partial \lambda_1}{\partial \dot{x}_n} \\ \ldots & \ldots & \ldots \\ \frac{\partial \lambda_m}{\partial \dot{x}_1} & \ldots & \frac{\partial \lambda}{\partial \dot{x}_n} \\ c_{m+1,1} & \ldots & c_{m+1,n} \\ \ldots & \ldots & \ldots \\ c_{n-1,1} & \ldots & c_{n-1,n} \end{vmatrix}.$$

Therefore, it is proved

Theorem. A necessary and sufficient condition for a set (3) to be integral manifold of a system of differential equations (1), (2) is that the vector-function f_2 and the matrix σ_2 of the closing equation (2) have accordingly the form (10) and (11).

Conclusions

In this article it is investigated the influence of randon perturbed actions on a resolvability of the inverse problem of circuit of the equations of second order. Namely, the system of stochastic closured equations is rebuilded by given partial integrals. The indicated criterion takes into account the intensity of randon perturbed forces, acting to the system.

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The Synthesis of a Non-Autonomous System Indirect Control

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Resume

The problems of high speed regulator and reregulation for of Popov's non-autonomous system of indirect control , with defined characteristics are resolved .

Keywords : *high speed regulator, reregulation, estimation, indirect control, manifold, Liapunov's function.*

Introduction. It is formulated in [1] the synthesis's problem for asymptotically stable systems, owning the given quality, and proposed certain method of synthesis of law of inverse connection. In [2] conceded the synthesis of automatic systems of certain quality. In [3] received the synthesis these systems wish properties in the form of given of integral manifold . In the present article we investigate Popov's non-autonomous system.

We concede a matrix's class E, with continuously differentiable and bounded norm for $\forall t \in [0,\infty[$ and given manifold $\Omega \equiv \omega(t,x) = 0$, which is an integral for system

$$\dot{x} = f(t,x) - B(t)\varphi(t,\sigma),$$
$$\dot{\xi} = \varphi(t,\sigma), \sigma = P^T(t)\omega - R(t)\xi \quad (1)$$

with the condition $R(t) >> 0$.

Here $B(t) \in \Xi^{n\times r}$, $P(t) \in \Xi^{s\times r}$, $R(t) \in \Xi^{r\times r}$, are a non-linear function satisfying the conditions:

$$\varphi(t,0) = 0 \wedge \varphi^T(t,\sigma)\theta(t)(\sigma - K^{-1}(t)\varphi(t,\sigma)) > 0 \forall\sigma \neq 0,$$
$$K_1(t) \le [d\varphi(t,\sigma)]/d\sigma \le K_2(t), [K(t) = K^T(t) >> 0] \in \mathrm{E}^{r\times r}, \quad (2)$$
$$[K_1(t) = K_1^T(t) >> 0, K_2(t) = K_2^T(t) >> 0] \in \mathrm{E}^{r\times r}$$

We shall notice, that (2) it is can obtain from condition the estimation

$$\left(\|\omega\|^2 + \|\xi\|^2\right)\frac{\beta_1}{\nu_2} \le \|\varphi\|^2 \le \frac{\beta_2}{\nu_1}\left(\|\omega\|^2 + \|\xi\|^2\right), \quad (3)$$

were

$\beta_1 = \min\{a_1, b_1\}$;

$\beta_2 = \max\{a_2, b_2\}, a_1, b_1, a_2, b_2, \nu_1, \nu_2$

are least and most of own numbers of matrixs

$Ph\theta P^T, R^T h\theta R, \theta K^{-1}; 0 < h(t) < K(t)$.

We shall introduce two spheres

$$\|z(t_0)\|^2 = \|\omega(t_0)\|^2 + \|\xi(t_0)\|^2 = R^2,$$
$$\|z(t_0^*)\|^2 = \|\omega(t_0^*)\|^2 + \|\xi(t_0^*)\|^2 = \varepsilon^2, R >> \varepsilon.$$

Then we receive by force of our suppositions the system in the form of Popov [2]:

$$\dot{\omega} = -A(t)\omega - B(t)\varphi(t,\sigma),$$
$$\dot{\xi} = \varphi(t,\sigma), \quad \sigma = P^T(t)\omega - R(t)\xi \quad (4)$$

Here [4] Erugin's function is $F(t,x,\omega) = -A(t)\omega$, $A(t) \in \Xi^{s\times s}$.

$H(t) = \dfrac{\partial\omega}{\partial x}$, $B(t) = H(t)B_1(t)$.

We suppose that the system (4) has a property of asymptotic stability into the sphere R for $\forall t_0$.. Then exist a moment t_0^* :

$$\| \quad z(t_0^*, t_0, z_0) \quad \| = \varepsilon; \| \quad z(t, t_0, z_0)$$

Statement of the problem : Let us give set M of laws of inverse connection. It is require to define the subset, were the condition of high regulator and reregulation in neighborhood of manifold $\Omega(t)$ are executed.

We construct the function for system (4)

$$V = \omega^T L(t)\omega + \int_0^{\varpi} \varphi^T(t,\sigma)\beta(t)d\sigma, \qquad (5)$$

$$\left[L = L^T >> 0\right] \in E^{s\times s}, \quad \left[(diag\beta) >> 0\right] \in E^{r\times r}.$$

In virtue the property (2), function (5) is satisfied the estimation

$$l_1(t)\|z\|^2 \le V \le l_2(t)\|z\|^2. \qquad (6)$$

Here $l_1(t), l_2(t)$ are real, positive, continuos, least and most characteristic equation's roots

$$|\quad \Lambda - lE \quad| = 0,$$

$$z = \|\quad \omega \quad \xi \quad\|^T, \varphi(t,\sigma) = h(t)\sigma;$$

$$\Lambda = \left\| \begin{matrix} L_1 & L_2 \\ L_2^T & L_3 \end{matrix} \right\|, L_1 = L(t) + P(t)K_0(t)P^T(t), L_2^T = PK_0R, \quad L_3 = R^TK_0R,$$

$$\sigma^T K_0(t)\sigma = \int_0^{\sigma} \sigma^T h(t) \quad \beta(t) \quad d\sigma,$$

$$K_0(t) = \left\| \begin{matrix} (K_{11}^{(0)})/2 & \cdots & K_{1r}^{(0)} \\ . & . & . \\ K_{r1}^{(0)} & \cdots & (K_{rr}^{(0)})/2 \end{matrix} \right\|;$$

If we differentiate the function (5) by force of system (4), then we have

$$-\dot V = \omega^T G_0\omega + 2\omega^T G_1\varphi + 2\omega^T G_2\xi + 2\varphi^T G_4\xi + \varphi^T G_3\varphi + \xi^T G_5\xi > 0, \qquad (7)$$

where

$$G_0 = A^TL + LA - \dot L + A^TPK_2\beta P^T - \dot PK_2\beta P^T - PN_1P^T;$$

$$G_1 = LS + \tfrac{1}{2}(P \quad \beta \quad K_2P^TB - P \quad \beta \quad K_2$$

$$G_2 = \tfrac{1}{2}\left(P\beta K_2\dot R + A^TPK_2\beta R - \dot PK_2\beta R\right) - PN_1R;$$

$$G_3 = \beta R; \quad G_5 = \dot R^T K_2\beta R - R^TN_1R;$$

$$G_4 = R^TK_2\beta R - B^TPK_2\beta R + \beta P^TR + \beta\dot R;$$

$$\int_0^{\sigma} \frac{\partial\varphi^T(t,\sigma)}{\partial t}\beta(t)d\sigma \le \int_0^{\sigma} \dot\sigma^T K_2\beta d\sigma;$$

$$\int_0^{\sigma} \sigma^T M^{(1)} d\sigma = \sigma^T N_1\sigma;$$

$$M^{(1)} = h\frac{\partial\beta}{\partial \quad t};$$

$$N_1 = \left\| \begin{matrix} m_{11}^1/2 & \cdots & m_{1r}^1 \\ . & . & . \\ m_{r1}^1 & \cdots & m_{rr}^1/2 \end{matrix} \right\|;$$

$$\varphi^T\beta \qquad \dot\sigma = \omega^T H_0 \qquad \varphi + \varphi^T H_1$$

$$\xi + \varphi^T H_2 \qquad \varphi;$$

$$H_0 = A^TP\beta - \dot P\beta;$$

$$H_1 = \beta \qquad P^TR + \beta \qquad \dot R;$$

$$H_2 = \beta \qquad R.$$

In virtue inequality (7) there is the estimation

$$q_1(t)\gamma_1\|z\|^2 \le -\dot V \le q_2(t)\gamma_2\|z\|^2. \qquad (8)$$

Here

$$z = \|\omega \quad \xi\|^T; \quad Q = \left\| \begin{matrix} G_0 & G_1 & G_2 \\ G_1^T & G_3 & G_4 \\ G_2^T & G_4^T & G_5 \end{matrix} \right\| >> 0;$$

are real, positive, continuos, least and most roots of characteristic equation's

$$|Q - qE| = 0,$$

$$\gamma_1 = \min\left\{1, \frac{\beta_1}{\nu_2}\right\}, \gamma_2 = \max\left\{1, \frac{\beta_2}{\nu_1}\right\}.$$

By force of estimations (7), (8) we obtain the inequality

$$l_2^{-1}(t)V_0 \exp\left[-\int_{t_0}^{t} \alpha_1(t) \quad dt\right] \le$$

$$\le \| \quad z \quad \|^2 \le l_1^{-1}(t)V_0 * \qquad (9)$$

$$* \exp\left[-\int_{t_0}^{t} \alpha_2(t) \quad dt\right],$$

where

$$\alpha_1(t) = [q_2(t)]/[l_1(t)];$$

$$\alpha_2(t) = [q_1(t)]/[l_2(t)]; V_0 = V(\omega_0, \xi_0).$$

If we suppose , that

$$\alpha_1 = \inf_t \alpha_1(t) \wedge \alpha_2 = \sup_t \alpha_2(t),$$

$$l_1 = \inf_t l_1(t) \wedge l_2 = \sup_t l_2(t),$$

then from inequality (9) we receive the simplicities estimations

$$l_2^{-1}(t)V_0 \exp[-\alpha_1(t-t_0)] \le$$

$$\le \| z \|^2 \le l_1^{-1}(t)V_0 \exp[-\alpha_2(t-t_0)] \quad (10)$$

By force of inequalities (7), (10) into the sphere R, we obtain the relation

$$\|z(t)\|^2 \le l_1^{-1} l_2 R^2 \exp[-\alpha_2(t-t_0)]. \quad (11)$$

Let we have then from (11) for $t = t_0$

$$l_1^{-1} l_2 R^2 \exp[-\alpha_2(t-t_0)] = \varepsilon^2$$

or

$$t_0^* - t_0 = -\alpha_2^{-1} \ln[(\varepsilon^2 l_1)/(R^2 l_2)].$$

Whence an expression for time regulation follows

$$t_p = t^* - t_0 = -\alpha_2^{-1} \sup_{t_0} \ln[(\varepsilon^2 l_1)/(R^2 l_2)].$$

Reception of the synthesis's problem a of high speed regulator will obtain from follows inequality:

$$-\alpha_2^{-1} \sup_{z_0} \ln[(\varepsilon^2 l_1)/(R^2 l_2)] \le t_з; \; \textit{were } t_з - \textit{is given}$$

For receive of reregulation problem $\Phi(\omega, \xi) = V$, where V is defined by relation (5), we linearize the function V:

$$V = \omega^T L_1 \omega + 2\omega^T L_2 \xi + \xi^T L_3 \xi .$$

By force of (11), we receive

$$\Pi = \sup_t \{ l_1^{-1} l_2 R^2 \exp[-\alpha_2(t-t_0)] - s \} / s; \quad s = z(\infty).$$

As $\alpha_2 > 0$, then by the given positive number $\Pi_з$ we have the condition of reregulation in the form of

$$R^2 \le s(\Pi_з + 1) l_1 l_2^{-1}.$$

Conclusion

It is received the estimations in the terms of system's coefficients by the method of Liapunov function in the form «of quadratic form plus integral from non-linearity » . These estimations make sure the conditions of high regulator and reregulation of process's transition for the non-autonomous systems in the form Popov in neighborhood of manifold $\Omega(t)$.

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Control in the Model Equation with Nonlinear Performance of a Material

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Resume.
The method of a functional Liapunov is applied to the model equation of the reactor of a new type.

Keyword. *Control, model, equation.*

Introduction. Subject of study is the model equation of an aspect

$$\frac{\partial u}{\partial t} = F(u) + \sum_{i=1}^{n} \frac{\partial}{\partial \xi_i}\left(g\left(\tau^2(u)\right)\frac{\partial u}{\partial \xi_i}\right) \quad (1)$$

where $F(u)$ - function of exterior action, and $g(u)$ - performance of a material depending on fluence of neutrons.

Let $\Omega \subset R_n$ area n-dimensional of space R_n, and $\partial\Omega$ - it the boundary. A point $u = u(\xi_1, \xi_2, \dots, \xi_n) \in \Omega_n$. We shall assume, that function [1].

1) $g(u)$ is definitely positive, continuously is differentiated and has a place of an inequality:

$$g(\zeta) + 2g'(\zeta)\zeta \ge a_1, \qquad a_1 > 0$$

2) there are constants α_0, α_1, A_0 and A_1 such, that

$$\alpha_0 + \alpha_1 \zeta^{\frac{p}{2}-1} \le g(\zeta) \le A_0 + A_1 \zeta^{\frac{p}{2}-1}$$

3) at $n \to \infty$ $\quad g'(\zeta) = 0\left(\zeta^{\frac{p}{2}-1}\right)$

4) at anyone final $\zeta \ge 0$ functions $g(\zeta)$ have a continuous flexon.

Let's enter space $\overline{W}^{l,p}(\Omega)$ which is a subspace Sobolev of space $W^{l,p}(\Omega)$ and represents closure in the metric $W^{l,p}(\Omega)$ of a set of rather smooth functions.

Let's with the help of shall enter kinetic energies

$$\tau(u) = \left(\sum_{i=1}^{n} \left(\frac{\partial u}{\partial \xi_i} \right)^2 \right)^{\frac{1}{2}}$$

a norm of space $\overline{W}^{l,p}(\Omega)$ under the formula,

$$\|u\| = \left(\int_{\Omega} (\tau(u))^{\frac{p}{2}} d\xi \right)^{\frac{1}{p}}$$

which is equivalent to a norm Sobolev of space.

Let's enter a class of monotone functions $\{u_k(\xi)\}$, possessing properties:

à) at everyone of $\xi \in \Omega$

$$u_k(\xi) \ge u_{k+1}(\xi)$$

also there are $\frac{\partial u_k}{\partial \xi_i}(\xi)$ k = 1, 2, …, L;

i = 1, 2, …, n, such, that

$$\frac{\partial u_k}{\partial \xi_i} \ge \frac{\partial u_{k+1}}{\partial \xi_i} \qquad k = 1, 2, \dots, L;$$

i = 1, 2, …, n

Set of such functions we shall designate through $L_M(\Omega)$ and on it we shall define space of Sobolev

$$H'(\Omega) = \left\{ u; \quad u \in L_M^2(\Omega), \quad \frac{\partial u}{\partial \xi_i} \in L_M^2(\Omega) \quad i = 1,2,\dots,n \right\}$$

$H'_0(\Omega)=\{u;\ u\in H'(\Omega)\ \ and\ \ u=0\ \ under\ \ \xi\in\partial\Omega\}$

Complicated from argument u the function g is supposed subordinate to conditions:

$$\left|g(u)\frac{\partial u}{\partial\xi_i}\right|\le a(\xi)|u|^2+b(\xi)\left|\frac{\partial u}{\partial\xi_i}\right|^2 \qquad i=1,2,\dots,n$$

where $a(\xi)$, $b(\xi)$ limited measurable functions defined in Ω with a limited Lebesgue measure. Under these conditions the equality

$$g(u,w)=-\sum_{i=1}^{n}\int_{\Omega}g(u)\frac{\partial u}{\partial\xi_i}\frac{\partial\omega}{\partial\xi_i}d\xi$$

is linearly limited functional on ω, that is why it determines nonlinear rather u an operator

$$g:H'_0(\Omega)\to H'(\Omega)$$

Let's define abstract function $x(t)$ with values in some Banach space as follows. Each function $u(t,.)$ at everyone fixed $t\in[0,T]$ from $L_M^2(\Omega)$ we shall refer function $x(t)\in L_M^2(\Omega)$. If additionally at fixed $\xi\in\Omega$ the function $u(.,\xi)$ is differentiated on t with values in space continuously of differentiable functions defined on Ω, that there is a derivative $\frac{dx}{dt}$ and has a value in $L_M^2(\Omega)$.

The function

$F(u)\in L^{p'}([0,T],W^{-1,p'}(\Omega)+H^{-1}(\Omega))$

is considered specific. By virtue of imposed conditions the constructed operator

$g:L^p([0,T],H'_0(\Omega)\cap W'_p(\Omega))\to$

$\to L^p([0,T],W^{-1,p'}(\Omega)\cap H^{-1}(\Omega))$

describes a lack of a radiation at anyone of $t\in[0,T]$ on the boundary $\partial\Omega$

Cauchy problem

$$\frac{dx}{dt}=F(x)+g(x) \qquad (3)$$

$$x(0)=x_0 \qquad (4)$$

in a Banach space

$$L^{p'}([0,T],W^{-1,p'}(\Omega)+H^{-1}(\Omega))$$

thus is obtained.

In (4) $x_0=u(0,\xi)$ specific at $t=0$ functions are described by a denseness of neutrons in an initial moment $t=0$ and by virtue of an embedding theorem it is considered as the element $W^{-1,p}(\Omega)$.

Let's assume, that

$$F\in L^{p'}([0,T],W^{-1,p'}(H^{-1}(\Omega)))$$

is, demicontinuous. Then from (2) follows demicontinuous of an operator

$$g\in L^{p'}([0,T],W^{-1,p'}(H^{-1}(\Omega)))$$

It is necessary to construct a functional of Liapunov of the task (3), (4) to show it a correctness.

Let's enter a functional

$$V(u)=\int_{\Omega}dy\int_{0}^{\tau(u)}g(\varsigma)d\varsigma$$

defined in space $\overline{W}^{1,p}(\Omega)$.

Lemma 1. The functional (5)

$$V:\overline{W}^{1,p}(\Omega)\to R_+$$

is continuous in all space $\overline{W}^{1,p}(\Omega)$.

Lemma 2. The functional $V(u)$ from (5) is potential, and it the potential V' is monotone in $\overline{W}^{1,p}(\Omega)$, that is why $V(u)$ convex.

Corollary. The functional $V:\overline{W}^{1,p}(\Omega)\to R_+$ is semicontinuous from below.

From a lemma 2 implies, that the operator

$$g\in L^{p'}([0,T],W^{-1,p'}(H^{-1}(\Omega)))$$

in a right member (3) is monotone, and as is marked above demicontinuous.

If to assume now, that monotone the operator

$F:L^p([0,T],W^{1,p}(\Omega)+H'_0(\Omega))\to$

$\to L^{p'}([0,T],W^{1,p'}(\Omega)+H^{-1}(\Omega))$

those all conditions of the theorem F. Brauder's [2] for the task (3) is also, (4) are carried out, that is why she is correctly posed.

So, the theorem is fair.

Theorem 1. If the conditions (1) –(3) are executed and the function

$F : L^p([0,T], W^{1,p}(\Omega) + H'_0(\Omega)) \to L^{p'}([0,T], W^{1,p'}(\Omega) + H^{-1}(\Omega))$ is demicontinuous and monotone, the task (3), (4) has in space $L^p([0,T], W^{1,p}(\Omega) \cap H'_0(\Omega))$ a unique continuous solution, depending on initial datas.

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Controllability and Limited Cycles of Control Systems in Critical Case

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Resume

By sinking a source problem in tantamount problem of controllability, constructive methods of limited cycles building were received.

Keywords: *Control systems, limited cycles, phase space, controllability, optimum control.*

Introduction Class of the ordinary differential equations, considered in given work, is mathematical model of: processes of setting rocket into target, automatic assembly of cosmic flying machines on orbits, automatic boarding a plane on aerodrome (on deck of aircraft carrier), dynamic processes in steering drives of planes and rockets and etc.

Unfortunately, because of difficulty of analytical resolution of nonlinear differential equations, today united mathematical conception for designing the nonlinear control systems does not exist.

Possibility to save positions of balance at influence of external indignations in the manner of initial deflections is one of the dynamic system characteristics.

If position of dynamic system balance absolutely stably, such system capable to go back to initial condition (position of balance) under any sudden external indignations in the manner of initial deflections.

Determination of area corresponding limited cycles has such important value as the area of absolute stability. There are set of dynamic systems intended for getting the periodic motions For example, electronic generators, multivibrators and ets.

Consider equations of motion of the controlled system in the manner of:

$$\dot{y} = \overline{A}y + \overline{B}\varphi(\sigma),$$
$$\sigma = Sy,\ \varphi(\sigma) \in \Phi_0,\ t \in \mathrm{I}_r = (-\infty,+\infty) \qquad (1)$$

There is determined permitted area for each dynamic system in phase space, where regulation system ensures normal operation for the whole system. Let permitted area for system operations assigned by following phase restrictions: $\gamma(t) \le F(y(t),t) \le \delta(t)$, (2), where $\gamma(t) = (\gamma_1(t),...,\gamma_r(t))$, $\delta(t) = (\delta_1(t),...,\delta_r(t$ - given continuous vector – functions, function *F(y,t)* determined and unceasing on the union of arguments $(y,t) \in R^{n+m} \times I_1$.

Definition. Resolutions of the system (1), on conditions (2), are limited cycles if $y_*(t) = y_*(t+T_*)$, $\forall t,\ t \in \mathrm{I}_1$, moreover $\gamma(t) \le F(y_*(t),t) \le \delta(t)$, $\forall t,\ t \in \mathrm{I}_1$, where T_* – period. Following problems are putted:

Problem1. To find necessary and sufficient conditions of existence of the T_* – periodical resolutions of system (1) in given area of phase space of the system (2);

Problem2. To find a periodic resolutions of system (1) at conditions (2).

Resolutions of problem 1,2 are considered in two cases: 1) when the "the worst" element of set Φ_0 is known, i.e. $\varphi(\sigma) \in \Phi_0$ – is fixed element; 2) $\varphi(\sigma) \in \Phi_0$ – any fixed function.

I. Consider event, when $\varphi(\sigma) \in \Phi_0$ – is fixed element. As far as system (1) is autonomous; i.e. right part of the

differential equation obviously does not depend on t, i.e. $\bar{A}y_*(t+T_*)+\bar{B}\varphi(Sy_*(t+T_*))=\bar{A}y_*(t)+$ $+\bar{B}\varphi(Sy_*(t)),\ \forall t,\ t\in I$ for any periodic decision $y_*(t),\ t\in I_1$, so building of periodic resolution of the system (1) reduced to determination of the vector $\bar{y}_*=y_*(0)=y_*(T_*)$ and scalar T_*.
Bases of the theory of building of periodic resolutions for ordinary differential equations with phase restrictions stated in monograph [2]. The results of using a given theory for controlled systems are brought below.

Submersion. It's easy to make sure in that problems 1,2 sunk in the following problem of optimum management

$$J(u,w,\bar{y},T)=\int_0^T \begin{matrix}[|u(t)-\varphi(S_\xi(t))|^2+\\ +|w(t)-F(\xi(t),t)|^2]\end{matrix} dt\to\inf \qquad (3)$$

on conditions

$$\dot{\xi}=\bar{A}\xi+\bar{B}u,\ t\in[0,T]=I_2,\ \xi(0)=\xi(T)=\bar{y}, \qquad (4)$$

$u(\cdot)\in L_2[I_2,R^m]$,
$w(\cdot)\in W=\{w(\cdot)\in L_2[I_2,R^r]/\gamma_i(t)\le w_i(t)\le\delta_i(t),$
$i=\overline{1,r}$

п.в. $t\in I_2=[0,T]\},\ \ \bar{y}\in R^{n+m},\ \ T\in R^1.$ (5)
Examine separately marginal problem (4). Let matrixes and vectors

$$W(0,T)=\int_0^T e^{-\bar{A}t}\bar{B}\bar{B}^*e^{-\bar{A}^*t}dt,$$

$$W(t,0)=\int_t^0 e^{-\bar{A}\eta}\bar{B}\bar{B}^*e^{-\bar{A}^*\eta}d\eta,$$

$$a=a(\bar{y},T)=e^{-\bar{A}T}\bar{y}-\bar{y},\quad \lambda_1(t,\bar{y},T)=C(t,T)a$$

$$C(t,T)=\bar{B}^*e^{-\bar{A}^*t}W^{-1}(0,T),$$

$$N_1(t,T)=-C(t,T)e^{-\bar{A}T}.$$

Lemma 1. Let matrix $W(0,T)$ positively determined. In order to $\xi(t)=\xi(0)=\bar{y}$ for any $\bar{y}\in R^{n+m}$, it is necessary and sufficiently, that control

$$u(\cdot)\in U=\{u(\cdot)\in L_2(I_2,R^m)/u(t)=$$
$$=v(t)+\lambda_1(t,\bar{y},T)+N_1(t,T)z(t),\ t\in I_2\}$$

where $v(\cdot)\in L_2(I_2,R^m)$ – any function, $z(t),\ t\in I_2$ – resolution of the following differential equation

$$\dot{z}=\bar{A}z+\bar{B}v(t),\ z(0)=0,\ t\in I_2,$$
$$v(\cdot)\in L_2(I_2,R^m)$$

It is possible to find the proof of lemma in [1]. Resolution of the differential equation (4) corresponding to control (6), will be written as

$$\xi(t)=z(t)+\lambda_2(t,\bar{y},T)+N_2(t,T)z(t),$$
$$t\in I_2 \quad (7)$$

where

$$\lambda_2(t,\bar{y},T)=$$
$$=\left[e^{\bar{A}t}W(t,T)W^{-1}(0,T)+e^{\bar{A}t}W(0,t)W^{-1}(0,T)e^{-\bar{A}T}\right]\bar{y},$$

$$N_2(t,T)=-e^{\bar{A}t}W(0,t)W^{-1}(0,T)e^{-\bar{A}_0T}$$

As follows from lemma1, problem (3)-(5) is tantamount to problem: to minimize functional

$$J_1(v,w,\bar{y},T)=$$
$$=\int_0^T[|v(t)+\lambda_1(t,\bar{y},T)+N_1(t,T)z(T)-$$
$$-\varphi(S[z(t)+\lambda_2(t,\bar{y},T)+N_2(t,T)z(T)])|^2+$$
$$+|w(t)-F(z(t)+\lambda_2(t,\bar{y},T)+N_2(t,T)z(T),t)|^2]dt\to$$
$$\to\inf \quad (8)$$

on conditions

$$\dot{z}=\bar{A}z+\bar{B}v(t),\ z(0)=0,\ t\in I_2, \qquad (9);$$

$$v(\cdot)\in L_2(I_2,R^m),\quad w(\cdot)\in W,\quad \bar{y}\in R^{n+m},$$

Here correlations (6), (7) were used.

Theorem 1. Let matrix $W(0,T)$ be positively determined. In order that system (1) on conditions (2) had periodic resolutions it is necessary and sufficiently that value $J_1(v_*,w_*,\bar{y}_*,T_*)=0$, where $(v_*,w_*,\bar{y}_*,T_*)\in L_2(I_2,R^m)\times W\times R^{n+m}$ optimum resolution of the problem (8) - (10). Function

$$y_*(t) = \xi(t,T_*) = z_*(t,v_*) + \lambda_2(t,\bar{y}_*,T_*) +$$
$$+ N_2(t,T_*)z(T_*,v_*), \quad t \in [0,T_*]$$

is periodic resolution of the system (1), satisfied to phase restriction (2).

Proof of more general theorems on necessary and sufficient conditions of existance of periodic resolutions and methods of their building is possibly to find in [2]. Note that if phase restriction is absent, so $F \equiv 0, \ w \equiv 0$.

II. Consider event, when $\varphi(\sigma) \in \Phi_0$ – is any element of set Φ_0. Function $\varphi(\sigma) \in \Phi_0$ – can be presented in the manner of

$$\varphi(\sigma(t)) = \bar{V}(t)\sigma(t) = \sum(y(t))v(t), \quad t \in I_2 \qquad (11)$$

where

$$\bar{V}(t) = diag(v_1(t),...,v_m(t)),$$
$$\sum(y(t)) = diag(\sigma_1(t),...,\sigma_m(t)), \quad \sigma = Sy(t),$$
$$v = (v_1(t),...,v_m(t)) \in V =$$
$$= \{v(\cdot) \in L_2(I_2,R^m) \,/\, 0 \le v_i(t) \le \mu_{0i}, i = \overline{1,m}\}. \qquad (12)$$

Now resolutions of problems 1,2 can be received from the resolution of the following optimization problem:

$$\inf_{(u,w,y,T)} \sup_v J(u,v,\bar{y},T) =$$
$$= \inf_{(u,w,y,T)} \int_0^T [|u(t) - \sum(\xi(t))v(t)|^2 + |w(t) - F(\xi(t),t)|^2]dt, \qquad (13)$$

at conditions

$$\dot{\xi} = \bar{A}\xi + \bar{B}u(t), \ \xi(0) = \xi(T) = \bar{y}, \ t \in [0,T] \qquad (14)$$

$$u(\cdot) \in L_2(I_2,R^m), \quad \bar{y} \in R^{n+m}, \quad v(\cdot) \in V, \quad T \in E^1$$

Lemma 2. . Let pair $(\bar{A},\bar{B})$ - controlled, i.e. $rang(\bar{B},\overline{AB},...,\bar{A}^{n+m-1}\bar{B}) = n+m$. In order that system (1) at conditions (2) for all $\varphi(\sigma) \in \Phi_0$ had periodic resolutions it is necessary and sufficiently that value $J(u_*,v_*,\bar{y}_*,T_*) = 0$, where $(u_*,v_*,\bar{y}_*,T_*)$ – optimum control of the problem (13) - (15).

In turn, problem (13) - (15) is tantamount to the following problem (refer to. Lemma 1):

$$\inf_{(\vartheta,w,y,T)} \sup_v J(\vartheta,w,v,\bar{y},T) =$$
$$= \inf_{(\vartheta,w,y,T)} \sup_v \int_0^T [| \ \vartheta(t) + \lambda_1(t,\bar{y},T) + N_1(t,T)z(t) - \qquad (16)$$
$$- \sum[z(t) + \lambda_2(t,\bar{y},T) + N_2(t,T)z(t)] \ |^2 + |w(t) -$$

at conditions

$$z = \bar{A}z + \bar{B}\vartheta(t), \ z(0) = 0, \ t \in [0,T] \qquad (17)$$
$$\vartheta(\cdot) \in L_2(I_2,R^m), \quad \bar{y} \in R^{n+m}, \quad v(\cdot) \in V,$$

Theorem 2. Let pair $(\bar{A},\bar{B})$ - controlled. In order that system (1) at conditions (2) for all $\varphi(\sigma) \in \Phi_0$ had periodic resolutions it is necessary and sufficiently that value $J(\vartheta_*,w_*,v_*,\bar{y}_*,T_*) = 0$, where $(\vartheta_*,w_*,v_*,\bar{y}_*,T_*) \in L_2(I_2,R^m) \times W \times V \times R$ optimum control of the problem (16) - (18). If value $J(\vartheta_*,w_*,v_*,\bar{y}_*,T_*) > 0$, so system (1) at conditions (2) hasn't a periodic resolution. In case of $J(\vartheta_*,w_*,v_*,\bar{y}_*,T_*) = 0$ function $U_*(t) = z(t,\vartheta_*) + N_2(t,T_*)z(T_*,\vartheta_*) = y_*(t)$, is periodic resolution of the system (1) at conditions (2) for any fixed $\varphi(\sigma) \in \Phi_0$

It is possible to find proof of the theorem in [1].

Conclusion. In the given work, were examined dynamic controlled system characteristics, in case when integrated sections of second order exists in each closed sidebar. Equations of moving of the dynamic system consist of equations of its separate nodes or sections. Quite often equations of sections are defined by experimental way, moreover, because of changing the conditions of experiment, different equations of one and same node can be defined. Can turn out that feature (i/o) of the node can't be presented in the class of elementary functions. In such events, feature of node can be presented in the manner of function $\varphi(\sigma) \in \Phi_0$, where Φ_0 certain given set.

Bases of the theory of building of periodic resolutions for common differential equations with phase restrictions, stated in monograph [2], were carried on controlled systems and offered constructive method of building of limited cycles.

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The Recursive Scheme of Normalization in a Disturbance Problem of Two Bodies Utilizing the Method of Infinite Systems

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The matrix clone the theory of normal forms of differential equations grounded on a method of infinite systems is offered, according to which one the finite-dimensional non-linear system of ordinary differential equations (ODE) is resulted in a countable system of linear differential equations. The equations of motion of a perturbed problem of two bodies in relative rectangular coordinatess look like:

$$\ddot{x}+\frac{\mu}{r^3}x=\varepsilon G(x,t),x,G\in R^3,r=\sqrt{\langle x,x\rangle} \tag{1}$$

Where ε - small parameter, the function G is holomorphic on *x*, quasiperiodic on *t*. The equations (1) generally do not enable a deflating at the expense of integrals. Therefore for submission of motions, close to elliptical, it is necessary to go by a standard way [3]. Let's proceed in (1) to deviations from elliptical motion of a perturbed problem $\varphi(t): x=\varphi+y$ also we shall enter vector $z=(y,\dot{y})$ we shall receive an equation:

$$\dot{z}=A(t)z+f(t,z,\varepsilon)+\varepsilon g(t) \tag{2}$$

Where *A (t)* - periodic matrix of equations in variations of a problem of two bodies. Under the theory a Flock - Lyapunov for it there is a periodic matrix *S(t),* having restricted return, presenting matrix *A (t)* to a constant matrix *J,* having the complex Jordan form. The construction of a matrix *S (t)* is rotined in activity [5].As a result of replacement *z=s (t)u* the system (2) looks like

$$\dot{u}=Ju+\widetilde{f}(t,u,\varepsilon)+\varepsilon g(t) \tag{3}$$

The solution of an equation (3) can be received with applying of the scheme of normalization ODE, grounded on a method of infinite systems. Really, we shall enter a padding variable ε, then for shall receive an equation

$$\dot{x}=B(t)x+F(x,t) \tag{4}$$

Where *B (t)* - quasiperiodic, of the top triangular with constant diagonal members. Decomposing members *B(t)* and *F(x, t)* in trig numbers, we come to conditions, in which one the recurrent scheme is applied. Let $H(t)\in Cr_T^{\nu}(A)$ - matrix of the Carleman applicable to a normal form of an equation (4). Is representable *H* as the sum

$$H=\Delta+N,\Delta\in Cr^7(C),N(t)\in Cr_T^7(A),$$

where Δ - scalar matrix of the Carleman, *N* - matrix of the Carleman, all non-zero members by which one are above a main diagonal. Then from definition of a normal form of matrixes of the Carleman follows

$$\widetilde{N}=\exp(-\Delta t)N\exp(\Delta t)\in Cr_T^7(C)$$

in activity [1] is rotined, that the general solution of a countable system $\frac{d}{dt}\xi=H\xi,\xi(t_0)=\xi_0$ is determined by an exponent, from here we receive:

$$\xi=\exp(\Delta t)\exp(\widetilde{N}t)\exp(-\Delta t_0)\xi_0=$$
$$=\exp(\Delta t)\left[E+t\widetilde{N}+\frac{t^2}{2!}\widetilde{N}^2+\frac{t^3}{3!}\widetilde{N}^3+\ldots\right]\exp(-\Lambda t_0)\xi_0,$$

Where $\exp(\Delta(t-t_0))\xi_0$ - trig part, and $\xi-\exp(\Delta(t-t_0))\xi_0$ - mixed and century part of disturbances in coordinates ξ after integrating a normal form, using a matrix of the Weierstrass of normalizing transformation, we receive submissionof the solution of an equation (3).

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An Optimal Control Problem of the Velocity of the Gas Stream

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To transient regimes in catalitic fixed-bed reactor there corresponds the non-stationary process heat and mass transfer with the exothermal response.
In case the inequality St /□ TagW □ 100 is fulfilled, where a St- Stanton criterion, the transitional conditions in a stratum practically are not sensitive to intensity of heat release inside a grain and it is possible to take advantage quasigomogenical model, which mathematical exposition has an aspect:

$$\frac{C}{C_p}\frac{\partial T}{\partial t} = \frac{\lambda}{C_p}\frac{\partial^2 T}{\partial l^2} - u\frac{\partial T}{\partial l} + \Delta Tag \cdot W(X,T), \qquad (1)$$

$$\varepsilon\frac{\partial X}{\partial t} = D\frac{\partial^2 X}{\partial l^2} - u\frac{\partial X}{\partial l} - W(X,T).$$

$$(l,t) \in Q = (0,L) \otimes (0,t_K),\ t_K < +\infty$$

Initial and boundary conditions:

$$t = 0 : T(l) = T_O,\ X(l) = X_O. \qquad (2)$$

$$l = 0 : D\frac{\partial X}{\partial l} = u\cdot(X - X_1), \lambda\frac{\partial T}{\partial l} = u\cdot C_p\cdot(T - T_1); t \in (0,t_K). \qquad (3)$$

$$l = L : \frac{\partial T}{\partial l} = 0, \frac{\partial X}{\partial l} = 0; t \in (0,t_K).$$

Let's set a criterion of effectiveness of realization of the process (1) - (3) as a functional of an aspect

$$J = \int_0^{t_K}\int_0^L \left(X(l,t) - X^*\right)^2 \cdot dl \cdot dt \qquad (4)$$

Where X*- the greatest possible degree of transformation in a gas stream.
Let on control

$$u = u(t)$$

The restriction $u_{min} \le u \le u_{max}$
Is imposed

Where

u_{min}, u_{max}

- specific positive constants, difiniendums by the requirements of the technological process.
In space V we define the set of admissible controls

U = {u/u є V, u (t) є G п.в. On (0, tk)},

where G - convex bounded closed set;
G = [u1, u2].
We pose the following problem: find control u of є U,providing on the set U a minimum of the functional (4).

SECTION
“AUTOMATIC CONTROL SYSTEM THEORY”

Practical Engineering Identification Methods on the Basis of General Parameter

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Resume.

The problems and methods of parametric identification of complicated objects of control of high dimension and presence of noise are given. The new principles of construction of systems of identification in these conditions are confirmed on the basis of a method of general parameter simple enough in structural implementation.

Keywords: *identification, system, technology process, object, model, estimation of parameters, method, recurrent algorithm.*

Introducing. The modern stage of development of the theory and practice of automatic control is characterized by increase of the requirements to quality indexes of management systems. On the basis of the analysis of modern problems of identification of technical objects, it is marked, that in conditions of the incomplete information about object of control it is expedient to use adaptive systems.

General provisions. The estimation of parameters, i.e. obtaining of conformity to a mathematical model to the characteristic to a given system consist in the minimization of some measure of an error between the characteristics of model and object. Least squares method has special value among methods of an estimation of parameters of a dynamic system on given measurements of input and output signals of a system. The method works at small noises at measured systems and at linear structure of model. Violations conduce to systematic errors in these conditions [1].

The problem of identification, when the uncertainty in a noise of observations and parameters is characterized only by boundaries of their observations is worth of considering. In this case the task of problem of identification is in finding of area in space of parameters, which one will be matched to observations, boundaries of a noise, Information on limitations on values of parameters.

For example let's consider a problem of identification of process, which one with usage of dynamic submission(representation) can be expressed in the form(shape):

$$x(t)=\theta^T\varphi(t)+\nu(t), \qquad (1)$$

where $x(t)$: output signal; $\varphi(t)$: vector of measured inputs; $\nu(t)$: vector not of measured noise; θ: vector of estimated parameters; t: discrete time.

Let's assume, that structure of model is determined correctly and in view of estimated vector of parameters is represented as

$$\hat{x}(t)=\hat{\theta}^T(t-1)\varphi(t), \qquad (2)$$

where $\hat{x}(t)$: output signal of model; $\hat{\theta}(t)$: estimation of parameters θ.

Concerning sequence of random noises the following assumptions are possible: 1) $\nu(t)$: sequence of a white noise with $M\{\nu(t)\}=0$, $M\{\nu(t),\nu(k)\}=\sigma_\nu\delta(t,k)$ for any t, k, and $\delta(t,k)=1$ if t=k and $\delta_{tk}=0$ if $t\neq k$, M: operator of expectation; 2) the noise $\nu(t)$ has definite boundaries $\pm w^{\frac{1}{2}}(t)$ for any t. Let input signals conditions:

$$\begin{cases} M\{\varphi_i(t)\}=0,\ M\{\varphi_i(t)\varphi_j(t)\}=0,\ i\neq j; \\ M\{\varphi_i^2(t)\}=\sigma^2, M\{\varphi_i(t)\varphi_i(t+m)\}=0,\ m\neq 0 \end{cases} \qquad (3$$

The error of simulation with the registration (1), (2) can be shown as:

The error of simulation with the registration (1), (2) can be shown as:

$$e(t) = x(t) - \hat{x}(t) = \mathbf{r}^T(t)\varphi(t) + \breve{u}(t \ , \qquad (4)$$

where $\mathbf{r}(t) = \theta - \hat{\theta}(t)$ and $v(t)$, $\mathbf{r(t)}$ have following limitations at $t \geq 0$

$$\|\mathbf{r}(t)\| \leq \eta, \quad |v(t)| \leq w^{1/2}. \qquad (5)$$

Using (4), (5), it is possible to receive

$$\frac{|e(t)|}{\|\varphi(t)\|} \leq \eta + \frac{w^{1/2}(t)}{\|\varphi(t)\|}. \qquad (6)$$

Thus, the problem of identification consists in finding of the ellipsoid

$$E(t)\left(\theta - \hat{\theta}(t)\right)^T P^{-1}(t)\left(\theta - \hat{\theta}(t)\right) \leq 1, \quad (7)$$

which one contains all values θ, matching with observations to t. Then, if boundaries of a write noise:

$$F(t):\ w(t)\left(x(t) - \varphi^T(t)\theta\right)^2 \leq 1, \qquad (8)$$

that E(t) comprises interception E(t-1) and F(t). Thus $\lambda(t) > 0$ any point θ in E(t-1) and F(t) fulfil a condition

$$\left(\theta - \theta(\hat{t} - 1)\right)^T P^{-1}(t-1)\left(\theta - \hat{\theta}(t-1)\right) +$$
$$+\lambda(t)\, w(t)\left(x(t) - \varphi^T(t)\theta\right) \leq 1 + \lambda(t). \qquad (9)$$

The expression (9) is represented in the recurrent form

$$\hat{\theta}(t) = \hat{\theta}(t-1) + \lambda(t)$$
$$w(t)Z(t)\varphi(t)\left(x(t) - \varphi^T(t)\hat{\theta}(t-1)\right), \quad (10)$$

where

$$Z(t) = P(t-1) -$$
$$-\frac{x(t)w(t)P(t-1)\varphi(t)\varphi^T(t)P(t-1)}{1 + \bar{u}(t)w(t)\varphi^T(t)P(t-1)\varphi(t)} \qquad (11)$$

and $P(t) = z(t)Z(t)$,

where

$$z(t) = 1 + \lambda(t) -$$
$$-\frac{\lambda(t)w(t)e^2(t)}{1 + \lambda(t)w(t)\varphi^T(t)P(t-1)\varphi(t)}.$$

Let initial matrix $P(0) = \delta I$, where the value δ is some small positive number, I is unit matrix.

The essential singularity of considered algorithm (10), (11) is in free parameter $\lambda(t)$, which one can be determined so that to minimize a volume of an ellipsoid E(t) on observations up to an instant t, which one limits

area $\Omega(\theta)$, which one contains all values θ.

Method of general parameter. The formal application of classic methods and algorithms, for example (10), (11), to the solution of a problem of identification without accounting of properties of object and conditions of his operation is the basic reason of failures at aiming to receive more precise estimations of all parameters of an studied system of high dimension. In aspect of the formulated problem a methodology, theory, mathematical models and algorithms of methods of general parameter [2], [3] can form the basis for construction of systems of an identification of objects and processes of the broad class with maintenance of the requirements of speed and simplicity at implementation, and also improving of present methods of identification. So instead of (10) it is possible to organize a procedure, while estimating of vector θ not all components of vector of

estimations $\hat{\theta}(t)$ are renovated, where only one parameter $\beta(t)$, being their general constituent is renovated.

In this case parameter $\beta(t)$ is determined as general parameter, and implementation of the different approaches to a parameter estimation with usage $\beta(t)$ as a method of general parameter. The mathematical models of a system (1) with usage of general parameter can be written to a view

$$\hat{x}(t) = \left(\hat{\theta}(0) + \text{Ŗ}(t\text{-}1)\mathbf{q}\right)^T \varphi(t). \qquad (12)$$

here $\hat{x}(t)$ is output signal of model; $\hat{\theta}(0)$ is vector of initial values of parameters; $\mathbf{q}$ is vector of weighting coefficients; $\beta(t)$ is general parameter.

As now vector of parameters of model (2) is

represented as $\hat{\theta}(t) = \hat{\theta}(0) + \text{Ŗ}(t)\mathbf{q}$, outgoing from expressions (7) - (9) recurrent algorithms

(10) changes of general parameter $\beta(t)$ is representable as

$$\beta(t) = \beta(t-1) - \lambda(t)w(t)\mathbf{q}^T Z(t)\varphi(t)e(t). \quad (13)$$

For a case of scalar parameter $\beta(t)$ in problems of identification the matrix $P(t)$ can be defined as unit. Then the algorithm (10) can be written to a view

$$\beta(t) = \beta(t-1) - \gamma(t)e(t)\mathbf{q}^T\varphi(t), \qquad (14)$$

where $\gamma(t) = \lambda(t)w(t)$. Let's assume, that in (1) $\nu(t) = 0$. Then, if the input signals fulfil a conditions (3) and general parameter of model (12) is adjusted according to algorithm (14) at values g, meeting condition $0 < \gamma < (\|\mathbf{q}\|^2\sigma^2)^{-1}$, then $M\{\beta(t)\} \to c$, where c is some average value of general parameter in steady state.

By selection $\gamma = \left(3\|\mathbf{q}\|^2\sigma^2\right)^{-1}$ it is possible to estimate value of speed of convergence for algorithm (14) by expression of a view

$$M\{\Delta\beta^2(t)\} = l^t\,\Delta\beta^2(0) + (l^t - 1)\frac{\|\mathbf{r}_*\|^2}{3\|\mathbf{q}\|^2},$$

$$l = \frac{2}{3}, \qquad 15)$$

where

$\Delta\beta(t) = \beta(t) - c$, $\mathbf{r}_* = \theta - \hat{\theta}(0) - c\mathbf{q}$ and $\mathbf{r}_*^T\mathbf{q} = 0$. Here $\mathbf{r}_*$ is vector of parametric errors in steady state after realization of a procedure of identification of a definite phase s. The value of a dispersion of general parameter at the given phase s in steady state is determined from (15) as

$$\sigma_\beta^2 = M\{\Delta\beta^2(\infty)\} = \frac{\|\mathbf{r}_*\|^2}{3\|\mathbf{q}\|^2}. \qquad (16)$$

For a case, when the random disturbances $\nu(t) \neq 0$ and have limitations (5) value of a dispersion of general parameter at a definite phase s of identification it is similarly possible to present as

$$\sigma_\beta^2 = \frac{1}{3\|\mathbf{q}\|^2}\left(\|\mathbf{r}_*\|^2 + \frac{w}{\sigma_\nu^2}\right). \qquad (17)$$

Let's mark, that equations (16), (17) is determined at $t \to \infty$. However given condition for algorithm (14) is not in dispensable, as at dagging t the improvement o parameters with increase of number of iteration of estimation fast decreases and it is possible t limit by their approximate value for $t = 8 \div 10$ The fairness of the given statement is checke up by an equation (15).

As it is visible from (16), (17), that at input signals obeying (3) follows, that than closer than value of estimations of parameters to true, the less value of a dispersion of general parameter, and at precise definition of values of parameters of object, for a case $\nu(t) = 0$ (16), the dispersion of general parameter is equals to zero.

If definite accuracy of an estimation of parameters δ given value, for cases $\sigma_{\beta_s}^2 \gtreqless \delta$ after each phase of tuning of general parameter is necessary or to finish process of identification, or to pass to a following phase of tuning of general parameter or to pass to other methods and algorithms of identification with the purpose of raise of accuracy of parametric estimations. In this case, when $\sigma_{\beta_s}^2 > \delta$, the course implements to s+1 phase of identification and we shall conduct tuning of general parameter according to algorithm (14).

At it him s+1 to a phase of looking up of vecto of parameters of model (12) the valu $\hat{\theta}_* = \hat{\theta}(0) + c\mathbf{q}$ is assigned and the new vecto $\mathbf{q}_1$ for model (12) on s+1 a phase of tuning o general parameter is selected. It is shown, tha the sequential looking up enables for eacl subsequent stage to receive more precis estimations of the norm of parametric errors than at the previous phase, that is $\|\mathbf{r}_{*s-1}\| > \|\mathbf{r}_{*s}\|$.

Conclusion. The new concepts of construction of models of high dimension are formulated on the basis of a method of general parameter. It is shown, that the application of models and algorithms of a method of general parameter and of known schemes of a estimation of parameters allows to use the advantages of combined algorithms is high speed of convergence of algorithms of a method of general parameter and capability of maintenance of accuracy of parametric identification of known algorithms.

tification of known algorithms.

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Principle of Guaranteed Dynamics in the Theory of Control

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Resume.

The fundamentals of the new theory of control by multidimensional dynamic systems, based on the concepts of an admissibility of transients are discussed.

Key words. *The theory of control, concept of an admissibility, principle of quaranteed dynamics, engineering indexes of quality.*

Introduction. The modern theory of control has rather effective methods of synthesis of systems of automatic control (SAC) [1-5]. However, many of them not to the full take into account the initial nonproduction and technological requirements to a designed system. In particular, in majority of methods the registration of the indicated requirements is carried out with the help of integrated or rooted criterions. As is known, these indexes do not allow to the full to take into account the primary requirements to a designed system, that is connected to a lack of effective functional relations between indirect criterions (weight factors of a functional of optimization, disposition of poles of the closed system) and direct (engineering) indexes of quality. At the same time for the theory and practice of control the most actual is the problem of system design under the engineering requirements to quality of control. Within the framework of this problem the series of the important tasks of control of multi-dimensional plants until now remains or unsufficiently investigated, or up to an extremity not decided.

Purpose of the present work - brief account of bases of the uniform approach to problem solving of control of multi-dimensional dynamic plants directed on a raise of quality and effectiveness of projected control systems with use of primary engineering indexes of quality and the concept of an admissibility. The basic idea is-under the revolting factors (exterior perturbations, indeterminacies in exposition of plant, nonzero entry conditions) dition of plant; u (t) - m-dimentional a vector of control actions; $\xi(t)$ - r-dimentional a vector of revolting actions;

$f(*)=[f_1(*),f_2(*),K,f_n(*)]^T$ - n- dimentional a vector function satisfying to conditions existences and uniqueness of a solution; T - sign of a transposition; t_o, t_k - initial and final moment of the process of control; λ - v-dimentional a vector - parameter of plant, inhering to an admissible set Λ.

2. Initial information about parameters of object of control. The following cases are considered:

a) The vector - parameter (is known with an adequate accuracy, i.e. $\lambda = \lambda^*$, where λ^* - vector composed from nominal (calculated) values of parameters of plant;

б) The value a vector - parameter λ precisely is not known, but the intervals are known, in which their components can lay, i.e. the set is given

$$\Lambda=\{\lambda \in R^v : \left|\lambda_k - \lambda_k^*\right| \le \Delta \lambda_k,\ k=\overline{1,v} \quad ,(2)$$

where λ_k^* - face value of a parameter λ_k; $\Delta\lambda_k$ - maximum admissible deviation λ_k From λ_k^*.

3. Vector of controlled variables $y=[y_1, y_2, \dots, y_N]^T, y=y(t)$.

4. Set of admissible values initial X^o and final X^k of condition of plant (or accordingly Y^o and Y^k for a vector y).

5. Vector of exterior revolting actions. From a set of perturbations are considered:

quality of realization of the purpose of control (4) we shall use the concept of an admissibility. Thus the target relations are considered

$$|e_i(t)| = |g_i(t) - y_i(t)| \le \sigma_i(t), \; i = \overline{1, N}, \quad (5)$$

where $\sigma_i(t)$ - positive continuously differentiable functions, with the help of which are set maximum admissible deviations (majorant) of controlled variables $y_i(t)$ from their desirable (nominal) values $g_i(t)$ are set. Thus, according to a criterion (5) in an interval of $[t_o, t_k]$ for transients $y_i(t)$ some admissible areas $Y_i(t)$ are set. For an error of control e (t) appropriate admissible sets

$$E_i(t) = \{ e_i \in R^1 : \; |e_i(t)| \le \sigma_i(t) \},$$

$$E(t) = \{ e \in R^N : \; e_i \in E_i, \quad i = \overline{1, N} \}.$$

In the correspondence with the concept of an admissibility of the requirement to quality of control are, that the transients in a projected system stipulated initial displacement $e(t_o)$ and an operation of perturbations $\xi(t)$, should satisfy to target relations (5), i. e. $e_i(t) \in E_i(t)$, $i = \overline{1, N}$. Thus the choice of functions $\sigma_i(t)$ should provide stability of controlled dynamic processes in a projected control system and given engineering parameters of quality (time of regulation, overshot and static mistake of control). By main peculiarity of a considered criterion of quality (entered by the professor V.V. Solodovnikov [1]), is that it immediately describes the primary engineering requirements to projected SAC. This criterion is based on the admissibility concept , instead of optimality of controlled processes. Thus to each given set direct - engineering parameters of quality there corresponds set of transients processes $e_i(t) \in E_i(t)$. That is important for maintenance of the compromise between quality of system and complexity of an technical realisation of a control subsystem.

9. Restriction on components of a vector of control u (t):

$$|u_\ell(t)| \le u^+_\ell, \; \ell = \overline{1, m} \;, \quad (6)$$

where u^+_ℓ - is maximum allowable values $u_\ell(t)$. The appropriate allowable areas for control influences:

$$U_\ell(t) = \{ u_\ell \in R^1 : |u_\ell(t)| \le u^+_\ell \}, \; \ell = \overline{1, m}$$

$$U(t) = \{ u \in R^m : u_\ell(t) \in U_\ell(t), \; \ell = \overline{1, m} \},$$

$$t \in [t_o, t_k].$$

The general statement of a problem of control consists in the following. For multidimensional object of control (1), it is necessary to define structure and parameters of a controlling subsystem (regulator) ensuring guaranteed performance of target ratio (5), on the basis 1- 9.

The analysis shows, that the effective decision of the formulated problem of control can be carried out on a basis of following:

1) Definitions of general functional ratio, installing communications between a desirable condition of object, its dynamic properties and given characteristics of direct parameters of quality of a projected control system.

2) The descriptions of conditions, which guarantees an accessory of controlled processes of system to the given sets.

3) Use of the specified functional ratio determining the conditions of performance of target restrictions (5) and (6), for the decision of tasks of control by multidimensional objects.

Decision of task of control. The decision of the formulated problem of control is based on the following provisions admissibility of controlled processes.

Theorem 1. For performance of target conditions (5) and restrictions (6) it is necessary and enough the ratio were provided:

$$2\int_{t_o}^{t} \left[e_k(\tau)\,\dot{e}_k(\tau) - \ddagger_k(\tau)\,\dot{\ddagger}_k(\tau) \right] d\tau \le \ddagger_k^2(t_o) - e_k^2(t_o$$

$$k = \overline{1, N}, \quad (7)$$

$$2\int_{t_o}^{t} u_\ell(\tau)\,\dot{u}_\ell(\tau)\,d\tau \le u_\ell^{+2}(t_o) - u_\ell^2(t_o), \; \ell = \overline{1, m} \quad (8)$$

for all $t \in [t_o, t_k]$.

For the decision of tasks of control in most cases it is expedient to use simpler ratio - sufficient conditions of an admissibility of controlled processes, which are formulated later.

Theorem 2. Let $e(t_o) \in E(t_o)$ and $u(t_o) \in$

$U(t_0)$. Then for maintenance of conditions (5) and (6) it is enough the following inequalities were carried out

$$\int_{t_0}^{t} e_k(\tau)\,\dot{e}_k(\tau)\mathrm{d}\tau \le \int_{t_0}^{t} \ddagger_k(\tau)\,\dot{\ddagger}_k(\tau)\,\mathrm{d}\tau\,,\ \ k=\overline{1,N},($$

$$\int_{t_0}^{t} u_\ell(\tau)\,\dot{u}_\ell(\tau)\mathrm{d}\tau \le 0\,,\ \ \ell=\overline{1,m}\,, \qquad (10)$$

for all $t \in [\, t_0, t_k \,]$

Theorem 3. Let $e\,(t_0) \in E\,(t_0)$. Then the target ratio (5) are carried out, if the conditions are fair

$$e_k(t)\,\dot{e}_k(t) \;\le\; \sigma_k(t)\,\dot{\sigma}_k(t), \quad k=\overline{1,N} \qquad (11)$$

for all $t \in [\, t_0, t_k \,]$.

The analysis shows, that the analytical conditions of an admissibility of controlled processes (7) - (11) are a constructive basis for development of the uniform theory of synthesis of automatic systems on primary parameters of
a control efficiency.

The structures of the received ratio (7) - (11) are those, that in them simultaneously enter desirable) g (t) and speed of change of coordinates of controlled object $\dot{x}(t)$, and also engineering requirements to quality of regulations determined $e_i^{+}(t)=\sigma_i(t)$ and $e_i^{-}(t)=-\sigma_i(t)$ of mistakes of the control $e_i(t)$. Hence, these conditions establish communicationsbetween a desirable condition of object of management, its dynamic properties and required primary parameters of quality of system.

The approach to the decision of tasks of control based on use of the received conditions of allowable quality of control, is named as a principle of guaranteed dynamics [6], as the performance of these conditions provides guaranteed achievement of target ratio (5) and restrictions (6).

Conciusions. The decision of tasks structural - parametrical and parametrical synthesis of regulators multidimensional control systems is considered on the basis of the formulated principle.

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The Syntheses of Modal Regulator with Increased Potential Robust Stability

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Summary.

In the report the method of parametric syntheses of the modal regulators with the increased potential of robust stability under incomplete object controllability on Kalman is expounded.

Keywords: *syntheses, modal regulator, robust stability, incomplete controllability, matrix, object.*

Introduction. At present time the majority of real system administrative dutieses in conditions one or other degrees of uncertainty is admited. The uncertainty can be stipulated by the ignorance of true values of management object parameters and unpredictable change them in time. So solely important role in theories of dynamic object, controlling plays of robust stability. Unlike the widely known approach to setting and saving the problems of control in conditions of uncertainty, in accordance with restrictions on changing the parameters of nominal managerial system are defined, under which the stability is saved. In the given work, inherently concept of increasing a potential of robust stability, basing on results of theories of catastrophes is used. One of the approaches to the syntheses of robust stable control system with the increased potential for single-line objects by the material groups simple, multiple and complex-associate own values, with the nonlinear law control, given in the field of canonical system coordinates in the form of one-structurally firm displaying, adding control system limiting robust stability amongst all possible structures, is expounded. The analytical expressions for the calculation of factors of control system's modal feedbacks on variable conditions of objects at the condition of their incomplete controllability on Kalman are obtained. For the syntheses of control laws in the class of structured-firm displaying in the field of variable canonical transformations theapproach based on the adduction matrixes of object to block-diagonal form is used. The researches robust stability, based on idea of a principle linearized systems stability are confirmed by unlimited increasing of potential stability of synthesized systems with laws control in the class of structured-firm images.

Let stationary single-line control object is described by an equation of condition

$$\frac{dx}{dt} = AX, x \in R^n \tag{1}$$

where A - square matrix of object parameters of dimensionality n x n. The control object matrix A can be reduced with the help of a nonspecial matrixes P, of canonical transformation [6] columns which are own functions matrixes A, to block-diagonal form

$$\tilde{A} = P^{-1}AP = diag\{\lambda, J_1,\ldots,J_m J_1^i,\ldots,J_k^i\} \tag{2}$$

with diagonal square blocks an aspect

$$\lambda = diag\{\lambda_1,\ldots,\lambda_l\} \tag{3}$$

$$J_j = \begin{Vmatrix} \lambda_j & 1 & . & . & . & 0 & 0 \\ 0 & \lambda_j & . & . & . & 0 & 0 \\ . & . & . & . & . & . & . \\ 0 & 0 & . & . & . & \lambda_j & 1 \\ 0 & 0 & . & . & . & 0 & \lambda_j \end{Vmatrix},$$

$$N_j \times N_j \quad j = \overline{1,m}; \tag{4}$$

$$J_j^i = \begin{Vmatrix} \alpha_j & -\beta \\ \beta_j & \alpha_j \end{Vmatrix} \quad j = \overline{1,k}. \qquad (5)$$

where $\lambda_1,\ldots,\lambda_l$-real simple, λ_j-real, N_j-multiple, $\lambda_j = \alpha_j \pm j\beta_j$ -complex-associate own values matrixes A, moreover naturally that $N_1+\ldots+N_m = L$; $l + N_1+\ldots+N_v + 2k = n$.

In the work [7], is shown that accepted structure (2) allows separate control of canonical coordinate (harmonicas) systems, appropriate to any diagonal block (3), (4), and (5) matrixes $\widetilde{A}$ and is obtained that stationary condition of canonical systems written to the unrolled form

$$\frac{d\widetilde{x}_i}{dt} = \lambda_i\widetilde{x}_i - \widetilde{x}_i^3 + k_i\widetilde{x}_i, \quad i = \overline{1,l} \qquad (6)$$

$$\frac{d\widetilde{x}_i}{dt} = \lambda_j\widetilde{x}_i - \widetilde{x}_i^3 + k_i x_i, \quad i = \overline{l+1,l+L},\ j = \overline{1,m} \qquad (7)$$

$$\frac{d\widetilde{x}_i}{dt} = d_j\widetilde{x}_i - \widetilde{x}_i^3 + k_i x_i,\ i = \overline{l+L+1,n},\quad j = \overline{1,k} \qquad (8)$$

asymptotically firm under any possible changing the vague object's parameters and chosen parameters of control device(regulator), i.e. is shown that the structured syntheses ofautocontrol systems (ACS) with the choice of control laws in the class of structured firm displaying in the field of variable canonical transformations $\widetilde{x} = P^{-1}x$, allows extreme to enlarge a potential of robust stability of ACS.

Equation Systems (6), (7), (8) allow a separate management of own values closed system matrixes and corresponding harmonicas of deciding linearized equations system condition. Linearizing Systems (6), (7), (8) depending on stationary conditions [7], is representable them by the way

$$\frac{d\widetilde{x}_i}{dt} = (\lambda_i + k_i)\widetilde{x}_i \quad \text{or} \quad \frac{d\widetilde{x}_i}{dt} = -2(\lambda_i + k_i)\widetilde{x}_i, \quad i = 1,l \qquad (9)$$

$$\frac{d\widetilde{x}_i}{dt} = (\lambda_j + k_i)\widetilde{x}_i \quad \text{or} \quad \frac{d\widetilde{x}_i}{dt} = -2(\lambda_j + k_i)\widetilde{x}_i, \quad j = \overline{1,m};\ i = \overline{l+1,l+L} \qquad (10)$$

$$\frac{d\widetilde{x}_i}{dt} = (\alpha_j + k_i)\widetilde{x}_i \ \text{or}\ \frac{d\widetilde{x}_i}{dt} = -2(\alpha_j + k_i)\widetilde{x}_i, \quad j = \overline{1,k}\ \ i = \overline{l+L+1,n} \qquad (11)$$

1. Thereby, task is reduced to the consequent syntheses of single-line modal regulators for the canonical system (9),(10), (11). Considered alternately these tasksFor a full controllability of canonical object (9) is required all diagonal elements control matrixes in (9) were not zero. By the grouping operated and uncontrolled coordinates in vectors $\widetilde{x}_1$ and $\widetilde{x}_2$ system (9) is possible to reduce in an aspect

$$\frac{d\widetilde{x}_1}{dt} = (\Lambda_1 + \mathrm{K}_1)\widetilde{x}_1, \qquad \frac{d\widetilde{x}_2}{dt} = \Lambda_2\widetilde{x}_2 \qquad (12)$$

Let's designate through $G = \Lambda_1 + \mathrm{K}_1$ closed system matrix, corresponding operated canonical system coordinates (9).

operated canonical system coordinates (9).

Let $\lambda_1,\ldots,\lambda_{l_1}$ are own values matrixes Λ_1, a $\mu_1^*,\ldots,\mu_{l_1}^*$-desired own values matrixes G_1^*, then having equated matrix G_1 to the matrix of desired own values to the closed system G_1^*, possible define elements matrixes of modal control

$k_i = \mu_i^* - \lambda_i$, $\quad i = \overline{1l_1}$ and law of modal control $u_{ii} = \dfrac{1}{b_{ii}}[-x_i^3 + (\mu_i^* - \lambda_i)\widetilde{x}_i]\,, i = \overline{1l_1}$.

2. For a full controllability of canonical object (10) is required that last N_i- element matrixes, corresponding to j multiple own value of N_i multiplicity, was distinct from the zero point.

Considered object with double $(N_i = 2)$ and triple $(N_i = 3)$ by own values matrixes J:

under $N_i = 2$

$$k_1 = \mu_1^* - \lambda_1\ ,\ k_2 = \mu_2^* - \lambda_1$$

$$u_{11} = \frac{1}{b_{11}}[\ -\tilde{x}_1^3 + (\ \mu_1^* - \lambda_1\ )\tilde{x}_1 - \tilde{x}_2\ ],$$

$$u_{22} = \frac{1}{b_{22}}\left[-\tilde{x}_2^3 + \left(\mu_2^* - \lambda_1\right)\right] \text{ under } N_i = 3$$

$$k_1 = \mu_1^* - \lambda_1,\ k_2 = \mu_2^* - \lambda_1,\ \ k_3 = \mu_3^* - \lambda_1,$$

$$u_{11} = \frac{1}{b_{11}}\left[-\tilde{x}_1^3 + \left(\mu_1^* - \lambda_1\right)\tilde{x}_1 - \tilde{x}_2\ ,\right.$$

$$u_{22} = \frac{1}{b_{22}}\left[-\tilde{x}_2^3 + \left(\mu_2^* - \lambda_1\right)\tilde{x}_2 - \tilde{x}_3\right],$$

$$u_{33} = \frac{1}{b_{33}}\left[-\tilde{x}_3^3 + \left(\mu_3^* - \lambda_1\right)\tilde{x}_3\right]$$

3. For a full controllability of canonical objectof second order (11) with the matrix $J_j^{'}$, type (5) is required to at least one of the fresh elements $\tilde{b}_{ii}, \tilde{b}_{i+1,i+1}$ matrixes of control was distinct from the zero point.

Coefficients of modal regulator and control law for such object are defined by expressions:

$$k_i = \mu_i^* - \alpha_j,\ \ i = \overline{1k},\ \ j = \overline{1,k} \text{ under even } i$$

$$u_{ii} = \frac{1}{b_{ii}}\left[-\tilde{x}_i + \left(\mu_i^* - \alpha_j\right)\tilde{x}_i + \beta_j \tilde{x}_{i+1}\right],\ \ i = \overline{1,2k}$$

$, \ j = \overline{1,k}$

under uneven i

$$u_{ii} = \frac{1}{b_{ii}}\left[-\tilde{x}_i + \left(\mu_i^* - \alpha_j\right)\tilde{x}_i - \beta_j \tilde{x}_{i-1}\right],$$

$$i = \overline{1,2k}\ ,\ \ j = \overline{1,k}$$

Conclusion. For the case of completely operated object on Kalman known methods of syntheses of the modal regulator is based on the preliminary adduction matrixes of object A to the triangular type, herewith as nonspecial matrixes of transformation the matrix of controllability is used. But majority of real objects are not completely controlled on Kalman and such path is unacceptable from for a degeneracy matrixes of controllability. There fore more universal and general is an approach, based on the adduction matrixes of object to block-diagonal form. The Approach explained in given work allows analytically to decide the problem of parametric syntheses of modal regulators with the increased potential of robust stability under incomplete object controllability on Kalman. The syntheses of control laws is produced in the field of canonical variable separately for groups simple material, multiple and complex-associate own values matrixes of object.

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Stability with Respect to the Limits of Qualitative Variations in Asymptotically-Stable Robust Control Systems

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Resume.

Method of estimation of proximity nominal system with increased potential robust stability to borders of qualitative changes.

Keywords: *Stability, catastrophe theory, estimation, qualitative changes, matrix, norm, control system.*

Introduction. At the present time developmentof methods for extending of potential of robust stability of automated control system. Such systems widespread in all kind of science and technics. These systems usually works in circumstances with uncertainty of parameters of object under control and big fluctuation of characteristics during exploitation. One of the approach to build control system with increased potential of robust stability is choice of rules of regulator control for linear objects with undefined parameters in the class of structurally stable reflections from catastrophe theory [1], mentioned in references [2,3] robust stable control system. These systems characterized by loss of stability of zero and emerging stable polystationary conditions with qualitative changes in Automated Control Systems. This happens in dependence of changes undetermined parameters and set by object.

This control system which described by the following equation

$$\frac{dx(t)}{dt} = Ax(t) + Bu(t) \qquad (1)$$

where:

x(t)- n-dimensional vector of object status,

u(t) - m- dimensional non-linear control matrix,

B – (n x m) dimensional control matrix

A- (n x n) dimensional control object matrix

Non-linear system (1) with rule describing control of the system, components of which specified for example in terms of one parameter structurally stable reflections, $u = -x^3 + kx$. are described in this report.

If we will linearize equation (1) around stationary condition x_s we will get:

$$\frac{dx(t)}{dt} = (A + BU(x_s))x(t) = C_s x(t), \qquad (2)$$

where C_s – matrix of closed linearized system matrix

$$U(x_s) = \|u_{ij}\| \Rightarrow u_{ij} = \left.\frac{\partial u_i}{\partial x_j}\right|_{x_s}, i = \overline{1,m},$$

$$j = \overline{1,n}$$

Different methods of estimation of remoteness nominal robust stable control system from borders of qualitative changes by the norm ermit part of the matrix of closed linearized system (2) G are described in this report.

G matrix can be broke down into sum ermit matrix D with matrix C by the following equation $D = \frac{1}{2}(G - G^*), C = \frac{1}{2}(G - G^*)$. If G^*=G, then C=0 and all own values of G matrix are real. This means that norm of the C matrix can set high estimation for imaginary parts of own values G matrix. Also, if G^*=-G, then D=0, and all own values of the matrix G(μ(D)=Reμ(G)) accordingly represents estimation of remoteness of control system from borders of qualitative changes.

Degree of remoteness stable to the limit control system from borders of qualitative changes determined by degree of remoteness of D matrix from degeneracy. It is necessary to choose a function which determined on square D matrixes which can be only if detD=0. Such function is low plane of D matrix determined relatively to any vector norm h

$$\mathrm{glb}_h(D) = \inf_{\vec{x}\neq 0} \frac{h(dx)}{h(x)} \qquad (3)$$

Matrix norm (3) is inducted by different vector norms determined by elements of D matrix and therefore by parameters of control system.

Two notions were formulated which set remoteness of stable to the limit system from borders of qualitative changes in dependence from parameters of object and regulator.

Notion 1. Let D – ermit part of linearized matrix, which is closed and stable to the limit control system G

$$D = \begin{Vmatrix} d_{11} d_{12} \dots d_{1n} \\ d_{21} d_{22} \dots d_{2n} \\ \dots\dots\dots\dots\dots \\ d_{n1} d_{n2} \dots d_{nn} \end{Vmatrix}$$

and let degree of remoteness of stable to the limit system from borders of qualitative changes determined relatively to vector norm

$$\rho(x) = \sum_j |x_j|, \text{ then}$$

$$\mathrm{glb}(D) = \min_j |\mu_j| = \min_j \sum_k |d_{jk}| \text{ or}$$

$$\mathrm{glb}(D) = \min_j |\mu_j| = \min_k \sum_j |d_{jk}| \ .$$

Notion 2. Let D matrix is ermit part of matrix of linearized, closed and stable to the limit system G with its own values $\mu_1, \mu_2, \dots, \mu_m$ и $|\mu_m| = \min_j |\mu_j|$, so with Euclid vector norm h following inequality is valid

$$\mathrm{glb}_h(D) \le \min_j |\mu_j| ,$$

so low facet of real part of linearized, closed system by Euclid norm h will not exceed minimal by module value of D matrix D.

Conclusion. Stable to the limit robust control systems can make qualitative changes depending from values undetermined object.parameters and set parameters of control system. It was offered to measure proximity of nominal extremely stable control system to borders of qualitative changes by lower facet of matrix norm from ermit part of linearized closed system. The notions which were formulated and proved allow estimate nearness to the borders of qualitative changes by

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A Syntheses Method of Control Systems with Varying Organization

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Resume.

Synthesis method of control systems with varied organization only are considered in this article. This method to be based on transformation of optimal control synthesis initial problem into sequence of control synthesis problem on set of structural differences control laws.

Keywords: *Synthesis problem, optimal control, restrictions to phase variables, structure of control laws.*

Introduction. Actual control theory problem is methods development of synthesis problem solution in piecewise-continuous control function category and receiving control laws in analytical form. Synthesis problems belong to such category, where control law is changed several times at the control time interval. Such situation can arise in problems with restrictions to phase variables and controls with large initial conditional state deviations from balance position in the nonlinear systems with object structure change, etc.

Problem statement. Control object, describing with the following equation, is given:

$$dx(t)/dt = f[x(t),u(t),t], \quad t \in [t_0, t_k] \quad (1)$$

$$x(t_0) = x^0 \neq 0; \quad t_k < \infty; \quad t_0 \geq 0. \quad (2)$$

Optimality criterion is given

$$J(x,u) = \int_{t_0}^{t_k} F[x(t),u(t),t]dt,$$

$$F[x(t),u(t),t] > 0, \quad F[0,0,t] \equiv 0 \quad (3)$$

and constraints are as follows:

$$G[x(t),u(t),t] \leq 0, \quad \forall t \in [t_0,t_k]. \quad (4)$$

All constraints are supposed to be active and satisfy the following condition:

$$\begin{aligned} &\exists [t_\alpha^i, t_\beta^i] \subseteq [t_0,t_k], \ \forall t \in [t_\alpha^i, t_\beta^i] \ G^i[x^*(t),u^*(t),t] = 0 \\ &\forall i = 1,2,..\chi \rightarrow |x^*(t)| \neq 0, \ |u^*(t)| \neq 0; \\ &[t_\alpha^\omega, t_\beta^\omega] \cap [t_\alpha^\rho, t_\beta^\rho] = 0 \ \forall \omega \neq \rho, \ \forall \omega,\rho \in \{1,2,..\chi\}; \\ &\|G^i[x(t),u(t),t] - G^j[x(t),u(t),t]\| > \delta \ \forall i \neq j \end{aligned} \quad . (5)$$

It is required to determine the control law

$$u(t) = \varphi[x(t),t], \quad t \in [t_0, t_k], \quad (6)$$

ensuring the minimum value of the optimality criterion (3) with relations (1), (2) and constraints (4), (5). We shall search for the optimal control $u^*(t) = \varphi^*[x(t),t]$ at $[t_0, t_k]$ in piecewise-continuous functions category. Let operators of expressions (1)-(5) satisfy condition of solution existence of (6) optimization problem. Else, constraints (4), (5) and initial condition (2) are coordinated between themselves. Abbreviations accepted here: x,u - are n- dimensional and m- dimen sional vectors of state and control; x*(t) and u*(t) are optimal trajectory and control; $G^i(\cdot)$- *1*-dimensional vector-function of constraints, active at the interval отрезке $[t_\alpha^i, t_\beta^i]$ $\forall i = 1,2,\ldots,\chi$

Synthesis method of control systems with varied organization. Let there is M_0 - the set of the following control laws:

$$M_0 = \{u^{\nu_0}(t) = \varphi_0^{\nu_0}[x(t)], t \in [t_\alpha^{\nu_\sigma}, t_\beta^{\nu_\sigma}],$$
$$t_\alpha^{\nu_0} < t_\beta^{\nu_0}, \ \nu_0 = 1,2,\ldots,k_0, k_0 > 1\},$$
$$\sigma = 1,2,\ldots; t_\alpha^{\nu_\sigma} = t_\beta^{\nu_\sigma - 1} + \varepsilon; \quad (7)$$

$$[t_\alpha^{\nu_1}, t_\beta^{\nu_1}] \cap [t_\alpha^{\nu_2}, t_\beta^{\nu_2}] = 0,$$
$$\forall \nu_1 \neq \nu_2, \ \forall \nu_1, \nu_2 \in \{1,2,\ldots,k_0\} \quad (8)$$

$$\min_\nu \{t_\alpha^\nu, \nu = 1,2,\ldots,k_0\} = t_0,$$
$$\max_\nu \{t_\alpha^\nu, \nu = 1,2,\ldots,k_0\} = t_k \quad (9)$$

$$\left\|\left(\phi_0^{\nu_0}-\phi_0^{\nu_0+1}\right)*x(t)\right\|\geq\delta$$
$$\forall\nu_0=1,2,\ldots,k_0-1,\ \delta>0$$
$$\forall t\in\left[t_\alpha^{\nu_0},t_\beta^{\nu_0}\right]\subseteq\left[t_0,t_k\right] \qquad (10)$$

where k_0 is positive integer; δ - positive number, describing structural difference of two control laws, ε-infinitely small value. Function u(t) is supposed to be continuous for all $t\in[t_0,t_k]$ except finite number of time moments t_β^ν, $\nu=1,2,\ldots,k_{\sigma-1}$, where function may has first-order brakes.

Let input the abbreviation of elements number in $M_{\sigma-1}$:

$$\dim M_{\sigma-1}=k_{\sigma-1}. \qquad (11)$$

Obviously, that

$$k_{\sigma-1}>2 \qquad (12)$$

the (7) set of control laws can contain control laws equivalent in structure. Let set $M_{\sigma-1},\sigma=1,2,\ldots$ elements are formed according to the following algorithm:

$$\phi_\sigma^{\nu_\sigma}[x(t)]=\gamma\left\{\phi_\sigma^{\nu_{\sigma-1}}[x(t)],\phi_\sigma^{\nu_\sigma+1}[x(t)]\right\},$$
$$t\in\left[t_\alpha^{\nu_\sigma},t_\beta^{\nu_\sigma}\right]$$

with $\nu_\sigma\neq2^\sigma\cdot(\nu_0-1)+1;\ \nu_\sigma=1,2,\ldots,k_\sigma;$

$$\sigma=1,2,\ldots; \qquad (13)$$

$$\phi_\sigma^{\nu_\sigma}[x(t)]=\phi_0^{\nu_0}[x(t)],\quad t\in\left[t_\alpha^{\nu_\sigma},t_\beta^{\nu_\sigma}\right]$$

with $\nu_\sigma=2^\sigma\cdot(\nu_0-1)+1;$

$\nu_\sigma=1,2,\ldots,k_\sigma;\sigma=1,2,\ldots,$

(14)

where $\gamma\{\ \}$- is the operator, producing such new control law, satisfying the following conditions, that function u(t) is continuous at $\left[t_\alpha^{\nu_\sigma},t_\beta^{\nu_\sigma}\right]$:

$$\left\|\left(\phi_\sigma^{\nu_\sigma}-\phi_\sigma^{\nu_\sigma+1}\right)*x(t)\right\|\geq\delta,$$
$$\forall\nu_\sigma=1,2,\ldots,k_\sigma,\sigma=1,2,\ldots,,$$
$$t\in\left[t_\alpha^{\nu_\sigma},t_\beta^{\nu_\sigma}\right] \qquad (15)$$

$$\phi_\sigma^{\nu_\sigma}[x(t)]=\phi_\sigma^{\nu_{\sigma-1}}[x(t)]$$

with $t=t_\beta^{\nu_{\sigma-1}};$

$$\forall\nu_\sigma=2,3,\ldots,k_\sigma-1;\ \sigma=1,2,\ldots; \qquad (16)$$

$$\phi_\sigma^{\nu_\sigma}[x(t)]=\phi_\sigma^{\nu_{\sigma+1}}[x(t)]$$

with $t=t_\alpha^{\nu_{\sigma+1}};$

$$\forall\nu_\sigma=2,3,\ldots,k_\sigma-1;\ \sigma=1,2,\ldots. \qquad (17)$$

It is follows of (13) and (14), that

$$\dim M_\sigma=2*\dim M_{\sigma-1}-1\ \ \forall\sigma=1,2,\ldots, \qquad (18)$$

where k_0 - defined integer, $k_0>1$. Let input abbreviations of time set characteristics of (7):

$$\Delta t_{\max}^{\sigma-1}=\max_\nu\left\{t_\beta^\nu-t_\alpha^\nu,\nu=1,2,\ldots,k_{\sigma-1}\right\},$$
$$\sigma=1,2,\ldots. \qquad (19)$$

The following relation follows from condition (18):

$$\Delta t_{\max}^\sigma\leq\Delta t_{\max}^{\sigma-1},\quad\forall\sigma=1,2,\ldots. \qquad (20)$$

It can be mentioned, that each set of (13)-(17) corresponds the definite control system with varied organization (CSVO).

Definition 1. Let the following problem be called the nonlinear programming problem (NPP) for control systems synthesis with varied organization at $M_{\sigma-1}$ set:

$$\min_{T_{\sigma-1}\in L_{\sigma-1}}J(T_{\sigma-1}), \qquad (21)$$

where $T_\sigma=(t_\beta^1,t_\beta^2,\ldots,t_\beta^{k_\sigma-1})^T;$ (22)

$$J(T_{\sigma-1})=\sum_{\nu=1}^{k_{\sigma-1}}\int_{t_\alpha}^{t_\beta}F[x(t),u^\nu(t),t]dt; \qquad (23)$$

$$L_\sigma=\{T_{\sigma-1}|\ t_\beta^\nu\in[t_0,t_k]\forall t_0\geq0,t_k<\infty,$$
$$dx(t)/dt=f\left[x(t),u^\nu(t),t\right],$$
$$x(t_0)=x^0;\ \max_\nu\left\{t_\alpha^\nu,\nu=1,2,\ldots,k_{\sigma-1}\right\}=t_0;$$
$$\max_\nu\left\{t_\beta^\nu,\nu=1,2,\ldots,k_{\sigma-1}\right\}=t_k;$$
$$u^\nu(t)=\phi_{\sigma-1}^\nu[x(t)];t\in\left[t_\alpha^{\nu_\sigma},t_\beta^{\nu_\sigma}\right];$$
$$G\left[x(t),u^\nu(t),t\right]\leq0,\ t\in[t_0,t_k],$$
$$\nu=1,2,\ldots,k_{\sigma-1}\}. \qquad (24)$$

Theorem 1. If control law (6) looks like (13)-(17), and the right part of system is determined at $[t_0,t_k]$, moreover the following functions

$$f_i^\nu(x,t)=f_i\left\{x(t),\phi_{\sigma-1}^\nu[x(t)],t\right\},$$
$$\partial f_i^\nu(x,t)/\partial x_j\forall i,j=1,2,\ldots,n,\quad;$$
$$F\left[x(t),u^\nu(t),t\right]$$

are continuous at the interval $\left[t_\alpha^{\nu_\sigma},t_\beta^{\nu_\sigma}\right]$ and have the finite limits with $t\to t_\alpha^\nu$ and $t\to t_\beta^\nu$ for all $\nu_\sigma=1,2,\ldots,k_{\sigma-1}$, than NPP has the optimal solution

$$T^*_{\sigma-1} = \arg\min_{T_{\sigma-1}\in L_{\sigma-1}} J(T_{\sigma-1}). \qquad (25)$$

Let there is the M_0 set of (13)-(17), satisfying the following conditions

$$\dim M_\sigma = \dim M^*_\sigma \qquad (26)$$

$$\exists\sigma \in \{1,2,...\} : \sigma > 1 \to \to \left|\dim M^*_{\sigma-1} - \dim M^*_\sigma\right| > 0. \qquad (27)$$

Definition 2. Objective of control systems synthesis with varied organization, we'll call the problem, where it is required to define the set among the $M^*_{\sigma-1}$, $\sigma = 1,2,...$ sets of (13)-(17), so that providing minimal volume of optimal criterion (3), having (1), (2) connections and (4), (5) constraints.

Definition 3. Let M_0 set (13)-(17) exists satisfying conditions (26)-(27). Than solution of control systems synthesis with varied organization for this M_0 set is such M^*_σ set, for which the following condition is satisfied for the first time

$$\dim M^*_\sigma = \dim M^*_{\sigma-1} \qquad (28)$$

with increasing of σ ($\sigma = 1,2,...$) index. Let all M^*_σ sets satisfy (28) condition, beginning with some $\sigma = \sigma*$ index, i.e. . $M^*_{\sigma^*}$, $M^*_{\sigma^*+1}$. But $M^*_{\sigma^*}$ set only will be called the solution.

Theorem 2. If M_0 set is defined for the problem of control system synthesis with thevaried organization, and M_0 and M_σ sets are connected with relations (13)-(17), than the following condition is true:

$$J(T^*_\sigma) = J(T^*_{\sigma-1}) \qquad \sigma = 1,2,... \quad (29)$$

Theorem 3. It time space $[t_0, t_k]$ in the problem of control system synthesis with varied organization is finite, than there is optimal solution for such problem and the following condition is true

$$\dim M^*_\sigma < \infty, \quad \|T^*_{\sigma^*}\|_E < \infty. \qquad (30)$$

Theorem 4. If nonzero initial conditions (2) are given in problem (1)-(6) relatively the right part of system (1) and integrand function (3) and conditions (31)-(33) are true

$$\left\|f[x(t),u^1(t),t] - f[x(t),u^2(t),t]\right\| \le \le P\cdot\left\|u^1(t) - u^2(t)\right\|, \mathrm{P} < \infty, \qquad (31)$$

$$F[x(t),u(t),t] > 0, \quad F[0,0,t] = 0, \quad [t_0, t_k] \qquad (32)$$

$$[t^\nu_\alpha, t^\nu_\beta], \ \nu_\sigma = 1,2,...,k_\sigma, \qquad \sigma \in \mathrm{N}, \qquad (33)$$

than there is optimal solution in the control system with varied organization category for such problem and the following condition is implemented:

$$\dim M^*_\sigma \ge (1+\chi), \qquad \sigma \in \mathrm{N} \qquad (34)$$

Algorithm of problem solution of control system synthesis with varied organization. If M_0 set (7)-(10) is given, than algorithm of problem solution of CSVO can be described as follows.

Step 0. Defining positive number $\varepsilon = \varepsilon_0$ in (7).

Step 1. Taking cycle number $\sigma = 1$. Forming $M_{\sigma-1}$ set, satisfying conditions (13)-(17).

Step 2. Solving the problem of NPP for CSVO synthesis at $M_{\sigma-1}$ set. Receiving $M^*_{\sigma-1}$ set, $T^*_{\sigma-1}$ vector, numbers $\dim M^*_{\sigma-1}, J(T^*_{\sigma-1})$ as a result.

Step 3. Checking implementation of (26) condition. If it is broken, than decrease value of ε (for example, $\varepsilon_\sigma = \varepsilon_{\sigma-1}/2$) and return to step 1; otherwise go to the following step.

Step 4. Forming M_σ set, using relations (13)-(17).

Step 5. Solving NPP problem for CSVO synthesis at M_σ set. We'll receive M^*_σ set, T^*_σ vector, numbers $\dim M^*_\sigma$, $J(T^*_\sigma)$ as a result.

Step 6. Checking the implementation of condition (26). If it is true, than taking $\sigma = \sigma + 1$ and go to step 4; otherwise go to step 7.

Step 7. Checking the implementation of condition (28). If it is true, than go to step 8; otherwise go to step 4 with $\sigma = \sigma + 1$.

Step 8. Finish the search and take the last results, received at step 5, as decision.

Conclusions. Synthesis method of control systems with varied organization are developed. This method allows to receive the analytical solution even for the difficulties optimal control synthesis problem. For example, solution the optimal control synthesis problems with inequality constraints (which often to be considered how testing problem for very much working [1,2]) are received.

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Synthesis of Control Laws for Linear Discrete Systems on the Basis of the Admissibility Concept

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Resume.

New approach to synthesis of automatic regulators for multi measured longitudinal systems of control is directed to the case of discrete line determine stationary systems. Resulted analytical conditions provide guarantee for achievement of direct engineer quality identifications.

Keywords: synthesis, control subsystem, quality of control, discretic system, admissibllity concept.

Introduction. Establishing of modern effective systems of automatic control non-available without considerations of real conditions of their function. Furthermore there it's necessary to provide project system for required quality control. Currently it has been worked out wide class of methods in synthesis of automatic control system. [1-3]. However, despite of great deal of these methods, actually their use is limited; and otherwise, methods designed comparatively for wide use (integral, route criteria) do not consider prior engineer requirements for project system. Absence of effective functional correlation between parameters of that criterias on the one hand and direct engineer indications on the other hand, such as, over regulation, regulation time, etc., is not acceptable for getting, in many cases, desirable meanings of that indications for synthesis system. Actually, there are also some more insufficient research or solved questions properly in investigations for links between desirable condition of object and system control indications, problem of control system for managing subsystems directly on limitations for transitive process and that problem in the frame of lack of information about indignant influences and uncertainty in description of object and so on.

In work [4-6] there is developed approach based on acceptability conception that allows considering pointed engineer points of quality. Main idea in this consists of having factors controlled by dynamic process or their summarized characters should belong to set multitudes. The last are formed on the base initial engineer requirements to project system. Approach was used for multi measured longitudinal systems with full information about control object and with different kinds of indefinites in describing object. The purpose of this work is spreading indicated approach to multi measured discrete linear systems in case of full information about object.

Task setting. It is supposed, that there is follo wing initial information.

1. Mathematical description of object of control in the form vector-matrix equation

$$x(\nu+1) = Ax(\nu) + Bu(\nu), \qquad (1)$$

Where $\nu = 0,1,2,\ldots$ – discrete time moment;

$x(\nu)$ - n – measured vector of changeable statement;

$u(\nu)$ – m – measured vector of control;

A – constant matrix of measure n x n;

B – constant n x m matrix; matrixes A and B properly established.

2. Vector of established influences $g = [g_1, g_2, \ldots, g_n]^T$, $g = g(\nu)$.

Components $g_к(\nu)$ describe desirable laws of changing for operative alternating $x_к(\nu)$.

3. Purpose of control that established by correlation

$$e(\nu) = g(\nu) - x(\nu) = 0, \qquad (2)$$

Where $e = e(\nu)$ - is vector of control mistake; 0 – zero vector.

4. Quality index. For quality estimation of control purpose performance (2) as well as in [4-6] concept of admission will be used. At this case one kind of purposeful correlation will be considered.

$$|e_i(\nu)| = |g_i(\nu) - x_i(\nu)| \le \sigma_i(\nu),\ i = \overline{1,n}, \ (3)$$

where $б_i(\nu)$ - positive functions with the help of that acceptable defections (majorants) of operative alternating are set in maximum from their desirable (nominal) meanings $g_i(\nu)$. So for transitive process of these alternating $x_i(\nu)$ some acceptable areas are set. For control mistake $e_i(\nu)$ sets are:

$$E_i(\nu)=\{e_i \in R^1 : | e_i(\nu)| \le \sigma_i(\nu)\},$$

$$E(\nu)=\{e \in R^N : e_i \in E_i,\ i=1,N\}.$$

General setting of task consists of: to determine structure and parameters of control subsystem (regulator) for multi-dimensional stationary discrete linear object (1) on the base of given in sub issues 1-4 information about, providing guarantee for perfomance of purposeful correlation (3), i.e. т.е. $e(\nu) \in E(\nu)$.

Decision of the task. Dicision of formulated task we will develop according to common principles, used in [4].

Purposeful correlation (3) we will write in equivalent kind

$$e_i^2(\nu) \le \sigma_i^2(\nu), \quad i = \overline{1,n}. \qquad (4)$$

Evidently that correlation (3) and (4) follow from each other.

Regarding to condition (4) it's trustful following

Theorem. Let initial conditions on control mistake satisfy correlation $| e_i(0)| \le \sigma_i(0)$. Then to satisfy this requirement (4) it's necessary for all N >0 the performance of following correlation:

$$\sum_{\nu=1}^{N}[e_i(\nu) - e_i(\nu-1)][e_i(\nu) + e_i(\nu-1)] -$$
$$-\sum_{\nu=1}^{N}[\sigma_i(\nu) - \sigma_i(\nu-1)] \qquad (5)$$
$$[\sigma_i(\nu) + \sigma_i(\nu-1)] \le \sigma_i^2(0) - e_i^2(0), \quad i = \overline{1,n}.$$

Analysis of resulted condition (5) shows that in task decision of structured synthesis for their effective use it's necessary to put the limits on difference of component of vector of control mistake $e_i(\nu+1)$ or on their derivatives

$$\Delta e_i(\nu+1) = e_i(\nu+1) - e_i(\nu)$$

so, as to provide accessory transitive process to set accepted sets $E_i(\nu)$. For this purpose, for example, we can introduce into consideration some sets of functions $\Psi_i(\nu)$, describing purposeful trajectory of speed movement the vector component of control mistake.

$$\Psi_i(\nu) = \{\Psi_i \in R^i : | e_i(\nu) | \le \sigma_i(\nu)\}, i = \overline{1,n},$$

where $\Psi_i = \Psi_i(p^i, e)$ - function from element vector of mistake control $e_i(\nu)$ and variation of m_i - measured vector-parameter p^i. Choice of vector – parameter p^i is used from the condition of providing for purposeful correlation (2), i.e. $e_i(\nu) \in E_i(\nu)$. Now for the achievement purpose for control – desirable condition (movement) of control object we will require increasing of control mistake to subordinate to correlation

$$(\nu+1) = \psi_i(p^i, e), \quad i = \overline{1,n}, \qquad (6)$$

Probable set P_i for vector-parameter p^i is determined by expression

$$P_i = \{ p^i \in R^{mi} : \psi_i(\nu) \in \Psi_i(\nu) \}, \quad i = \overline{1,n}.$$

Now it's not so difficult to be persuade that at $p^i \in P_i$ correaltions (6) give opportunity to form synthesis equation of sought control laws and on it's base to perform structured synthesis of controlled subsystems by set initial quality indications. By this approach to control system building main tasks are: to determine function structure $\psi_i(p^i, e, \nu)$ and description of multitudes P_i.

Indicated functions could be chosen differently particularly

$$\psi_i(p^i,e)=\sum_{j=1}^{n} p_{ij}e_j(\nu), \quad ,$$

$$\mathrm{p}^{\mathrm{i}}=[p_{i1},\dots,p_{in}], \quad \mathrm{m}_{\mathrm{i}}=n, \qquad (7)$$

$$\psi_i(p^i,e)=\mathrm{p}_{\mathrm{i}}e_i(\nu)+\beta_i,$$

$$p^i=p_i, \quad m_i=1, \qquad (8)$$

where parameters $p^i = [p_{i1}, p_{i2},..., p_{in}]$ and function β_i are determined from the following conditions:

$$\sum_{\nu=0}^{N}\psi_i(p^i,e,\nu)\left[\psi_i(p^i,e,\nu)+2e_i(\nu_i)\right]$$

$$\leq\sum_{\nu=1}^{N}\left[\sigma_i(\nu+1)-\sigma_i(\nu)\right]\left[\sigma_i(\nu+1)+\sigma_i(\nu)\right], \quad (9)$$

$i=\overline{1,n}$.

Increasing of dimension m_i of vector-parameter p^i leads to extend of sets $\Psi_i(\nu)$, that it improves opportunity for achieving of set requirements to projected system. However in this case technical realization of sought control laws and synthesis procedure. It's necessary to provide for compromise among these requirements.

In case when $g(\nu) = 0$, i.e. $e(\nu) = x(\nu)$, and functions $\psi_i(p^i, e)$ were set as (8), and task is considered as structure parameter synthesis of control law for object (1) we can determine from synthesis equation

$Ax + Bu = Px + \beta$,

where

$P = \mathrm{diag}(p_1, p_2,...,p_n)$, $\beta = [\beta_1, \beta_2,..., \beta_n]$.

Conclusion. In this work we have observed task of analytical construction for regulators of linear discrete systems on bounds for transitive process on the base of principles of quarantined correlations. Analytical conditions were found presuming to synthesize control laws for linear multi-dimensional object that provide for guarantee performing of set engineer requirements to projected systems.

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Synthesis of Automatic Systems Under Parametric Uncertainty

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Resume.

The procedure of the synthesis of the law of control of the specified structure with a linear stationary object given parametrical uncertainty in the representation of an object is offered for consideration. The offered approach is based on admissibility concept.
Keywords: *Systems of automatic control, ad-missibility concept, system quality, paramet-rical uncertainty.*

Introduction. Currently, growing complexity of control objects, high efficiency and quality requirements of the processes under control given the set of restrictions and incompleteness of apriory information are the main characteristic for problems of control. Therefor, the methods of construction of adaptive and robust control systems hold one of the leading positions in the theory and practice of synthesis of control systems given uncertainty [1-3].

However, the majority of methods based on the adaptive and robust control theory make use of indirect, integrated criteria of quality by parameters, of the synthesized system, and that doesn't allow to take the requirements for the system characteristics into account to a great extent. The offered approach consideration in the report partially solves the problem. The principle of guarantied ration resting upon admissible and quality primary parameters concept is the basis of the given approach to SAC synthesis. Such an approach is more natural and expedient as the efficiency of functioning of the majority of automatic systems is estimated by the quality of transition processes. The principle of guaranteed ratio [4,5] defines the number of functional ratio, the execution of which guarantees accessory of transition processes to the given sets, in its turn, it guarantees the system stability and execution of engineeringrequirements placed for the quality of contcontrol of the designed system.

One of the potential approaches to the synthesis of the robust law of control of linear stationary object on the basis of guaranteed ratio principle is considered in the report.

The problem statement. As a rule, the majority of the nonlinear equations of objects models can be replaced by linear equations, as the duty of the control system is often reduced to the maintenance of small deviations of motions parameters from their determined meanings. Therefore we are to consider the classical variant of the control object as the linear stationary vector equation.

$$\dot{x}(t) = Ax(t) + Bu(t), \qquad (1)$$

where A – is a material matrix with n x n dimension; B- is a matrix with n x m dimension; x (t) - is n-dimension vector of condition of an object; u (t) – is m-dimension control vector.

The matrixes $A=\{a_{ij}\}$ and $B=\{b_{ij}\}$of the control object are supposed to be precisely unknown:

$$A = A^* + \Delta A, \quad B = B^* + \Delta B, \qquad (2)$$

where $A^* = \{a_{ij}^*\}$, $B^* = \{b_{ij}^*\}$ – are matrixes of the object with n×n and n×m dimensions respectively, they are made up of rating values a_{ij}^* of A elements and b_{ij}^* of B elements ; $\Delta A=\{\Delta a_{ij}\}$, $\Delta B=\{\Delta b_{ij}\}$ – are matrix defining uncertainty in the representation of the control object. Uncertainties intervals for Δa_{ij} and Δb_{ij} are supposed to be known:

$$|\Delta a_{ij}| = |a_{ij} - a_{ij}^*| \le \Delta a_{ij}^+,$$

$$\left|\Delta b_{ij}\right| = \left|b_{ij} - b_{ij}^{*}\right| \leq \Delta b_{ij}^{+}, \qquad (3)$$

where Δa_{ij}^{+}, Δb_{ij}^{+} - are positive numbers determining variation limits of Δa_{ij} and Δb_{ij} parametrical disturbances. Using (2) the object equation obtains the form:

$$\dot{x} = A^{*}x + B^{*}u + \Delta Ax + \Delta Bu. \qquad (4)$$

Proceeding from such reasons, we are to impose restrictions on the object transition processes, considering, to the quality of the synthesized system are defined by transition processes due to the control error e (t):

$$|e_i(t)| = |x_i(t)| \leq \sigma_i(t), \qquad (5)$$

where $\sigma_i(t)$ - positive functions, setting peak admissible deviations x_i (t) in transition processes. It means, admissible interval will correspond to each x_i (t) controlled process. The choice of $\sigma_i(t)$ restrictions is carried out under the primary (engineering) requirements to quality parameters of the designed system.

It is considered, that the object (1) is controlled, and x (t) vector of condition is accessible for measurement at any moment. It is considered, that the regulator's structure is given as linear feedback:

$$u(t) = K\,x(t), \qquad (6)$$

where K – a m×n dimension matrix of a required regulator. We are to make up a vector $p=[k_1, k_2, \ldots, k_m]$ of $r=m\times n$ dimension of kj lines of K matrix.

The task of synthesis robust system of control for a linear object (4) is formulated in the following way:

To find p vector - parameter (K elements) of a regulator, supplying accessory of x_i (t) transition processes correspondent admissible intervals and performance of target ratio (5) given parametrical indeterminancies (3), i.e. $p\in P$ a subset of admissible parameters is as follows:

$$P = \{p\in R^{r}:\ x_i \in E_i,\quad i=\overline{1,n}\}.$$

The solution of the synthesis task. Let's consider the synthesis task solution having admissibility concept as the basis [4,5].

The theorem 1. Let in the initial moment of time $t=t_0$ the inequalities are satisfied

$$|x_i(t_0)| \leq \sigma_i(t_0),\ i=\overline{1,n}.$$

In this case the target ratio (5), if for all $t\in[t_0,t_k]$, the following restrictions hold true:

$$\int_{t_0}^{t} x_i(\tau)\dot{x}_i(\tau)d\tau \leq \int_{t_0}^{t} \sigma_i(\tau)\dot{\sigma}_i(\tau)d\tau,\ i=\overline{1,n}. \qquad (8)$$

Let's consider the vector equation of the object(4) for the solution task of the robust systems of control for mulated above with due account of point (2) and the control law (6) the equation be written in the following way :

$$\dot{x} = (A^{*} + B^{*}K)x + (\Delta A + \Delta BK)x.$$

In the coordinate form it is as follows

$$\begin{aligned}\dot{x}_i &= \sum_{j=1}^{n}(a_{ij}^{*} + \sum_{\nu=1}^{m} b_{i\nu}^{*}k_{\nu j})x_j + \\ &+ \sum_{j=1}^{n}(\Delta a_{ij} + \sum_{\nu=1}^{m}\Delta b_{i\nu}k_{\nu j})x_j\end{aligned}, \quad i=\overline{1,n}. \qquad (10)$$

$$\begin{aligned}&\sum_{j=1}^{n}(a_{ij}^{*} + \sum_{\nu=1}^{m} b_{i\nu}^{*}k_{\nu j})\int_{t_0}^{t} x_i(\tau)x_j(\tau)d\tau + \\ &+ \sum_{j=1}^{n}(\Delta a_{ij} + \sum_{\nu=1}^{m}\Delta b_{i\nu}k_{\nu j})\int_{t_0}^{t} x_i(\tau)x_j(\tau)d\tau \leq \\ &\leq \int_{t_0}^{t}\sigma_i(\tau)\dot{\sigma}_i(\tau)d\tau, \qquad i=\overline{1,n}.\end{aligned}$$

To continue, making use of the approach similar to that of from Reference [6], we are able to show, that

$$\begin{aligned}&\left|\begin{aligned}&\sum_{\substack{j=1\\ j\neq i}}^{n}(a_{ij}^{*} + \sum_{\nu=1}^{m} b_{i\nu}^{*}k_{\nu j})\int_{t_0}^{t} x_i(\tau)x_j(\tau)d\tau + \\ &+ \sum_{j=1}^{n}(\Delta a_{ij} + \sum_{\nu=1}^{m}\Delta b_{i\nu}k_{\nu j})\int_{t_0}^{t} x_i(\tau)x_j(\tau)d\tau\end{aligned}\right| \leq \\ &\leq \int_{t_0}^{t}\sigma_i(\tau)\dot{\sigma}_i(\tau)d\tau - (a_{ii}^{*} + \sum_{\substack{\nu=1\\ j=i}}^{m} b_{i\nu}^{*}k_{\nu j})\int_{t_0}^{t}\sigma^{2}{}_i(\tau)d\tau, \\ &i=\overline{1,n}.\end{aligned} \qquad (11$$

The theorem 2. The satisfaction of the following ratio will be sufficient for the fulfilment of the terms of admissible quality of control (11):

$$\sum_{\substack{j=1\\ j\neq i}}^{n} (a_{ij}^{*} + \sum_{\nu=1}^{m} b_{i\nu}^{*} k_{\nu j}) \mid \int_{t_0}^{t} \sigma_i(\tau)\sigma_j(\tau)d\tau +$$

$$+\sum_{j=1}^{n}(\Delta a_{ij}^{+} + \sum_{\nu=1}^{m}\Delta b_{i\nu}^{+}|k_{\nu j}|)\int_{t_0}^{t}\sigma_i(\tau)\sigma_j(\tau)d\tau \leq \qquad (12)$$

$$\leq \int_{t_0}^{t}\sigma_i(\tau)\dot{\sigma}_i(\tau)d\tau - (a_{ii}^{*} + \sum_{\substack{\nu=1\\ j=i}}^{m} b_{i\nu}^{*}k_{\nu j})\int_{t_0}^{t}\sigma^2{}_i(\tau)d\tau,$$

$$i = \overline{1,n}.$$

Thus, the required p vector - parameter of a robust automatic control system defines the solution of inequalities system (12).

Conclusion. The uncertainties (12) got in terms of the guaranteed ratio principle, guarantee, that the transition processes will be situated in the admissible zone satisfactory for the given quality parameters the problem of synthesis of the control.

Law given parametrical uncertainty is restricted to the determination of the area of admissible parameters of the robust control system.

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About Motion Instability in Automatic Control System

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Many real mechanical systems are under the influence of small disturbing forces not to be considered at its mathematical modeling.
Since the elaboration of fine mathematical model is connected with the great difficulties it is an important to solve the problem of instability of disturbed equation. At solving concrete applied problems investigation of instability of motion is of great important not only for momentary acting indignation but for constant acting indignation. There are various constant working disturbances: the small, small on average and which are disappeared on the infinity.
Differential equations without disturbances have been considered:

$$\frac{dx_s}{dt} = X_s(t, x_1, \ldots, x_n) \qquad s = 1, \ldots, n \qquad (1)$$

where the right parts of these equations are continuous in the field

$$t \geq t_0, \quad |x_s| \leq H \qquad (2)$$

and assume the existence of unique solution at initial conditions specified in advance
$t_0, x_1^0, \ldots$
x_n^0 in the field (2), $X_s(t,0,\ldots,0)=0$,
$s=1,\ldots,n$

$$\frac{dx_s}{dt} = X_s(t, x_1, \ldots, x_n) + R_s(t, x_1, \ldots, x_n)$$

$$s = 1, \ldots, n$$

where functions R_s are characterize constant acting disturbed factors.
We consider constant acting indignation which are small on average and disappeared on the infinity i.e answer the next condition in the field (2)

$$\int_{t_0}^{t} |R_s(\tau, x_1, \ldots, x_n)| d\tau \langle \rho \qquad s \equiv 1, \ldots, n \qquad \rho\text{-}$$

small enough positive number.
The conditions of instability of nonlinear differential equations have been received when the right parts of equations without acting indignation (1) answer the next conditions in the field (2).
right parts of equations without acting indignation (1) answer the next conditions in the field (2).

$$|X_s(t,x)| \leq L(t) \sum_{k=1}^{n} |x_k| + M(t) \sum_{k,i=1}^{n} |x_k| |x_i|$$

$$s = 1, \ldots, n$$

$$|X_s(t,x)| \langle b \sum_{k=1}^{n} |x_k| + \frac{c}{n} \sum_{k,i=1}^{n} |x_k| |x_i| \quad s = 1, \ldots, n$$

where b, c- are positive numbers $t \in [t_0, T]$, $\quad T \langle t_0 + \frac{1}{bn} \ln \frac{b+ac}{ac}$
at the presence of constant acting indignation are small on average and disappeared on the infinity.
Previously the lemmas similar to Granuol-Bellman Lemma have been proofed.
The theorem about instability of motion of automatic control systems at constant acting indignation are small on average and disappeared on the infinity has been proofed.
The theorem about instability of motion of automatic control systems at constant acting indignation are small on average and disappeared on the infinity has been proofed.

Application of MID-Square Method for Estimation of General Parameters in Orthogonal Directions

Alexander V. Zagranichniy

In mathematical model development according to the measurements of input and output signals the mid-squares method (MSM) and its modifications have acquired the wide extension.

One of the approaches allowing to rescue the difficulties during the matrix inversion and its nonsingularity is connected with the estimation of scalar or vector general parameter.

The linear approximations are viewed in the following shape

$$Z = HX_i + V \qquad (1)$$

where $Z = [z_1, z_2, ..., z_k]^{\mathrm{T}}$ - vector of measured output signal $\dim Z = k \times 1$; $H = [h_1, h_2, ..., h_k]^{\mathrm{T}}$ - matrix of measured input signals; $\dim H = k \times n$, $V = [v_1, v_2, ..., v_k]^{\mathrm{T}}$ - vector of not measured noise, $\dim V = k \times 1$, k-sample number; X_i- vector of constant parameters, dim $X_i = n \times 1$, that is chosen in the shape:

$$X_i = X_0 + q_i b_i, \qquad (i = 1,2,..n) \qquad (2)$$

where b_i- scalar parameter for i-approximation, $q_1, q_2, ..., q_i, ..., q_n$ - is the system of orthonormalized vectors, generating n- dimensional metric space, X_0- initial value of estimation vector, that is considered to be equal for every approximation (1).

The estimations b_i are searched by the minimum of quadratic form

$$J_i = 1/2(Z - H(X_0 + q_i b_i))^{\mathrm{T}} G^{-1}(Z - H(X_0 + q_i b_i)) \qquad (3)$$

where G^{-1} - matrix of weighting factors with dimension $k \times k$.

Then the estimations of general parameters b_i are searched by algorithm

$$b_i = (q_i^{\mathrm{T}} H^{\mathrm{T}} G^{-1} H q_i)^{-1} q_i^{\mathrm{T}} H^{\mathrm{T}} G^{-1}(Z - HX_0) \qquad (4)$$

The expression (4) is used for for construction of the following estimating procedures:

1. Sequential estimator b_i in directions determined by vectors q_i with the attained accuracy control on variance of general parameter.

Parallel estimator b_i in n orthogonal directions defined by the choice of basis $(q_1, q_2, ..., q_n)$. The calculation of estimations X is performed in direction q_i

2. That realized the minimum variation of general parameter, or by the solution of linear equation

$$X = X_0 + QM\{B\} \qquad (5)$$

where $Q = [q_1, q_2, ..., q_n]^{\mathrm{T}}]$, $B = [b_1, b_2, ..., b_n]^{\mathrm{T}}$ - vector of general parameters, $\dim B = n \times 1$.

The MSM estimation of general parameter allows to rescue the difficulties connected with matrix inversion by the change of n – dimensional optimization problem for n one – dimensional problems. Thus, the possibility to stop the estimation of parameters on the hitting of attained accuracy of estimation is appeared.

Correlation-Extremal Combined System Synthesis Concept for a Navigation Complex

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This article presents concept of combined synthesis correlative-extreme system of optimum direction on a forecasting model base.

Aircraft maintenance shows the rigid requirements to the systems, providing an airship to a certain point. The optimality problem of navigation complex becomes actually with increasing of speed, height and range of flights. For normal navigation process it is necessary to know aircraft position at each moment of time.

The given work mentions questions of algorithms of correlative-extreme system combined synthesis for a navigation complex of an aircraft. Correlative-extreme navigation systems (CENS) theory is not-new direction, methods of which are possible optimization of a navigation complex. The gradual introduction of principles CENS, cardinally changes traditional methods for onboard navigation devices.

Following the way of analysis of already known algorithms of CENS, their construction methods and modeling, one of this work directions is the consideration non-searching CENS with condision optimum apprising algorithms. On their basis the non-searching CENS algorithms conceptiong with optimum apprising of object forecasting condition is created. In this work formed for forecasting navigation variables and use of forecasting results is defined as an element of quorum. Beside, the concept of necessary and sufficient conditions of optimum control synthesis for designing structure of effective and independent navigasion complex is formed.

This concept of navigation complex designing, base on CENS theory, which algorithms presented in A.A. Krasovsky works. Appraising facilities of aircraft location presents in use with mathematics models of geophysical fields (maps), Earth model and computer of object forecasting condition. It is main differ from the available methods.

Designing navigation complex will excel of characteristics of stability, accuracy, reliability and autonomy.

A Central Approach in Solving the Task of Parametric Synthesis of Control System for Multidimensional Intervally Specified Objects

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As classical methods of the theory of control are oriented on precisely known mathematical models calls definite difficulties when solving tasks of the analysis and synthesis of control systems of uncertain objects. As uncertainty of mathematical model in specifying parameters is characteristic to the majority of control objects, a development of new algorithms and methods of construction of control systems of parametrically uncertain objects becomes actual. In the paper the task of parametric synthesis of a multi-dimensional control system of the interval-specified object is solved on the basis of use of a matrix equation of Sylvester. For finding an inner estimation of the generalized solution set of an interval matrix equation of Sylvester the center approach is used. The sufficient conditions of an belonging to the generalized solution set, so-called, "middle" solution of Sylvester equation are obtained.

Analytical Design of Optimal Control Systems for Particular Class of Objects

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In this article one of the approaches to problem solving of analytical designing of system of optimal control for particular class of objects realising the concept of the combined synthesizing of controls is stated during functioning system. Its based on a combination of automatized procedures of identification of parameters OC at the incomplete information on its state, reception of estimations of a complete state vector with procedures of syn – thesizing of controls.

The majority of chemical-technological processes (ChTP) at some assumptions can be related to a class of linear dynamic of objects of control (OC).

The problem of analytical synthesizing of system of optimal control for particular class of objects is reduced to a finding of the law of control u_k , getting minimum to the squareli criteria of quality of functioning of system of optimal control of a following kind:

$$J(x,u) = X'_N Q X_N + \sum_{k=0}^{N-1} [X'_k Q X_k + u'_k R u_k] \to \min_{u_k}$$

and supplying asimptotical stability of a closed system in condition that the object has property of complete controllability.

On the basis of methods Kalman - Koepcke, by drive away of a solution in return time, and by method of a gliding variation, satisfying of principle maximum Pontryagin, the automatiized procedures of synthesizing of optimimal of control are proposed. The latter is used in conditions of closing of set of available controls.

For a solution of the problem of parametrical identification in conditions of the incomplete information is chosen the adaptive discretic observer, using Lyapunov's direct method , allowing simultaneously to get estimations of a state vector and parametrs OC, guaranteeing asimptotical stability of vectors of an error of parametrs and are difference on a state vector under condition of complete information of an input signal.

The introduced approach to a solution of a problem of analytical designing of system of optimal control for particular class of objects has the large community, provide demanded precision and quality of control at an incomplete state information OC in real conditions, with errors of measurings and in view of the requirements of information-measuring subsystem.

Robust Stability of Nonlinear Automatic Control Systems with a Nonunique State of Equlibrium for a General Case with One Nonlinearity

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In the tasks of control of real plants the parameters them, as a rule, are precisely unknown. Therefore problems of creation of control systems and data processing, which dynamic properties would vary at small deviations of their parameters from calculated a little, have arisen already in the beginning of development of the theory of automatic control.

Now a lot of attention is given to a problem of research of robust dynamic properties of nonlinear systems of automatic control, but these researches yet do not cover needs of the theory and practice.

In the given paper the frequency criterion of a robust stability of the determined interval nonlinear systems of automatic control with a nonunique state of an equilibrium is obtained, the main cases are considered.

Group Lee Formulation Conditions for Control Systems of Intervally-Defined Objects

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The research of dynamic properties of uncertain control systems is connected to series ofdifficulties, which are stipulated by using of interval arithmetic's, which can be overcome with the application of the group approach. Interval values of classical interval arithmetic's $\langle I(R),+,\cdot\rangle$ [1] form only commutative semigroup both additional, and multip-licational. The capability of formation groups for a set of interval values gives application extended Kaucher's arithmetic's *IR* [2], which operates interval elements with the inverse elements on addition and multiplication.

The report deals with conditions of existence of a Lie group for set of interval matrixes.

Condition 1. The extended interva multiplication is commutative and associative but the multiplicative group *IR* is formed onl by intervals $[a_1,a_2]$ with $[a_1,a_2]>0$, as on an more broad subset *IR* the law of reduction doe not hold [3].

Condition 2. The set of interval matrices $\left\{e^{[A]_i t}\right\}$ forms a Lie's group G in that case if $e^{[A]t}>0$.

In summary, it is possible to formulate conditions of existence of a Lie's group for set of interval matrices.

Condition 3. In order to diagonal and off-diagonal elements of matrix $e^{[A]t}$ would be positive, it is necessary that:

in 1th case (degree of decomposition in exponential degree alternating series not even) — off-diagonal elements of a matrix $[A]$ would be positive; the diagonal elements belonged to an interval $\left[-\left[a_g\right];+\infty\right)$;

in 2nd case (degree of decomposition in exponential degree alternating series even) — off-diagonal elements belonged to an interval $\left(-\infty;-[a]_k\right]\cup\left[0;+\infty\right)$, diagonal elements of matrix $[A]$ can have both positive, and negative value.

SECTION

“MODELING IN THE SOCIO – ECONOMIC SYSTEMS”

Simulation Models of Economic System Development

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Resume.

Offered mathematical model macro economical and system of modeling of modeling information, values other scenario of development of economy of country depending on values of initial conditions and mechanisms of macro economical government regulation.

Keywords: *economy words, modeling system, requirement, offers, price, goods, product, population, bank, condition, market, money, system information.*

Introduction. Economic life of sufficiently far off complex of society, which possible definitely confirms that any staff an working perspective economic program or public-economic reform require serious scientific occupations. Economic system does not allow product and enterprise target-oriented experiments natural required for deep and detailed analysis of development of economy of country. Ithaca, impossible exactly and cheque public-economic politician generally accepted in natural sciences by fetters, on which experiment with the nature.

On the light has said an object or ambience of experiment can be only images real economy models; modeling models is experimented in the computer - the most natural system economic analysis facility. If manage to build sufficiently identical mathematical model, modeling is experimented on her by means of the computer to gain a feature of full-fledged scientific analysis and allows on the lecturer of complex of output factors (pointers) value other scenario of development of economy of country depending on economic, public, budgetary and politicians conditions.
Important place is conducted here questions of evaluation of efficiency [1] financial – credit, фискальной, investment politicians and foreign economic state activity. So - so important and actual development of mathematical models [2], acceptable describing total principles and regularities of economic process development in the system, so it is necessary does technologies information and system of modeling of modeling, intended for the support of deciding central tell of control be pointed to macro economical in the regulation within the framework of shaping a professional government.

In the given operation with provision for modern conditions of methods of system analysis of economic system development is designed macro economical mathematical model and system of modeling of modeling information, stability of value, stability and forecasting prospects of development of economy of country. In the economic model system presents in the lecturer as a collection-acting agents, for which clamped defining economic functions. Agents - product, population, bank system, condition, market of lab our, goods and money.

Considered opening economic system. In variable models that - length of time (k=0,1,2, . . .) и (k=t/T, $T = t_{k+1} - t_k$).
Below happen to main correlations and

mathematical economic system equation models.
Value reflecting condition of economy at a period k-м time of the gross internal product (VVP), is defined through earned one's living function [3] Kobba – Douglas:

$$y(k) = F(\chi, x(k), L_1(k)) \ ,$$

where χ - a vector of parameter of functions to product; x(k) – a volume of main fund and $L_1(k)$ - a number, working in earned one's living sector of economy at a k period time.
Track record of main fund is described by the equation [4]:

$$\frac{dx(k)}{dt} = I(k) - \mu x(k),$$

where μ- leaving main fund of factor; I(k) - an investment in product.
Expenses on buying a cheese, hiring labor facility and deduction in the fund of public insurance accordingly:

$$\Phi^A(k) = \epsilon\!-\!(k),\ R^T(k) = W_1 \alpha_1(k),$$

$$R^\phi(k) = \gamma_1 R^T(k),$$

where but - a share of the specific consumption of material in VVP; W_1 - an average level salaries in earned one's living a sector of economy; γ_1- a rate of deductions in the pension fund and public insurance.
Value added tax and on the profit in the economy accordingly:

$$N_{HБ,,}(k) = \eta_{HБ,,}(y(k) - ay(k))$$

$$N(k) = \eta\{y(k)\left[(1-a)(1-\eta_{HБ,,})\right] -$$

$$-(1+\gamma_1)W_1 L_1(k) - z(k)\Phi^K(k)\}$$

where $\eta_{НДС}$ and η - accordingly tax factors on the profit and on the addition cost, r(k) - a rate of percent in the loan capital.
The profit in earned one's living a sector of economy:

$$D^H(k) = 1 - \eta\{y(k)\left[(1-a)(1-\eta_{HБ})\right] -$$

$$-(1-\gamma_1)W_1 L_!(k) - z(k)\Phi^{Ж}(k)\} -$$

$$-\mu * x(k),$$

where $\mu *$ rate an indemnifying a capital comsuming.
Volume of loan capital in earned one's living sector of economy in (k+1)-m period:

$$\Phi^K(k+1) = \Phi^K(k) + D^K(k) - z(k)\Phi^K(k),$$

where $D^K(k)$- total amount of external and internal credit, chosen in the product development at a period k.
Volume in investments in product:

$$I(k) = \Phi^I(k) b / (a + b + d),$$

where b and d- accordingly share and working contents in VVP;

$$\Phi^I(k) = D^K(k) + D^H(k) + \mu * x(k)$$

- a total bankroll amount was made for product developments in the economy.
Track record of structure of population presents differencial an equation [5]:

$$N(m+1) = AN(m),$$

where

$$N(m) = (N_1(m), N_2(m), \ldots, N_n(m)) \ -$$

vector of population number at an age is grouped; m- length of time for modeling of structure of population (m=0,1,2, . . .), $m = t / T_H, \ \ T_H = t_{m+1} - t_m$

$$A=\begin{Vmatrix} a_{11} & a_{12} & a_{13} & \dots & a_{1,n-1} & a_{n} \\ a_{21} & a_{22} & 0 & \dots & 0 & 0 \\ 0 & a_{32} & a_{33} & \dots & 0 & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & 0 & \dots & a_{n,n-1} & a_{nn} \end{Vmatrix}$$

- a matrix of intensity of birth rate, death-rate, immigrations and emigrations at an age is grouped populations; $a_{11}, a_{13}, \dots a_{1\bar{n}}$ - an intensity of birth rate at an age is grouped; $a_{jj}(j=1,\dots,n)$ - an intensity in immigrations; $a_{j+1}, j = 1-\mu_j - m_j$; μ_j and m_j - accordingly, intensity of death-rate and emigrations in the age group j.

In results deciding given equation differencial under modeling modeling is determined: total number of population, their able-bodied part, retirees, unemployed individuals of school and preschool age, education in high and average scholastic institutions, populations poor layers in the country and etc..

Also in the given block computed: total amount salaries, pensions, erudition, advantages of unemployments, payments of transfer in the population, have paid from the budget of state, total amount salaries of financial basis and bank system $V_0^H(k)$ and tax on the profit this $N_0(k)$, total income-tax amount from physical persons in the country $N^H(k)$, total amount salaries in the country $W^H(k)$, consumer expenseses of population $\Phi^H(k)$ and total bankrolls of population of country $D^H(k)$.

Amount of bank contributions of population in (k+1)-m period

$$H(k+1)=(1-c)D^H(k),$$

where with- a factor of fitness of population in the consumption.

Condition

Profit of condition at a period D(k) be formed from the tax and profit неналоговых. To Tax a profit, pertain: tax on the profit of product N(k), income – tax from physical persons $N_H(k)$, value added tax $N_{НДС}(k)$, special tax and payments an resource $N_C(k)$, collection of excise $N_a(k)$, payments for the land $N_3(k)$, tax on the bank system profit $N_B(k)$ and duties of export import $N_T(k)$.

In the block of condition computed also profit an неналоговые - a profit: from selling a package and fixing capital, belongs staff DП(k), from the state property DG(k), tin a state official transfert $D^T(k)$, administrative collection and payment $D^A(k)$ and other profit an nontax $D^{H/H}(k)$.

$$D(k)=N(k)+N_H(k)+N_{HБ,,}(k)+$$
$$+N_C(k)+N_a(k)+N_,(k)+$$
$$+N_0(k)+N_T(k)+DG(k)+Dn(k)+$$
$$+D^T(k)+D^A(k)+D^{H/H}(k)$$

Articles of expenseses of condition $G^P(k)$ are expenseses: in earned one's living sector of economy $I^G(k)$, in international activity and control (indicate expenseses of total nature) $G^Y(k)$, on scientifically – cultural action $G^M(k)$, in protection $G^O(k)$, in law activity – enforcement and safety of condition $G^{ПО}(k)$, in the science $G^H(k)$, on formation $G^{об}(k)$, in the public health $G^3(k)$, in the public insurance $G^C(k)$, on servicing an internal state debt $G^D(k)$, in the excess of circumstances $G^Z(k)$, on servicing an external state debt $G^I(k)$ and other expenseses of condition $G^{ПР}(k)$:

$$G^P(k) = I^G(k) + G^Y(k) + G^M(k) + G^O(k) +$$
$$+ G^{nM}(k) + G^H(k) + G^{''‡}(k) + G^3(k) +$$
$$+ G^C(k) + G^D(k) + G^Z(k) + G^I(k) + G^{nm}(k)$$

Indicate a consumption or bulk aquisition:

$$C^G(k) = G^Y(k) + G^M(k) + G^O(k) + G^{nM}(k) +$$
$$+ G^H(k) + G^{''‡}(k) + G^3(k) + G^C(k) +$$
$$+ G^{nm}(k) - R^G(k)$$

where $R^G(k)$ - payments in the house from the state budget in the manner of the salaries of employees, pensions, erudition and allowances.

Condition gets internal loans for deficit of budget $D^{GD}(k) = D(k) - G^P(k)$ from the bank system on the amount $\Phi^G(k)$ and credits of from outside country $\Phi^{IG}(k)$. On the total amount of internal state addition $D^G(k)$ of banks of debt a percent z_G, so changing total internal state debt amount in (k+1) period is described by the equation

$$D^G(k+1) = D^G(k) + \Phi^G(k) +$$
$$+ z_G(k) - G^D(k)$$

On the total external state amount of debit $D^{IG}(k)$ added percent z_I, so changing external debit of condition in (k+1) period is described by the equation:

$$D^{IG}(k+1) = D^{IG}(k) + \Phi^{IG}(k) +$$
$$+ z_I D^{IG}(k) - G^I(k)$$

Foreign credits and trade on the foreign market can bring about the accumulation of foreign exchange on the amount $\Phi^{\Sigma I}(k)$ and shaping indebtedness external earned one's living sectoral obligees $\Phi_I^K(k)$ and state debt $D^{IG}(k)$. These values in (k+1)-м period will agree the following equations:

$$\Phi^{\Sigma I}(k+1) = \Phi^{\Sigma I}(k) + Ex(k) - \mathrm{Im}\,(k) + D_I^K(k) -$$
$$- z_I \Phi_I^K(k) + \Phi_I^K(k) - G^I(k)$$
$$\Phi_I^K(k+1) = \Phi_I^K(k) + D_I^K(k) - z_I \Phi_I^K(k)$$

where Ex(k) and Im(k)- accordingly, volume of export and import; $D_I^K(k)$ - a volume in foreign investments in earned one's living a sector of economy.

Changing own capital and reserve of bank expresses $D^B(k)$ a balance of operations, creating own facilities, and operations , using the surplus reserves. Main function of banks- to collect savings, pay for it percent β and allow it, alongside with the own capital, under the percents on credit and r_G. So]taking a percent in debts $r_G D^G(k)$ and $r\Phi^K(k)$ increases own capital of bank, but percent payment in debts $\beta H(k)$ reduce its. Possess capital and reserve of bank is determined:

$$D^B(k) = r_G D^G(k) + r\Phi^K(k) -$$
$$- \beta H(k) + \lambda H(k),$$

where λ - a rate of reserve of bank.

Tax on the profit of bank:

$$N_0(k) = \eta_0 [r_G D^G(k) + r(k)\Phi^K(k) -$$
$$- \beta H(k) - (1+\gamma_1) W^0(k) L^0(k)]$$

where η_0 rate of tax on the bank system profit, $W^0(k)$ and $L^0(k)$ - accordingly, average level salaries and number working in the bank country system.

Growing of own bank system capital:

$$\Omega^B(k+1) = \Omega^B(k) + (1-\eta_0)[z_G D^G(k) +$$
$$+ z(k)\Phi^K(k) - \beta H(k) - (1+\gamma_1)W^0(k)L^0($$

Massachusetts of money in the country (k+1) period is defined by the equation:

$$M(k+1) = \lambda H(k) + \theta y(k) + K_э M(k$$

where θ value, inverse amount turns financial devices on the device of time, $K_э$ - a factor of emission of money.

Market of money

It is Necessary to bear in mind that consumption consists of itself consumptions [1] personal (in houses), condition (public), financial institution. Reserve for arousing a development of embedding a capital of the form of economy $\Phi^I(k)$ where enclosed cleaned investments (new product of creation), amortization (indemnifying a wear-out of fund). Value of investments right before determined by savings: $S(k) = S^B(k) + D_I^K(k)$. Value internal spare S^B in the economy - a difference between the location of resources and expenseses is formed in the current consumption C(k) :

$$S^B(k) = y(k) + \mathrm{Im}(k) - Ex(k) - C(k)$$

Demand of money on the part of the fund or demand for the credit is defined by the expression:

$$\Phi^I(k) = (1-\eta)y(k) / (1 + z(k))$$

Offer of money on the market - a total, saving amount S(k). Thence get a description of market of money, changing value of credit factors in (k+1)-м period:

$$z(k+1) = z(k) + z(k)\frac{\phi^I(k) - S(k)}{S(k)}$$

Market of labour

Number, working in earned one's living sector of economy in (k+1) period is defined by the equation:

$$L_1(k+1) = L_1(k) + \Phi^I(k)d/(a+b+c)$$

Market of goods

For the description of changing a price level on the market of goods to define an offer , which

$$\tilde{y}(k) = y(k) + \mathrm{Im}(k) - Ex(k),$$

but price level on (k+1) period:

$$P(k+1) = P(k) + P(k)\frac{M(k) - \tilde{y}(k)}{\tilde{y}(k)}$$

Economic country development in the system information is evaluated: price level and inflation, nominal value and real VVP , number unemployed in the country, postpones an economy an монетизации, forms an arrival amount tax in the budget of state, credit rate level and etc.

Simulation modeling is realized in the ambience VISIAL FOXPRO-5.0., guaranteeing the most broad object-oriented programming possibilities.

Base, developping system menu includes the following modes:

-adjustment

-manegement

-viewing and installing data

-viewing an output given -output

Mode of installation allows be chosen for the concrete base variant of models or go back to it in the process of operation.

In the mode an maanegement an user, have fixing password, has a possibility to change base data.

Viewing and given adjustment contribution is realized for each block models: product, populations, bank, conditions. Whole entered information is tested for admissibility.

Viewing the output factor models is produced through the output form, where will be nominated period of modeling and choose

factor. Viewing is realized in numeric and graphic type.
System gives a chance behaviour of archive of other scenarioes in realization models, possesses a sufficient help amount for гарантирки greatly suitable operation (functioning) user in the system.

Conclusions. System of modeling of modeling Information is created in the base developping models and allows to track other scenario of development of economy of country under other contribution of combinations (initial) data and mechanisms of macroeconomical government regulation.
The numeric experiment in the simulation system allows:
- to value an influence of financial emission and including a money a development of economy of country;
- to value an influence of credit and investment politicians be referenced in the economic system development;
- to value politicians of tax of influence of condition in the economic system development;
- to value an influence public politicians of condition in the economic system development;
- to forecast structures of lecturer of population, toil a facility and unemployed in the country;
- to value an influence of expenseses of condition in protection, formation, science, contents of the state basis and т. д., in public-economic country development;
-to forecast arrivals in the budget of condition and etc.

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Economic-Mathematical Model in a Technique of Formation of the Tariff on Services of Transmission of the Electric Power

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Resume.

The new methodical approach on formation of the tariffs on service on transit electric power in application of economic-mathematical models allow to analyze economic situation in a part of prices of enegy producing organization in areas of Kazakhstan and to accept the administrative decision on their regulation.

Keywords: *Modeling, energy pricing, electricity market*

Introduction. One of lacks of a used now technique for account of the tariff is the rectilinear dependence of its size on distance between a source and consumer.

Thus, the consumers located at a great distance from the enterprise - producer of energy appear at a great disadvantage in comparison with the consumers located on smaller distance. Such differentiation of the tariffs depending on distance puts in unequal conditions of the consumers.

Proceeding from these reasons, it is offered to impose restrictions on a difference between the maximal and minimal sizes of a component, dependent on distance, of the tariff on services in transfer of the electric power, and for distances Lopt < L < Lmax it is recommended to accept the tariff constant and equal Tmax.

Formalizing initial parameters, having analysed functional dependences between structural elements of a variable component of the tariff, we receive economic-mathematical model in the form of a task of linear programming:

Criterion function:

$$Z_{\min} = {}^{offered}_{\max} - T^{offered}_{\min} \rightarrow \min \qquad (1)$$

The system of functions of restrictions accepts a kind:

$$S=S_1+S_2 \qquad (2)$$

$$S=({}^{working}_{\max} - T_{const})*\frac{1}{2}*L_{max}+ {}_{const} *L_{max} \qquad (3)$$

$$S_1= {}^{offered}_{\min} *L_{opt}+\frac{1}{2}({}^{offered}_{\max} - T^{offered}_{\min})*L_{opt} \qquad (4)$$

$$S_2= {}^{offered}_{\max} (L_{max}-L_{opt}) \qquad (5)$$

$${}^{offered}_{\max} - T^{offered}_{\min} \leq \mathrm{A} \quad \mathrm{A}>=0 \qquad (6)$$

$${}^{offered}_{\min} \geq {}_{const} \qquad (7)$$

$T_{const.}$ = const - Size of the tariff on services in transmission of the electric power not dependent from distance;

${}^{offered}_{\min}$ - The minimal tariff for services in transmission of the electric power, on offered model of formation of dependence from distance (at min of remoteness);

${}^{offered}_{\max}$ - the top limit of the tariff on offered model of formation of dependence from distance (at max of remoteness);

${}^{working}_{\max}$ - the top limit of the tariff on services in transmission of the electric power on existing model formations of dependence from distance (at max of remoteness);

L_{opt} - the optimum range to transfer of the electric power, over which is rational to use the tariff, independent of distance;

L_{max} - the greatest distance of the consumer from a source;

S - the area of a figure limited dependence of the tariff on distance according to.

However it is necessary to take into account the following circumstance: the change of dependence of the tariff from distance of transmission of the electric power should not change the total income of energy tranporting organization, which is proportional to product size of the tariff on length of a line of transfer for the given meaning of total volume transporting of the electric power.

Equality parameter of income on existing and offered model is the equality of the areas of figures under lines designating dependences of the tariff from distance at the working model of account and at offered.

In such statement of a task, the purpose of optimization is the restriction of a difference between the maximal and minimal meanings of a component of the tariff dependent on distance, that is it is required to reduce a difference (Tmax-Tmin).

One more condition of a task is the restriction from below of minimal meaning of the offered tariff by the minimal meaning of the working tariff equal to a part of the tariff, dependent from constant expenses, and independent from distance, i.e. T_{min} and $T_{const.}$ existing model;

S_1 - the area of a figure limited to an inclined site of a line of dependence of the tariff for services in transfer of the electric power from distance according to offered model of account;

S_2 - the area of a figure limited to a flat site of a line of dependence of the tariff for services in transfer of the electric power from distance according to offered model of account;

Control in the Model Equation with Nonlinear Performance of a Material

k - factor determining corner of an inclination of a line of dependence on the first site;

A - "corridor" of change of size of the tariff on services in transfer of the electric power depending on distances adjustable legislatively.

A and L_{opt} - varied parameters.

For an example of account on an offered technique we shall give constant known meanings to some parameters:

$T_{max}^{working}$ = const; $T_{const}^{working}$ = const;

L_{max} = const;

L_{opt} -	conditional - variable size;
Tmin.offered -	required variable;
S, S1, S2 -	intermediate results;
k -	required variable;
A -	adjustable variable

Proceeding from the assembled data and having carried out the economic analysis, we shall receive optimum meanings of parameters, which is considered constant.

Let's substitute these meanings, and also for convenience programming in Excel, we shall designate:

$T_{min}^{offered} = x_1$, $k = x_2$

Having accepted for base conditions same, that in a working technique:

$T_{max}^{working}$ =85,4 tiyn; $T_{const}^{working}$ =25,1 tiyn;

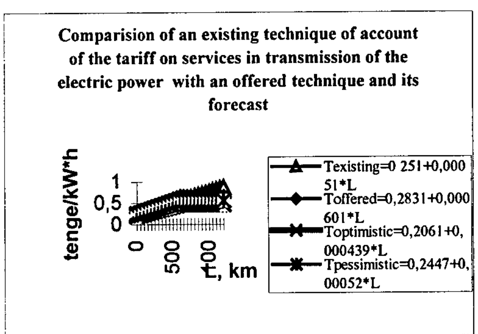
$T_{max}^{offered}$ =64,4 tiyn; L_{max} =1183 km.

$$T = \begin{cases} \text{Tmin.offered+k*Tmax.offered*L}, & \text{if } <L<L_{opt.} \\ \text{Tmax.offered}, & \text{if } L_{opt.} <L< L_{max} \end{cases} \qquad (8)$$

The results of an example of account are shown in the table 1.

The initial data	Units of measurements	Base conditions in the working model	The offered variants without changing of base conditions				Accounts on variants at forecasting changes Lmax	
Lmax	km	1183	1183	1183	1183	1183	1200	1150
Tworing,max	tg/kW*h	0,854	0,854	0,854	0,854	0,854	0,863	0,8375
Tconst.	tg/kW*h	0,251	0,251	0,251	0,251	0,251	0,251	0,251
Offered model								
		Variant 1	Variant 2	Variant 3	Variant 4	Variant 5	Variant 6	Variant 7
Lopt.(Point of a bend)	km	600	600	550	650	700	600	600
A>=(Tmax.offered - Tmin.offered)>0		true	true	true	true	true	true	true
k		0,00060	0,0009	0,0007	0,0005	0,0007	0,0005	0,00063
Tmax. offered	tg/kW*h	0,644	0,7	0,644	0,644	0,7	0,644	0,644
Tmin.offered	tg/kW*h	0,28318	0,1183	0,2503	0,3109	0,2014	0,296	0,26162
Tmax.offered - Tmin.offered		0,36081	0,5816	0,3936	0,333	0,4985	0,348	0,38237

Analyzing a real economic situation, it is possible to set meanings " L_{opt}" and width of "corridor" - "A", or to look after change of meaning "A" depending on change of size "L_{opt} ".



Thus, the received economic-mathematical model allows to analyse by a tabulared and graphic way dynamics of change of width of "corridor" between max and min by meanings of the tariff on services in transfer of the electric power at forecasting volumes on various distances according to the made contracts between the participants of the market.

In the developed technique of account of the tariff on transport of the electric power the following basic priorities are incorporated:

· conformity to the concept of development of the market in electropower branch to the usual structure of branch and mutual relation between its subjects;

· optimization of fuel and energy balance of Republic of Kazakhstan with the purpose of creation of favorable conditions for economy of fuel resources;

· maintenance of reduction of the tariffs on the electric power in energy producing organizations through a competition in the market and in transporting organizations at the expense of increase of volumes of its transmission;

· stimulation of increase of production in priority branches of economy (light industry, agriculture, small and meidum business);

· validity, logical and objectivity making of the tariff;

Simplicity and convenience of practical use of a technique.

Having carried out the analysis of the prices and volumes of production of the electric power on areas of Republic of Kazakhstan, is offered of a technique of account of the new tariff:

two rated tariff = a constant component + variable depending on restriction of length:

T=0,283+0,000601*L

The analysis shows (table 2), that at application of new techniques of the tariff on republic the redistribution of volumes of production of the electric power between stations of interregional purpose (EGRES-2, AES ST Ekibastuz, Aksu GRES) and stations of regional purpose is predicted.

On the estimated data of accounts in optimistic variant the interregional sources can increase production on 5900 mln. kW*h (on pessimistic up to 3000) counting:

· EGRES-2 - on 2170 mln. kW*h

· ATS ST Ekibastuz - on 2170 mln.kW*h

· Aksu GRES - on 1560 mln.kW*h

The offered techniques designed under condition of constant volume of transfer of the electric power and the income OAO "KEGOC", owe are updated on size of increase of volumes of transmission of the electric power (on optimistic variant 5900 mln.kW*h).
On optimistic variant the average tariff for services in transmission OAO "KEGOC" should decrease on 27 %, in such case the inital offered variants of technique of account of the tariffs should look as follows:
T=0,2831+0,000601*L.

VARIANT 1 (optimistic) - at volume of the superseded electric power on the wholesale market with the account quating of the electric power regional power station of Kazakhstan;
VARIANT 2 (pessimistic) - at reduction of volume of the superseded electric power by the wholesale market, that is at increase of deliveries of the electric power from regional power station in area.
Offered variant: $T_{offered} = 0{,}2831 + 0{,}000601*L$
Working variant: $T_{existing} = 0{,}251 + 0{,}00051*L$
Table 2.
The summary table of results of account on a technique in comparison to a working technique of account of the tariff on services in transfer of the electric power in area

The name of area	Tariff (for entrance) tenge/kW*h	Average tariff for purchase electricity of area, tenge/kW*h	Average tariff for purchase electricity of area, tenge/kW*h		Deviation in comparison with working, tenge/ kW*h	
		(working variant)	Optimistic	Pessimistic	Optimistic	Pessimistic
Karaganda	0,51	1,93	1,70	1,80	0,23	0,13
Kostanai	0,95	2,55	2,17	2,25	0,38	0,30
Zhambyl	0,75	2,20	1,75	1,98	0,45	0,22
Kyzylorda	0,41	3,81	2,22	2,71	1,59	1,10
Uzhno-Kazakhstan	0,50	3,25	2,60	2,92	0,65	0,33
Almaty	0,76	2,57	2,29	2,43	0,28	0,14
Taldykorgan	0,49	3,68	2,23	2,72	1,45	0,96

Conclusions. As show accounts the offered tariffs will affect transfer of the electric power favorably on change of balance of production of the electric power and it can be reflected in increase of efficiency of use of fuel resources of republic. Last will entail decrease a level of the tariffs of enegy producing ogranizations in regions. There will be no increase of the tariffs and at the nearby consumers.

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Optimal Problem of Net Structure

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Resume.

The work devoted to the solution of the problem concerning distribution of resources on nets. An offered approach lets us use specifity of a given problem for building an effective method.

Keywords. *Resource distribution, net, graph.*

Introduction. Let's see the complex of operations which must be done for getting an outlined aim [1,2]. Every operation has its certain number i-its conventional number. Then $\Gamma=\{1,2,...,n\}$ this is a multitude of operations which must be done. Let every operation have a multitude of operations $\Gamma 1_i$. Their fulfilment must precede i-operation, i-operation can't beginn before every operation from $\Gamma 1_i$ multitude has been finished.

So a final oriented graph without contours is given, the apexes of which i-operations and arcs are pairs (v,i), where v belongs to to $\Gamma 1_i$ multitude. Geometrically this graph is pictured in the following way. The multitude of operations is pictured by dots, every i-operation is connected with preceding operations of $\Gamma 1_i$ multitude and arcs pointed to i. Let $\Gamma 2_i$ be a multitude of operations for which i-operation isdirect predecessor.

Every i-operation from Γ multitude at the moment of time t has its certain corresponded number $x_i(t)$ reflecting its condition. Its name is a point or a portion to carry out the operation. When this point gets 1 the operation is considered to be done.The intensity of carrying out the operation at agiven moment of time is called the velocity of increasing point of operation's coditionat this moment of time.all the operations can't be broken up, i.e. their fulfilment is done without any breakTo carry out every operation one type of resource that can't be kept we consider that the resources are not interchangeable. The process of carrying out the complex of operations is controlled. Controls in calculation problems of carrying out the complex of operations are operations' intensities set to be done at that moment of time.

Let u(t) be the vector of intensities carrying out the operation at the moment of time t, $u_i(t)$- the intensity of carrying out the i-operation at the moment of time t. This problem can be written in the language of differential equations [1]. V_j - the intensity of receiving j-resources(constant in time) that can't be kept; d_{ji} - the intensity of j-resource expenditure while doing i-operation with the intensity 1; Γ_j - a multitude of operatrions consuming j resource. Dependence between $u_i(t)$ and V_j can be written in correspondences:

$$\sum d_{ji}u_i(t)\le V_j, j\in J=\{1,2,...,m\},\ i\in\Gamma_j, V_j>0 \quad (1)$$

$$u_i(t)\ge 0 \quad (2)$$

$$\forall I\ \exists j:\ d_{ji}>0,\ j\in J,\ d_{vi}=0,\ v\ne j,\ i\in\Gamma_j \quad (3)$$

Then the problem is reduced to the problem of optimum control with broken right parts for whih Hamilton function is built. So to find an optimum solution of a given problem control must be detected which deliver maximum of Hamilton function with limits to control, i.e. we must solve the problemof linear programming, the main function of which is Hamilton function and the limits are the ones for control. Factors beside u_i in Hamilton function are for those operations which don't answer tothe conditions of preceding operation or which are already finished and equal to zero. So without cyanging the significance of Hamilton function we may put ones corresponded to u_i equalled to 0 and search the maximum of this function only with those u_i which operations are not done yet and permissible by net logic.

The use of this fact reduces dimension of the problem of linear programming. So the number of unknown figures on every step in time in the problem of linear programming equals to the number of technologically independent operations at that moment of time(i.e. it equals to the front of operations). The number of limits in the problem of linear programming equals to the number of resources consumed by operations of the front.The problem of linear programming is solved at the moment of time when one of the operations of the front is finished because the functions of receiving the resources are constant and at the very moment of time a spare resource appears.To sort out the apaxes of a permissible field and choose an optimum one from them is enough to find an optimum solution. This fact lets use sorting methods like the method of branches and bounds to find an optimum solution. From the data (1),(2),(3) we see that the apaxes of a permissible field are calculated by the formula V_j/d_{ji}, i.e. every operation of the front is directed to carry out with high permissible intensity. u(t) control is called blind if increase' of intensity of carrying out any operation makes this control inadmissible according to the limits of the problem.

It is clear that blind controls may be a multitude. Let the multitude of all blind controls be R.

Theorem1. Optimum controls of a given problem belong to R.

The proof comes from the meaning of blind control.

Let G be the multitude of such blind controls u(t) that for every its component $u_i(t)=V_j/d_{ji}$ is done, i.e. this is a multitude of apaxes of apermissible field for the problem of linear programming. It is clear that R contains G.

Theorem2. In G multitude are contained the optimum controls of a given problem.

The proof is from that thing that G multitude contains controls the components of which are the apaxes of a permissible field in the problem of linear programming and Hamilton functionreaches an optimum significance in the apaxes of this permissible field.

Theorem3. Every control from G is corresponded to the consistency $I=(i_1,i_2,\dots,i_n)$, and vice versa, every I is corresponded to the control from G.The quantity of possible variants ofcontrols in G multitude equals to n!. Where n is the quantity of net operations.

The proof is given from theorem1 and theorem2.

Thus the problem of searching an optimum control in R multitude is reduced to the problem of searching optimum control in G multitude.

We'll use the phrase " the operation is on service", which means that the operation begins to be done occupying the resource needed for its fulfilment. The situation of taking a decision about sorting out operations for setting on service and intensities of their fulfilment is called competition.

The list of operations is called

technologically regulated if any of two operations i and v connected with atie of technological precedence the preceding i operation is higher than v in this list. The multitude of net operations is partly regulated for some pairs of operation are connected by the tie of precedence.So there is a multitude of technologically regulated (lists)operations differing from each other by the order of dispositionof technologically seperated operations. Every technologically regulated list detects an order of setting an operation on service. Let $I=(i_1,i_2,...,i_n)$ be a technologically permissible consistency, determining an order of setting operations on serviceat any moment of holding a competition and besides an available (at a given moment of time) quantity of resources reduces every time when a certain operation is set on service. The front of net operations is called a multitude of technologically prepared to be carried out at agiven moment of time. Let's solve the problem solving distributing at every moment of time the resources about the front of net operations. In such moments it is necessary totake decisions about the types and intensities of operations which must be set on service.

These decisions are taken according to I consistency. I consistency determines an order according to which operations of the front begin to consume resources. In I consistency i_k operation has a large priority in receiving resources comparing with $i_{k+1},i_{k+2},...,i_n$. The operations must be done with the intensity of high permisible limits, i.e. an optimum control is chosen from G multitude. Impossibility of setting on service the next operation of the front can't stop the next operation of the front if there are resources for it. From the condition unbreakability of the operation we see that the fulfilment of operation can't be broken up in the following moments for fulfilment of any other operation even if the last one is in I consistency before the carried out operation. This algorirhm is called F.

Theorem4. F algorithm sorts out the apaxes of a permissible field of the problem for linear programming according to I consistency.

The proof is that F algorithm sets the operations to carry out with the high permissible intensity $u_i(t)=V_j/d_{ji}$ according to I consistency that is corresponded to sorting out of the apaxes of apermissible field for the problem of linear programming according to technologically permissible consistency.

Theorem5. u(t) control built by F algorithm is blind and belongs to G multitude.

The proof of theorem comes from building F algorithm. Let Z be a multitude of all technological regulations arranging an order of setting the operations on service. Let W be a multitude of controls built by F algorithm according to all technologically permissible I consistencies belonging to Z multitude.

Theorem6. G multitude contains W multitude.

The proof comes from theorem 5 and F algorithv. In particular we see from theorem6 thet the quantity of possible variants of controls in W multitude equals to the quantity of technologically permissible consistencies. Thus, this theorem lets us search an optimum solution in W multitude instead of G multitude. W multitude is a submultitude of multitude and contains optimum blind controls answering to technological limits of the problem.

Theorem7. A certain consistency $I=(i_1,i_2,...,i_n)$ is corresponded to every control from every from W and vice versa.

The proof comes from theorem 6 and building F algorithm.

Theorem8. W multitude contains an

optimum solution of a given problem. The proof comes from theorem7 and building W multitude.

The given problem is solved by the method of branches and bounds. Besides, F algorithm organizes sorting out the variants of branching and technologically permissible consistencies $I=(i_1,i_2,...,i_n)$. Every technologically permissible partly consistency $I_s=(i_1,i_2,......,i_p)$ is the apax in the tree of branching and the low bound of the main function is calculated. The maximum of 2 quantities is calculated for it, the 1st of which equals to maximum prolongationof subnet beginning with the current front of operations(all the operations of subnet are technologically independent); the2nd one equals to length maximum in prolongation of the way in subnet(all the operations of subnet must be done with the high permissible intensities.

Conclusions. Calculation experiments shown effectiveness of the usage of the method of branches and bounds for a taken class of problems. And besides time of calculation depends on distribution of resourcetypes on operations.

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Solutions of Criterial Management Problems by an Active System

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Annotation

Paper considers methods of criterial management problem solving of active system. Problems of criterial management are concluded in the determination of special functions of elements, ensuring maximum criterion system's efficiency at the management open mechanism. The parametric problems of criterial management are solved by methods of " branches and borders' and local optimization.

Key words - *criterial management, active system, open management mechanism in organizational systems, coordinated management.*

Introduction. Perfection of economic mechanism in conditions of market economy - one of the vital problems nowadays. Among the problems of increasing management efficiency of economic activity the problems of development and research of organizational mechanisms of socio-economic systems play important role.

The problems of management are developed in different aspects of the active systems theory. One of the main results of the active systems theory are the theoretical research and substantiation of the open management mechanism in organizational systems.

The important peculiarity of the open management mechanism is a concurrence of plan to realization and reliability of receiving information, at the assumption that the management poorly depends on the information. These properties make this mechanism attractive for application in socio-economic systems. If there is the open management mechanism, then managing body can raise efficiency of system's functioning by choice of criterion functions of elements. The problem of choice of criterion functions of elements at the given open management mechanism is called a problem of criterial management.

Problem of criterial management. To determine the criterion functions of elements $\mathbf{W} = \{\mathbf{W}_i\}$ so that efficiency ratio $\mathbf{K}$ $(\mathbf{W})$ of open management mechanism $\sum = (\mathbf{W}, \pi_{oy})$ was in maximum. Formal statement of problem: to determine $\mathbf{W} \in \mathbf{G}$, that

$$\mathbf{K}_w = \min_{q \in \Omega} \frac{\mathbf{F(x(q),q)}}{\mathbf{F}_m(\mathbf{q})} \to \max,$$

where $\mathbf{x} = \{\mathbf{x}_i\}$ - a plan of system, $\mathbf{q} = \{\mathbf{q}_i\}$ - the parameters of system's model, Ω - a set of possible parameters, $\mathbf{F(x,q)}$ - a criterion function of system, $\mathbf{W} = \{\mathbf{W}_i\}$ - a set of criterion functions of elements, $\mathbf{G}$ - a multitude of system's possible criterion functions, , $\mathbf{F}_m(\mathbf{q})$ - maximumly possible value a criterion functions of system.

The given problem is rather difficult. There are methods of the problem solution for two cases, when there are no restrictions on the choice of criterion functions of elements and when restrictions are given on the choice of criterion functions.

In the first case the solution of the problem has the form of functions $\varphi_i(\lambda_i, x_i, q_i)$, that is functions depending on management λ_i and plan $\mathbf{x}_i$ and what is more there is no restrictions on the choice of functions φ_i. For this case the solution method is based on necessary conditions of optimum for initial problem.

Let the following initial problem $\mathbf{F(x,q) \to max, x \in Y(q)}$ to be given, for which necessary conditions of optimum are received in the form of $\mathbf{x_i = \xi_i(q), i = \overline{1,n}}$.

Enter managing variable $\lambda(\mathbf{q}) = \{\lambda_i(\mathbf{q})\}$ so that to present $\mathbf{x_i}$ as $\mathbf{x_i} = \xi_i(\lambda_i(\mathbf{q}), \mathbf{q}_i), \mathbf{i} = \overline{\mathbf{1,n}}$. Let now take for $\varphi_i(\lambda, \mathbf{x}_i, \mathbf{q}_i)$ any function, which sufficient conditions of maximum on $\mathbf{x_i}$ coincide with $\mathbf{x_i} = \xi_i(\lambda_i(\mathbf{q}), \mathbf{q}_i), \mathbf{i} = \overline{\mathbf{1,n}}$.

In this case a set of such criterion functions $\{\varphi_i\}$ determines the optimum solution of the problem of criterial management.

In the second case the criterion functions of elements are given in a parametrical form $\varphi_i(\lambda, \mathbf{x}_i, \mathbf{q}_i)$, where λ - vector -parameter, $\lambda \in \mathbf{L}$. The problem demands the selection of parameter λ.

The first method is based on the bringing of parametrical problem to problem of convex programming, the second method - on application of the method of 'branches and borders', and the third - on application of the local optimization method.

Convex case. Let the criterion functions of elements look like:

$$\varphi_i(\lambda, \mathbf{x}_i, \mathbf{q}_i) = \sum_{j=1}^{m}\left[\lambda_j \mathbf{x}_{ij} - \mathbf{q}_{ij}\mathbf{f}_j\left(\frac{\mathbf{x}_{ij}}{\mathbf{q}_{ij}}\right)\right], \text{wher}$$

e $\mathbf{f}_j$- convex continuously differentiating functions. The conditions of maximum of criterion functions look like:

$$\forall \mathbf{i}, \mathbf{j}: \mathbf{f}_j'\left(\frac{\mathbf{x}_{ij}}{\mathbf{q}_{ij}}\right) = \lambda_j, \quad \mathbf{x}_{ij} = \mathbf{q}_{ij}\xi_j(\lambda_j),$$

where ξ_j - function, reverse to $\mathbf{f}_j'$. Designating $\mu_j = \xi_j(\lambda_j)$, receive $\mathbf{x}_{ij} = \mu_j \mathbf{q}_{ij}$.

Substituting these expressions in an initial problem, receiving the problem in variables $\{\mu_j\}$:

$$\mathbf{\Phi(\mu,q) \to max, \mu \in M},$$

where $\mathbf{\Phi}$ - concave function, and $\mathbf{M}$ - convex multitude, then receiving the problem of convex programming.

It is shown that for special case in variables $\{\mu_j\}$ the problem of linear programming turns out.

Application of idea of the method of 'branches and borders'.

1) Solution of a problem without conditions of concurrence.

2) Check of existence of coordinated management $\lambda \in \mathbf{L}$.

3) Laying out set of solutions on subsets.

4) Solution of a problem for each subset.

5) Selection of a subset with the greatest estimation.

6) Return to item 2, and etc..

The method of local optimization consists in consideration of a problem in space of managements λ.

0 step. Choose $\overline{\lambda^0} \in \mathbf{L}$ and solve a problem of coordinated management

$$\Psi(\mathbf{x},\mathbf{q}) \to \mathbf{max};$$

$$\mathbf{x} \in \mathbf{Y(q)}, \varphi_i(\overline{\lambda^0}, \mathbf{x}_i, \mathbf{q}_i) = \max_{\mathbf{z} \in \mathbf{Y}_i(\mathbf{q}_i)} \varphi_i(\lambda, \mathbf{z}, \mathbf{q}_i).$$

Let Ψ, φ_i - be concave functions, and $\mathbf{Y}_i$, $\mathbf{Y}$ - be convex multitude. Then, this is a problem of convex programming. Designate

$$\mathbf{F}(\lambda) = \Psi(\mathbf{x}^0, \mathbf{q})$$

1 step. Determine environs of λ_0 - $\sigma(\lambda_0)$ and solve a problem:

$$\mathbf{F}(\overline{\lambda}) \to \mathbf{max}$$
$$\overline{\lambda} \in \sigma(\overline{\lambda_0})$$

.Find optimum $\overline{\lambda_1} \in \sigma(\lambda_0)$.

Check existence of local and optimum solution, if the solution is not found pass to the following step.

2 steps. Determine environs of $\lambda_1 - \sigma(\lambda_1)$ and solve a problem:

$$\mathbf{F}(\overline{\lambda}) \to \mathbf{max}$$
$$\overline{\lambda} \in \sigma(\overline{\lambda_1}),$$

Find optimum $\overline{\lambda_2} \in \sigma(\overline{\lambda_1})$, check the solution on local optimum.

The check of existence of coordinated management is made at fulfilment of the following condition of the perfect coordination:

$$\left[\max \lambda_k^0 r_{ik} - \lambda_j^0 r_{ij}\right] x_{ij}^0 = 0, \quad i = \overline{1,n}, \ j = \overline{1,m}$$

Or at the positive solution of the following system of equations inequalities:

$$\forall k, j: \ \lambda_j \geq \lambda_k \varepsilon_{jk}.$$

For solution of system it is necessary and enough to have an appropriate **m** - apex column with long arches ε_{jk} which does not have contours with the amplification more than one. The procedure of branching depends on number of arches of contour with amplification of arches more than one [4].

Conclusion

On the basis of stated approach the problem of criterial management is solved for the following cases:

a) Analytical dependence $\mathbf{x^0(q)}$ of optimum solution for the problem from parameters **q** (necessary and sufficient condition) is received;

б) Necessary conditions of optimum in the form of ambivalent ratio in the problem of linear programming are received;

в) Necessary conditions of optimum with use of the method of Langranzh's multipliers are received.

The parametrical problems of criterial management are solved by the bringing them to problems of convex programming or on the basis of methods of 'branches and borders' and local optimization.

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Modeling of the Population Development

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Resume.

In this report describe the mathematical model of the population development dynamics, notions of the stable and steady development of the population, the model system allowed to prognosticate the population number.

Keywords: *model, modeling, population, population number, dynamics, demographic indexes.*

Introduction. The scientific approach to the planning of the work resources use, their prognostication suppose the careful and detailed study of the demographic composition of the population, the tendencies and the conforming to the law influenced on the change of his structure. The elaboration of the mathematical model of the population age structure and the creation of the model system of the population number prognostication allow to have the timely prognosis of the demographic situation in the state observing the changes of the population number and the work resources in the country.

The making researches showed that on the population number essentially influence such demographic indexes as the level of the birth rate, the level of the death rate, the level of the immigration, the level of the emigration. Moreover on the population number render the essential influence social economic factors which include such as the level of the population life, the real incomes of the population, the unfavorable ecological situation, the uncertainty in the future day, the level of the inflate.

Describe the function of the population development as

$N_t(R, SM, IM, EM, UG, D, EK, INF)$,

where R - the level of the birth rate, SM - the level of the death rate, IM - the level of the immigration, EM - the level of the emigration, UG - the level of the population life, D - the real incomes, EK - ecological situation, INF - the inflate processes, t - current time.

Then $\Delta N = N_{t+1} - N_t$ show the change of the population number during the current year. For ΔN execute one of the expressions:

1) $\Delta N = 0$ - there are no the changes of the population number;
2) $\Delta N > 0$ - there is the increase of the population number;
3) $\Delta N < 0$ - there is the decrease of the population number.

There is the situation 2 in that case when for the function N_{t+1} observe next tendencies:

$$N_{t+1}(R\uparrow, SM\downarrow, IM\uparrow, EM\downarrow, UG\uparrow, D\uparrow, EK\uparrow, INF\downarrow),$$

where $\uparrow$ - the increase of the index, $\downarrow$ - the decrease of the index. The situation 3 describe in next appearance:

$$N_{t+1}(R\downarrow, SM\uparrow, IM\downarrow, EM\uparrow, UG\downarrow, D\downarrow, E\downarrow, INF\uparrow)$$

.

Introduce the notions of the stable and steady development of the population. Under the steady development of the population we understand the constant increase of population number from year to year. Under the stable development of the population we understand such development in which save the existent tendencies and observe the constant increase of the population number in just the same per cent expressions from year to year. If observe the systematic decrease of the population number from year to year we come nearer the crisis or catastrophe, we name that situation as the crisis state of the population number.

The stable steady development of the population characterize that $\Delta N_i = const$, i.e. $\Delta N_1 = \Delta N_2 = \ldots = \Delta N_i$, where i = 1, 2, 3 , . . ., $\Delta N_1 = N_{t+1} - N_t$, - the change of the population number for the first year from the year t, $\Delta N_2 = N_{t+2} - N_{t+1}$ - the change of the population number for the second year from the year t и so on.

The stabilization of the population development characterizes that $\Delta N \to const$, in those cases when $\Delta N_i \neq \Delta N_{i-1}$. Due to the levers had in the system $\Delta N_{i+j} = \Delta N_i$ over the time interval j (delay). If there is the crisis state of the population, i.e. $\Delta N_i < 0$, $i = 1,2,3\ldots$, then it is necessary to take the urgent measures to the stop of this process that over the any time interval will be the situation 1, i.e. $\Delta N_{i+j} = 0$, $i = 1,2,3\ldots$, j - delay, and then the situation 2, i.e. $\Delta N_{i+j+k} > 0$, $i = 1,2,3\ldots$, j + k - delay.

In [1] propose the mathematical model of the dynamics of the population structure in next appearance: $\dfrac{dN(t)}{dt} = AN(t)$,

where $N(t) = (N_1(t), N_2(t), \ldots, N_n(t))$ - the vector of the population number on the age groups.

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} & \cdots & a_{1,n-1} & a_{1n} \\ a_{21} & a_{22} & 0 & \cdots & 0 & 0 \\ 0 & a_{32} & a_{33} & \cdots & 0 & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ 0 & 0 & 0 & \cdots & a_{n,n-1} & a_{nn} \end{bmatrix}$$

the matrix of the intensities of the birth rate, of the death rate, of the immigration and of the emigration in the age groups; $a_{12}, a_{13}, \ldots, a_{1n}$ - the intensity of the birth rate in the age groups; $a_{jj}(j = 1,2,\ldots,n)$ - the intensity of the immigration in the age groups;

$a_{j+1,j} = 1 - \mu_j - m_j$; μ_j и m_j - accordingly the intensity of the death rate and of the emigration in the j age group. Common population number of the country: $N^0(t) = \sum_{j=1}^{\infty} N_j(t)$.

The able-bodied part of the population in the country: $N^T(t) = \sum_{j=\tau_{\min}}^{\tau_{\max}} \Omega(j) N_j(t)$,

where $\Omega(j)$ - the share of the able-bodied population depended from the health and the age, $\tau_{\min}$ and $\tau_{\max}$ - accordingly minimal and maximal able-bodied age.

On the base of the proposed model of the population structure dynamics is created the model system allowed to prognosticate the population number with the use of the basic demographic indexes. Let $N_0(0)$ - initial composition of the population on the age groups in the initial time moment; R(m)- the intensity of the birth rate for the m age groups; IM(m) - the intensity of the immigration for the m age groups; EM(m) - the intensity of the emigration for the m age groups; SM(m) - the intensity of the death rate for the m age groups.

Then the population number for all age groups besides the first group calculate on the formula:

$$N_i(m) = N_{i-1}(m)[1 + IMM(m) - \\ - TMG(m) - CMR(m)], \quad i = 2,3 \qquad (1)$$

And the population number for the first group:

$$N_i(1) = \sum_{m=1}^{M} N_{i-1}(m) \cdot ROD(m) \qquad (2)$$

The algorithm of the population number modeling with his development dynamics include next steps:

- task of the initial values N(m), R(m), IM(m), EM(m), SM(m) for every age groups;
- task of the modeling period K and the organization of the cycle on all modeling period;

organization of the cycle for the calculations on every age groups (m =1, M);

- calculation next value N(m) for the m age group with the use of formulas (1) or (2);
- conversion the m-1 age group in the m age group (the age increase on one year);
- calculation of the population number for the j year of the modeling period
- $N = \sum_{m=1}^{M} N(m)$;save the calculated values in the database;
- delivery the results.

On the base of the making algorithm is written and is tested the program on the language DBMS FoxPro. For the data storage is creating three databases: INTENS - contains the values of the intensities of the birth rate, of the immigration, of the emigration and of the death rate for every age groups; NAC - contains the initial values of the population number for every age groups; ITGN - contains the total values of the population number prognostication for the given period. The data is prepared for the seventy age groups on the base of the population statistics on the 1996 year for Kazakhstan. Since on the demographic indexes can to effect over economic levers as escaping of the recourses for the public health, ecology, social spheres, raise of the population life level however there is difficulty to get the strict mathematical dependence between this parameters, if it is not impossible, in the model system is making the possibility of the update of the demographic indexes.

For every type of the intensity: the birth rate, the immigration, the emigration, the death rate can to give for every parameter it will be increase, decrease or stop without the changes, to give the per cent of the change and the time period (delay) across which will be beginning the change. Suppose that the tendency on the behavior of the demographic indexes keep for all modeling period.

Conclusions. The receive results is showed that the tendencies on the demographic situation had the place in Republic of Kazakhstan beginning with 1996 year are traced obviously. The results of the population number prognostication calculated for 1999 year correspond to the official results of the population census 1999 year in Kazakhstan that confirm the reliably and accuracy of the used model of population development dynamics.

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About Optimization and Regulation of the Summary National Accounts of Income Generation

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Now the indices of national accounts system describe the mechanism of functioning and serve as the theoretical base for making the state economic policy.

After acceptance of state programme of the transition of the republic of Kazakhstan to the international practice of registration and statistics system in according to the demand of market economy, accepted in december in 1992, Committee on statistics and analysis of the Republic of Kazakhstan published in 1997 statistic series [1] in which there were quantitative information about generation, distribution and use of the national accounts. The optimization of national account indices leads to the acceptance ofdecisions in state economic policy regulation, that provides general economic balance and growth in all macroeconomical markets.

For the description and analisy of the structural conditions about macroeconomical circuit (circulation), the interbranchable balance model, elaborated by Leontiev [2] in 30th years is used. There are another models, for example, von Neiman's model, Gel's, Kantorovich's and Mark's ones [3-7].

In this article the problems of optimisation and regulation of the income generation summary national accounts under conditions of the SNA of Kazakstan are considered. It is proved that these problems reduced to the solving of the multidimensional linear programming problems and to the systems of the linear differential equations.

The conditions for optimization indices of the income generation summary national account and analynical mechanisms of the state regulation of the macroeconomical markets with the help of supply and demand prices are found.

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Analysis of the Market of Products on the Game-Theoretic Model Basis

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In this paper attention is focused on the application of game-theoretic methods in the field of economy. The analysis of «PLVZ» functioning has shown that the enterprise works very unsteadily and its financial situation is far from being satisfactory. During 1997-1998 it lost its leadership at the market. There exist a few reasons for it. In this work the game-theoretic modeling of the «PLVZ» functioning is considered for the first time.

We consider two variants in it while employing the patterns:

1. Absence of coalition of the producers. These are non–coalition game models 1- 4.

The coalition of producers is possible for the joint policy of deliveries to the market. This variant is analyzed with the help model that

2. admits cooperation between the two competing firms–model 5.

The first model represents a struggle of 2 competitive firms for the commodity market of wine and vodka. In this game two competitive firms «Arai» and «PLVZ» fight for the commodity market of wine and vodka sharing the same profit taken as one point between the markets. The pattern of the game is represented by the convex function. The values of rations were received as the result of the analysis made as the result of analysis made by us of the customers' preferences.

In the second model we consider the strategies of the vodka output increase by means of attracting the loans. The participants of the game are the «PLVZ» and its fictional competitor – the consumers' demand for expensive and cheap vodka. We hold that the demand is unknown. The model of this game is represented by the matrix of prizes.

The next model emphasizes the produce proper made by the «PLVZ». Its aim is improving competitiveness of the productions. game–theoretic methods requires attracting experts of the different fields of economy which will allow us to built a more adequate mathematical model of economic phenomenon. In this case the final antagonistic game set by the matrix of prizes, will act as the game – theoretic model of the conflict under discussion.

The fourth model allows us to define the type of produce which is advisable for each of the two competitors. This game is not antagonistic (as long as the prize of one player is not equal to the loss of the other), and, as far as we take into account two participants of the conflict, this game is a bi–matrix one set by the couple 2 x 2 matrixes. In the conclusion of the game we will consider a situation analogous to the situations in previous pattern, but which admits co–operation of the two competitive firms. For this purpose we use the arbitration scheme. In this work we did not get involved in building mathematical models of the industrial–technological level of economic systems, as we, first and foremost, are interested in the situation at the alcoholic drinks market and in how our decisions can change this situation. That is why we employed the game – economics methods as they presuppose there being one or more parties pursuing their aims and allow us to investigate the functioning of the factory alongside with other economic elements, not in isolation. But, no matter how wide our scope of thinking should be, the question of economic adequateness of the model remains actual. This is connected with the fact that during the mathematical analysis of the model it is very difficult to take into account all the organizational, social and economic factors affecting the effectiveness of the model.

Simulation of the Organization-Economic Control Mechanism of the Informatization Process

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Vital activity of modern society, its main subsystems: economics, production, science, education, state management and etc - all these mainly depends on the scale and level of informatization. Informatization today is the problem not only scientific-technological, but also an economic, social, political problem. This is a complicated, widely aspected and multidimensional process, characterized by connectedness, interconditionality and interaction of political, social, economic, scientific, technical, technological factors demanding highly systematized level on all levels of management and stages of its development.Systematic process of informatization can be provided on the base of working-out and realisation of purposeful state policy in the sphere of informatization, by the usage of an adequate to the market conditions , organizational-economic mechanism of management, working-out and realization of common-systematized decisions. Under the conditions of transition of the Republic to the market economy working-out of an effective organizational-economic management mechanism by the process of informatization is highly actual, which provides its flexibility and adaptability to the new conditions of management.

The suggested solution of the given problem is based on the methodology of the system analysis and supposed to consideration of the process of informatization as a complicated system, investigation and simulation of concrete mechanisms of interaction of its forming parts, inner and outer interdependence in coordination with goals and problems facing the society, with the priorities and demanding indices of the economic development of the Republic.

The results of the theoretical researches on the process informatization management are given in the report. Actually the process of informatization management in the work is simulating with the help of mathematical apparatus of active system theory, multicriteria optimization. For this the process of informatization is offered as an organizational-technological system, the functioning mechanism of which uncludes the system of formation of goals and planing, the system of stimulation, the system of evaluation of effectiveness. The centre of this organizational-technological system is offered by an authorized organ of the State Management. The elements of the system are certain objects (spheres) of informatization (the sphere of state management, finance-banking sphere, social sphere etc).

The dependence of economical interests of the elements of system on the process of informatization simulated by vector functions of stimulation.

Managing operations of the centre are the coordination of the actions on informatization for all the spheres and tuning in such an economic lever as taxation, customs, credit and finance, investing, innovation policy of the State and etc.

Working-out models can be used for creating effective organizational-economical mechanism of informatization in the Republic under the conditions of transition to the market economy.

The Latency Modeling in Investments Mastering

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One of the important questions in economic process modeling is the forming of connection between different economic factors with investment's lag accounting. For example, "investments – putting funds into operation" connection is one of the economic factors, that need lag accounting. Indeed, in real economic systems the process of investment's mastering is not momentary, because our investments convert into production funds only some time later. There are two ways for modeling latency in the investments mastering process. The first of them suppose, that is τ time interval, which shows how much time we need to convert our investments into production funds. According this approach the production funds changing in t time moment is going at the expense of investments, that were allocated in $t - \tau$ time moment, then we have the next differential equation for capital function:

$$\dot{\mathbf{K}}(\mathbf{t}) = -\mu \mathbf{K}(\mathbf{t}) + \mathbf{I}(\mathbf{t} - \tau).$$

For this differential equation we have the next restrictions for the initial and final capital function values :

$$K(\theta) = \varphi(\theta), \quad -\tau \le \theta < 0, \quad K(0) = K_0,$$
$$K(T) = K_T.$$

The second approach for modeling latency in the investments mastering process is based on supposition that investments allocated to production funds development are mastering gradually (bit by bit). In fact, let $\mathbf{I}(\tau)$ - investments allocated in τ time moment, then in $\mathbf{t}$ time moment will be mastered it $\mathbf{N}(\mathbf{t},\tau)$ share: $\mathbf{I}(\tau)\mathbf{N}(\mathbf{t},\tau)$. This kind of model called the model with distributing lag.

In any case was built the versatile economic model, were took into account real economic limitations, connections between different economic factors and investments lag. As a result, I received the optimal control problem on finite time interval. The welfare function is considered as control criterion:

$$\mathbf{J} = \int_0^T \theta(\mathbf{t})\mathbf{g}(\mathbf{t},\mathbf{C}(\mathbf{t}))\,\mathbf{dt} \to \mathbf{max},$$

where is $\theta(\mathbf{t})$ - discount multiplier, $\mathbf{g}(\mathbf{t},\mathbf{C}(\mathbf{t}))$ - utility function. Capital function K(t) was considered as a vector of system state and the function of putting funds into operation V(t) was considered as a control factor.

Optimal choice for the first approach was made on the base of Krotov's Theorem about sufficient conditions of optimality for the finite time interval and was applied Lagrange multipliers method. The Lagrange multipliers $\psi_i(\mathbf{t}), \lambda_i(\mathbf{t}), \gamma_i(\mathbf{t})$ have an important economic meaning, they express the following: $\psi_i(t)$ - product unit cost of the $\mathbf{i}$ -brunch,

$\lambda_i(t)$ - production funds of the $\mathbf{i}$ -brunch cost and $\gamma_i(t)$- labor cost of the $\mathbf{i}$ - brunch.

The second model (the model with distributing lag) was transformed to the linear system of differential equations and the problem was reduced to the optimal stability problem on finite time interval.

Comparing analysis between two kinds of systems: with and without latency shows, that lag influence covers the investment's function and consumption function. The capital functions with and without lag are the same. Graphic analysis of the investments functions with and without latency shows that we must invest more in the model with lag, consequently the consumption level in the latency model will be lower.

Natural Resources in Economy of Kazakhstan

B. Dlimbetov, S. Zhusipbekov

The main source of foreign currency income of Republic of Kazakhstan is the export of oil and metals. The huge volumes of processing of natural resources, result in large -scale influences on environment and pollution of this environment. If to define to the market a role of a regulator of production unit, it is necessary to leave to politics a role of management, by the formulation of targets and criterions. The proprietor of the capital through the target and mathematically defined criterions renders pressure on economy. The proprietor's target does not coincide with production's tasks of optimization and remains implicit. For economy the owner is indifferent, that is the exploitation of oil fields is taking the normal course.

As against land, oil, ore of metals and the chemical raw materials are not restored and in this sense the exhaustion of natural resources is infringement.

Therefore the purpose of extraction of minerals and oil can consists only in one- in the investments in others branches of manufacture of the countries ensuring longer operation. Here main is not in acceleration, not in increasing of productivity in what is interested the proprietor, but in use of profits of proprietor, in increasing of fixed assets and in their right distribution.

Influence of state property on regulation of economy manufacture are carried out through the given purposes of economic development of the control system:

Satisfaction of state's needs – social purpose;

Maximun growth of capital during operation (10-40 years) proprietor's, economical;

Preservation of the sovereignty and economic independence – political;

Maintenance of the employment and payments – social;

Proportional development of economical branches – economical – political.

The formulation of the purpose frequently carries declarative character, which not admitting checks or the proofs. Also the way of achievement of the purpose remains unknown. The maximum growth of the capital can be reached, for example, by freezing deposits of oil in conditions of reduction of world global stocks. In current period it is impossible to be limited to the only qualitative, declarative purposes, in economy it is necessary to replace them by strictly mathematical parameters developed in the management theory, so-called as a management criterions.

Maximum of growth rate of consumption

$d\Pi/dt = max$

Maximum of growth rate of the capital

$d2C/dt2 = max$

Maximum of average productivity of work

$1/N\ dC/dt = Pcp = max$ Maximum of productivity of a oil deposit per 1 year

Maximum of the investments at the expense of sale of oil deposits and operation

For realization of management by the given criteria the search, extreme control system should be used on the basis of computer simulating systems of forecasting and optimization. The state regulation should take into account restrictions caused both properties of the object, and systems of regulation, in this case of market economic system

Establishment of the theoretical prices on the identical and various goods and resources, regulation of manufacture through the price, establishment of all kinds of the rent, prices for deposits, rate of return on the capital

The Dynamic Model of Optimal Development Multibranch Economic Taking in to Consideration the Pollution of the Environment

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It`s necessary to take a look at economic system, which consists of n branches: among those m number of ranches produce the «net» product, (n-m) is directly related to the pollution.

$$A=\begin{pmatrix} A_{11} & \vdots & A_{12} \\ \dots\dots\dots & \vdots & \dots\dots\dots\dots \\ A_{21} & \vdots & A_{22} \end{pmatrix} \qquad (1)$$

$$X_1=(x_1, x_2, \dots, x_m)^T; \quad X_2=(x_{m+1}, x_{m+2}, \dots, x_n)^T;$$

(2)

$$Y_1=(y_1, y_2, \dots, y_m)^T; \quad Y_2=(y_{m+1}, y_{m+2}, \dots, y_n)^T.$$

The extended matrix of coefficients of the nation economy can be presented in the following shake of the block.Here the composition of matrixes can be represented by the gross and the find product, at the same time at the aggregate amount of the destroyed polluter and of the find supply of the polluter respectably are presented.

Thus, the model of development of the multibranch economy which will be studied below, look like the following:

$$\sum_{j=1}^{m}(E-A)_{ij}x_j-\sum_{j=m+1}^{n}a_{ij}x_j=Y_i, \quad i=\overline{1,m}, \quad \sum_{j=1}^{m}a_{ij}x_j-$$
$$-\sum_{j=m+1}^{n}(E-A)_{ij}x_j=Y_i, \quad i=\overline{m+1,n}. \qquad (4)$$

$$Y_i=\sum_{j=1}^{n}d_{ij}I_j+C_i, \quad i=\overline{1,r}, \quad Y_i=C_i, i=\overline{r+1,n} \qquad (5)$$

$$0\le X_i\le F_i(K_i,L_i,t), i=\overline{1,n}, t\in[0,T] \qquad (6)$$

$$\dot{K}_i=I_i-\mu_i K_i, \quad K_i(0)=K_{i0} \quad K_i(0)=K_{i0} \quad i=\overline{1,n} \qquad (7)$$

$$K_i\ge 0, \quad C_i\ge C_{i0}, \quad L_i\ge 0, \quad i=\overline{1,n} \qquad (8)$$

$$I_i\ge 0, \quad i=\overline{1,n}. \qquad (9)$$

$$L_i\le L_{i0}, \quad i=\overline{1,n}, \quad \sum_{i=1}^{n}L_{i0}\le L_0, \qquad (10)$$

There is a problem of calculating the maximum of the function W on multicude D, namely, it is necessary to find the process $\bar{\upsilon}=(\bar{X}(t),\bar{Y}(t),\bar{I}(t),\bar{K}(t),\bar{L}(t),\bar{C}(t))$ optimal of the sense

$$J(v)=-W(v)=-\int_0^T\theta(t)g(t,C)dt\to\min_D. \qquad (11)$$

This model is linear, according to K_i and to the operation (X,Y,I,L,C). Production function is not linear. Sufficient conditions of the optimality by Krotov were received for the dynamic of the multibranch economy considering the pollution of the environment. It is based on the interbranch balance and the capacity of the branches is describes by the production functions.

Thus, the considered balance model of V. Leontiev, which takes into the account environmental pollution, is being constructed with consideration of filtering events on the basis of their detalization in the cut of waste of each branch. At this point the number of lines and columns in balance coefficient matrix is increasing for the lines, appropriate in each branch of industry and filtering activity columns are being added. Such a classification determines the volume of polluters and expenses for neutralization of the unit of polluters volume.

SECTION

"THE CONCEPT, TECHNOLOGY AND PRACTICE OF DESIGNING OF INFORMATION SYSTEMS"

A Corporate Information System of Al-Farabi Kazakh State National University

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The summary.

The brief information on corporate information system of university, structure of a computer network, basic problems of administration management, soluble with the help of the given system is submitted.

Keywords: *Corporate information system, universities*

In modern conditions, in conditions of transition of economy of Kazakhstan to market economy, opening of private universities and, accordingly, increase of a level of competitiveness, before each Higher educational institution and, in particular, before Kazakh State National university There is the necessity of adequate reaction on the raising requirements of ability to live. Together with it grow the requirements by a level of preparation of the specialist, finishing higher educational institutions. Actual there is the preparation of the specialist, satisfying to the requirements western foreign standards.

How to ensure the raising requirements of the market ? One of to of ways of the decision of this problem is informatization of educational process and management of educational process. Not belittling problems of information of educational process, it is necessary to note huge gravity of informatization of management of educational process. The informatization of management of educational process was till now carried out by creation of local subsystems such, as "Dean's Office", "Applicants", "Staff" and etc., that resulted in mass duplication of data, impossibility of reception of the operative information by the administrative personnel of university. In this connection actual there was the development of administration management by university on new technical base, on base of network technologies.

Major problems of administration management in university are:

- management of reception of the students;
- the account of presence and movement of the students;
- formation of the educational plan and account educational one;
- distribution of the educational plans on faculties and teachers;
- formation of the time-table of employment;
- the account and control of progress;
- account pedagogical control on faculties, faculty and teachers;
- the analysis of results of session.

In a complex of problems of administration management important are the problems of management by finance-economic activity of university, being in close integration with set forth above problems.

The scheme of a computer network of AL-FARABI KAZAKH STATE NATIONAL UNIVERSITY is submitted on fig. 1. At the first stage of creation of a computer network of university the equipment of french firm ALCATEL is used. A central part of a network is the central switchboard, connected by a fiber-optic backbone with network switchboards of other buildings. With the central switchboard through 200 Mb/sec the channel is connected central server of databases. At the moment in administrative building, cable system on 70 sockets and in a building B3 (faculty of the international relations and faculty of a history) on 8 sockets is laid. To the end of a year is planned to connect to a general computer network of university a building B4 (faculty biology and geography), building B1 (faculty of journalist and philosophy), building B2 (institute of economy and law), and also building K1 (faculty the mechanics and mathematicians).

In view of significant removal network from the central switchboard (4-5 km) the building K1 will be connected through of a radiomodem links. The network and computer equipment is got and a installed under the project of fund TEMPUS-TACIS of European community together with the partners from R.Shuman University (Strasbourg, France) and Higher technical school (Darmshtat, Germany).

The technology of creation of corporate information system of university includes the following basic rules: at the choice of designing and realization of system; definition of means of designing and realization; a choice of a system platform and system software the client-server systems.

Choice of creation of designing, and realization of system. In technology of creation of information systems there are the various approaches - it:

1) Of designing of designing and realization "from above - downwards", i.e., when general architecture of system is at first built, then it is stage by stage detailed and at the last stage realization of system is made;

2) of designing of designing and realization of system "from below - upwards", when separate modules of the future system are realized, then they are integrated in larger modules of the second level and etc. before construction of all system;

3)"stratum " designing and realization of system, when for the future system the important nucleus is allocated, and it is projected and is realized, then on received "nucleus" of system is put (i.e. is projected and following "layer" of system and etc. before complete construction of system is realized).

In modern economic conditions of our republic the most expedient is, "stratum " designing and realization. This is allocated allows at early stages of creation of system to see real results of work of information system. It is favourable and from the point of view of the account of changes of external conditions - it is not necessary is not necessary all system, and changes in existing "layers" are brought in, and new "layers" are projected and are realized in view of changed conditions.

The standards of designing and the realizations of system of a problem of documenting of process of development of large information systems are rather urgent. It is provided number of the reasons:

1. The life cycle of programm products represents significant time: 3-4 years and are higher. In current of this period probably constant development of system and, accordingly, updatings of the initial texts of the programs, creation of new programm modules and them - with existing programm modules;

2. It is possible, that in current of this period structure of the developers of system can be replaced. Therefore there are the problems with development of system, if not will be the available well made out documentation on system.

Naturally, it is possible to put a question: what structure of the documentation should be? The logical answer will be, that the structure of the documentation should cover all stages of creation of system: the analysis, designing, programming, testing and support. Important for understanding of logic of system is documenting analysis stages and designing. In this area there are a few standards of the documentation, allowing to describe various making analysis stages and various designing

- Standard IDEF0 for documenting processes of manufacture;
- Standard DFD (Data Flow Diagramming) for the description of the documentation and processing of the information;
- Standard IDEF3 for the description of logic of interaction of information flows;
- Standard IDEF1X for documenting the information of manufacture;
- Standard UML (Unified Modeling Language - unified language of modeling).

The standard IDEF0 was for the first time offered at the end of 60's years unified (SADT - Structured Analysis and Design Technique). Originally will be SADT was intended for modeling technological processes, but here already more than 20 years are successfully applied all over the world in the most different areas. Model IDEF0 can be used as for the description of existing subject area (AS IS), and projected system (TO BE). According to the standard IDEF0 the module represents set of the hierarchically built diagrams, each of which is the description of any process (activity). The construction of model begins with the description of simulated system as a whole (contextual diagram).The interaction with the environmental world is described in the terms of "input" (data or objects, consumed or changeable process), "output" (result of activity of process), "management" (procedure, which process) and "mechanisms" (resources, necessary for process) is guided by.

The standard DFD (Data Flow Diagramming) is possible to use as addition to model IDEF0 for more evident display of current operations process in systems of processing of the information. DFD describes functions of processing of the information (work), documents (arrow), objects (employees or departments), which participate in processing the information and table for TO BE of the documents (storehouse of data).

The standard IDEF3, named workflow diagramming, is used for the description of mutual relations between process of processing of the information and objects. With their help it is possible to describe the script of action of the employees of organization, for example, sequence of processing of the order, which is necessary for processing for final time.

The standard IDEF1X represents the standard of model "entity-relations" (ER-model), which is used for construction of model of data of projected system and in subsequent allow to proceed(pass) to generation of structure of a database of projected system. The standard UML (Unified Modeling Language - unified language of modeling). The given standard has arisen in a direction " of объектно-oriented designing " of systems, as against the alternate "algorithmic" approach in designing systems, the standards of which are described above. UML was developed by firm Rational Software and its partners.

At the first stages of creation corporate information language of university the standards IDEF0 and IDEF1X are chosen.

Tool means of designing and realization of system. In described IDEF0 as tool means are used: a means BPWIN, supporting the standard IDEF0, means WINDEV, supporting the standard IDEF1X at designing the circuit of a database, means of development of the programs Visual Basic. As a system platform a system platform Microsoft is chosen: MS BackOffice (WINDOWS NT 4.0, SQL SERVER 6,5 And 7.0, SMS, Echange Server).

The developed corporate information system of university is oriented to the decision of typical problems of administration management of university, in a basis of creation of system the inexpensive decisions on a system platform are fixed. Thus, it is possible to hope, that the developed system will be together with and for other higher educational institutions.

Distributed Integrated Financial Information System

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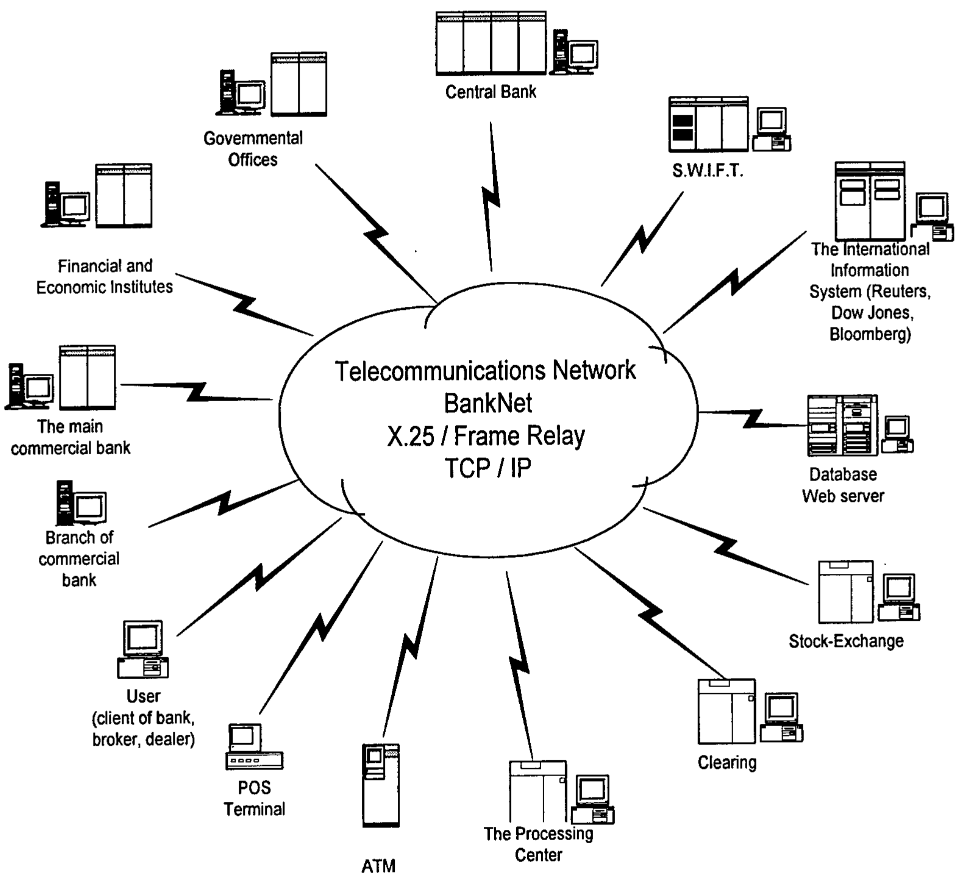
Summary.
The work is devoted to the issues of formation of financial information system in order to provide with adequate information in taking decisions using the wide range of communication and information services.
Keywords: ***Integrated information system, communication and information services, "Banknet" data base transfer network, Intranet.***

Introduction The successful development of country economy requires the wide range of communication and information services. The current economic crisis is directly connected with the informational crisis – the absence of appropriate information for taking decisions. The basic part of the information services market is the information on exchange and finance. Unfortunately, due to present economic difficulties and ignorance in the gist of the problem, this issue is not comprehended enough.

The solution for this problem is proposed within the framework of "Distributed Integrated Financial Information System (DIFIS)" project. The architecture of DIFIS is three-leveled. The first is the communication level, communication equipment (data transfer networks, computer machines – servers, working stations, etc.) is determined at this level. The second is the information level, all types of, and all devices for storage and processing of various types of information (financial, exchange, juridical and any other commercial information) is determined at this level. The third is the service level (the users level), actually at this level all types of users (legal entities and physical persons) have access to the system.
The project is realized by "Centre of interbank and financial telecommunications "CJSC based on "Banknet" data transfer network established in1996, a large number of financial and banking institutions are among the company's clients; Banknet data transfer network will constitute the first level. The basic DIFIS level is the information level, this level is being established now creating date storages and distributed WWW servers under Intranet technology. The work is carried out on the formation of huge volumes of juridical, exchange, statistical and banking information. The issue on intellectualization of information and access to it is also being developed now. The significant part of the project is the safety and fault-tolerance of the system, the security and protection of information by hard- and soft-ware.
Some parts of the project will be tested while participating in the competition for research and innovation projects conducted by the Ministry of science and higher education of the Republic of Kazakhstan within the subprogramme "Elaboration and realization of the pilot project of the segment of single information space the Republic of Kazakhstan".

Conclusion. This architecture is universal and will be used for the development of the following systems: electronic transactions, electronic banking operations, network electronic depositaries, processing centers, securities trade systems, clearing, various monitoring systems, electronic commerce, transfer-agent network and others.

Distributed Intergrated Financial Information System



Corporate Information Network of the Higher Education Institution

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The progressive development of network technologies given an opportunity to shift from the fragmental informatisation of Higher Education subsystems to the complete systematic Higher Education integration. The new created corporative network (CN) differs considerable from the network consisting only from network adapters, coaxial cabel and small file- server. The corporative network in the North- Kazakhstan University is complex conglomerate uniting powrful supplement file- servers, workstation and active network equipment.

The necessity of documents , circulation services organization, which service educational process, introduction of new educational technologies as distance learning, educating multimedia programs and other aspects require the use of computer and network technologies in the educational process. At taking into consideration the location peculiarities of the university building, we assume that the best variant of corporative network organizations the use of Ethernet technologies. Even technology allows to get a good passband with the sufficient reliability degree. It is also flexible and convenient for the network administrating. The network is well though-out and projected with the account of further development. The CN is notbased on the "tire" -network topology, which a more appropriate for North-Kazakhstan university structure.

The main networks OS used for the network functioning is Windows Nt 4.00. The use of the given OS allows to produce a processing and transmission of information with high velocity and on the high up to date level with the required level of information protection. For students' work in class a server OS NetWare is used as a supplement server.

The corparative network device hardware is isolated from the world. There is a constant access to INTERNET, the satellite television signals are being accepted.

The comparative analyses of the considerable number of corporative networks in the Republic of Kazakhstan and in the other country of CIS allows to make a conclusion that the choice of NKU network structure is the most appropriate in the respect of price/efficiency relations, this network structure level is high in comparison to other technologies.

Conceptual Approach for Designing Information Systems of Public Administration Institutions of the Republic of Kazakhstan

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Activation of reforming of political, economic, administrative structures of the society as a result of evolution of an independent Kazakhstan made the informatization one of top priorities of the country. Issues related to the informatization of public administration bodies are being addressed by many researchers and professionals.

At the first stage of studies conducted at the Academy of Public Service, the objective was to determine the place and role of information technology in the system of public administration of Kazakhstan. An analysis of current studies, upgrading, implementation and operation of information systems by the public administration bodies has demonstrated a lack of uniform methodology of development and implementation of such systems. Every top public administration body utilizes its own informatization project.

Such a process like the informatization of public administration bodies can not be chaotic, but it should be scientifically based and have a clear vision and strategy of development. The modern concept for designing information systems for public administration bodies should include a general methodology of designing information systems and the following evident trends:

Currently there are higher requirements to

- the terms of development and implementation systems and to the quality of their work;
- there is an opportunity for an effective and complex utilization of various software, technical tools and available technological solution, which allow to develop, adjust and implement rather quickly new information systems and to upgrade the existent ones;
- a number of managerial processes require the development and implementation of own applications which are more flexible the changing information demands from the side of uses and software and technical configuration of system.

The current unsatisfactory state of informatization of public administration bodies is mostly related with the absence of a competent state body responsible for the informatization of public administration bodies, capable to inspect and ask reports on use of funds, to regulate the expenses, especially at purchase of foreign technology, and so on.

Of not less importance is to create a regulatory and legislative basis in the field of informatization.

About an Integrated Automated Banking System J.S.A.B.(Joint Stock Agroindustrial Bank)

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In the report the experience of choice and introduction of an integrated automated banking system is represented within the framework of one многофилиального of bank of Republic of Kazakhstan.

Banking integrated bank automated system, guard of an information

Now huge significance has efficiency and concreteness in a decision making in management of Bank. For this purpose it is necessary to process a stream of a state information of Bank on concrete time. For want of it the treated information should be actual and authentic.

In a 1996 J.S.A.B. had 236 branches. Each branch worked practical as independent bank. Had correspondent account in National Bank of Republic of Kazakhstan. A head office grantave only reportings. Besides the branches had the software at own software: developed it's pogrammers or purchased at the outside developers. In total on Bank there were programs of seven different firms or own developers. In too time any from the programs did not correspond to the international standards.

Therefore it was necessary to select an ABS (automated banking system) answering to modern requests of bank technology.

The study modern ABS has shown, that they can be devided on three classes: systems based on bank transactions, documents and bargains. Accordingly it is possible to speak about three bank technologies. On the closed tender of the projects on automation of a banking system J.S.A.B. have presented the projects from the following firms:

- Kirchman (USA) together with IBM
- Ipacri (Italy) together with IBM
- Sybase (Kazakhstan, Алматы) together with SUN Microsystems
- FORS Ltd (Russia, Moscow) together with ORACLE and SUN Microsystems
- LVS/Price Waterhouse Business Solution (Russia, Moscow) together with ORACLE and SUN Microsystems
- Joint-stock company "BackUp" (Russia, Novosibirsk) together with ORACLE and IBM

For a correct evaluation of the projects, it is offered to all participants to formulate the offers on the following basis:

- The correspondence of an offered automated banking system (ABS) to the international standards (GAAP);
- The correspondence of all parts of the project (hardware, operational system, database management system (DBMS) and ABS) requests on a guard of an information on a class C-2;
- Use of an existing telecommunication data network BankNet (protocol X-25, X-28);
- Possibility of using of existing park of computers (AT -486, SX-25, RAM 4M);
- A pilot zone including central office with the region branches plus Taldeecurgan region;

In all the remaining participants of the tender were not limited.

On a solution of a commission the project of firm FORS on the basis of ABS "Va-Bank" was recommended on introduction.

Main distinctive advantages selected ABS "Va-Bank":

- Possibility of creation of the federated system of bank, servicing all of its branch
- Realtime processing and batch mode
- Possibility of set-up on the changed plan of the accounts
- Flexible structure settlement and personal accounts
- Absence of structural restrictions on development of a system
- Automation of operations with foreign and local currency
- Modern architecture of computer networks "client-server"

Reliable guard from unauthorized access

- both warranty of safety and interconsistency of all datas for want of any failures in work of the equipment.

For reaching the current purposes and introduction of a system "Va-Bank" all system have transferred to the uniform program " Operational day of bank ", have created a uniform Customer, Credit and Deposit data base. To a moment of a beginning of the project the bank had an own corporate net supporting protocols x.25 and x.28. Hereafter was assumed to proceed to protocol Frame Relay.

Had two variants of construction of a system:

1. Is conditional decentralized, when in each regional level are installed of the server for information processing at a regional level. Informations on these servers replicate with the central server in the certain time.
2. Centralized, when the server one - central, and remaining remote consoles working in an actual mode of time.

Advantages of the first variant consist a minimum request to telecommunications. And main defect - the hard request to regional servers and experts, that is was increased by(with) cost of the project.

Advantage of the second variant - minimum quantity of servers (at centre one and reserve), competent experts (they are necessary only at centre), and the defect consist of a high request to telecommunications - the possibility of work of branch in real-time mode was required.

As the existing corporate web allowed to work in real-time mode, the second scheme was selected.

During introduction have met difficulties connected with a discordance of existing bank technologies and introduced system. In most cases changed technology of work of bank, in some it was necessary to change an introduced system.

In a middle of a 1998 the test of a system in variant centre and one branch was conducted. In an outcome the test was clarified, that for want of to work with branch in real-time mode the huge traffic of a transmitted information is received. It meant expansivness of a system for want of of operation. A solution about development of the additional module - server of the messages therefore is accepted which should ensure operation of a system in a batch mode with one central server.

The spring of a 1999 finished construction of an integrated automated system J.S.A.B. on the basis of ABS "Va-Bank" of firm FORS on the UNIX platform. Now, depending on quality of the used communications, the bank subdividings can work on the federated system in real-time mode or in batch, exchanging with a central data base by the documents with the diversified structure. In connection with introduction of a system have taken place a radical modification in technology of operation of Bank.

In branch the payment document in due form is prepared and departs to head Bank.

- In head Bank the payment document is sorted according to carried out of operations and is transmitted on consideration to appropriate management.
- The controller of management checks up a correctness of the payment document, necessity and expediency of realization, further gives the sanctions to realizations of payment.
- Group of the uniform correspondent account checks up a financial possibility of realization of payment and gives the sanctions to realizations of payment.

The department of realization of payments carries out the payment document up to the addressee (through Clearing centre, KCMR, SWIFT).

Was increased a degree of service of the custo mer. The customer of Bank can be served in any branch, is not dependent on a place of registration. For this procedure it is necessary to the customer for want of registration to transmit to Bank the photo and signature. There is a module the customer - bank, that is the customer can be served at itself at office.

Basic;in essence at a new level the guard of an information is organized. In the correspondence with a request of National Bank of Republic of Kazakhstan the guard of an information under the international standards is organized. The access to an information is grantiven in the correspondence with technological process and the protocol of work of the user is conducted.

In an outcome the multybranches bank has acquired all advantages of a uniform information structure with a centralized direction.

The Object-Oriented Approach at Designing the Banking Information System

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The approach reducing complexity of the information system simply deciding problems of a control and allocations of access to objects and functions of the system is offered. The described approach differs by representation of information system as a tree, in which the management of work of system is made from each top of a tree.

The information system of the enterprise can be considered as system of the quantitative account of condition of objects of management.

The real objects of a determined type have hierarchical structure (for example, the balance-sheet of bank consists of classes, they, in turn, consist of groups of the accounts, which include of the account, which include the obverse accounts and etc.). According to it, the objects of the projected system can be presented as sites of a tree, in which each object has a name, properties and the link to the object of a top level. Thus the uppermost site of a tree is the root and it has a level 0. All sites having the link to the given root site is sites 1 level etc. The terminal tops of a tree characterize an amount of the given object, for example, currency or material unit, for example, computers or defined goods. A collection of all trees, together with costs on periods and transactions on dates (change of cost in the given period) make information base of all projected system.

Except the above mentioned information, the objects have the various characteristics – property.

Usually, the properties have practically constant meaning and are entered an once for each object. All properties of objects are possible to define as values of fields of the certain forms.

Traditionally, the information systems are intended for fulfilment of various operations above objects, which change a condition of objects. The function, which change a condition of objects as object programming , is possible to name as methods or operations. Thus object, above which operation is made is all subtree, the root of which is in that place, whence the given operation is made. Usually, the operations are made in terminal tops. If the operation is made not in terminal top, such top limits set of terminal tops participating in the operation.

Initial status of the information system will be presence of several root sites of the defined type.

The collection of all trees of various types with their statuses of sites and set of operations, which can be fulfilled, were in the given site, makes the information system bodily. A subset of the subtrees, which are accessible to the concrete user and a subset of operations for this user define concrete client part.

On the basis of the described approach the first-order description of bank information system is received and development of the programs is conducted.

The Concept of an Information Model of Bank

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In the report the new approach to the analysis of banking distinguished from object, traditional by a modification, of the analysis is represented to consideration. Some aspects of construction of an information model of bank are considered.

Banking, analysis, information model, automated banking system.

1. Basis of an information model

Now there is a set of software products intended for automation to banking. All these automated banking systems (ABS) differ on a degree of complexity, functional filling of the interface, analytical possibilities etc. All these ABS function under one scheme:

There is a set of objects, integrated in an array ACCOUNTS. The objects are characterized by the identifier (Id) by a status (S) and parameters. The status of object is number from area of real numbers. The sum of status of all objects at any moment of time is equal to zero.

The status of object can be changed by means of operations of addition and subtraction above a status (S) of object with the identifier (Id). All operations of addition and subtraction are incorporated in an array TRANSACTIONS.

Parameters of objects are magnitude constant.

Solution of a problem is the modification of statuses of objects of an array ACCOUNTS.

Because of solutions are formed various groupings of objects according to their parameters (balances, reports etc.). Because of of obtained groupings all analytical activity of bank is carried out.

The possibility of decisionmaking in these conditions is connected to deep understanding of an essence of various groupings of objects and huge experience of work. Not without reason there is a saying that the good banker ripens by 50 years.

For facilitation of decisionmaking in some ABS the possibility of a "trial" solution of a problem for want of specific conditions (that will be, if ...) is realized, however, such the path does not give a possibility of the analysis of all candidate solutions for acceptance optimal.

In an outcome of the analysis of the arisen situation, we offered other approach to construction of an information model of bank.

The main object (criterion) of the analysis selects not any grouping of the accounts on any indication, and new object of the analysis - bargain.

The bargain - population of services rendered by Bank to the customer. The bargain consists of one or several services connected among themselves and rendered to one or several customers simultaneously.

The service - population of banking operations, which outcome is sufficing needs of the customer. The set of services represented by bank should envelop all spectrum of banking.

Banking operation- set of operations, standardized according to requests and recommendations of National Bank attracting for itself shaping of a number of the payment documents.

The payment document - set of the instructions, standardized according to technology accepted in the given bank, which performance forms an array of transactions.

2. The description of types of the documents

The types of the documents should be strictly standardized and are determined from technology of work separately of taken bank. Let's consider some types of the documents on an example of Joint Stock Agroindustrial Bank.

- The inside branch document (D1)
- The interbranch document (D2)
- The interbank document (D3)
- The cash document (D4)
- The expendable-profitable document (D5), etc.

According to positions acting in Agroindustrial Bank, the instructions for shaping transactions for each type of the documents are determined.

All types of the documents are integrated in one dictionary of the documents (DOCUMENTS) allowed to application.

3. The description of types of operations.

The types of operations also are standardized within the framework of activity of separately taken bank. As an example, leaning on it is possible to consider activity of Agroindustrial Bank, some types of operations:

- Issue of the non-cash credit in branch
- Calculation of interests
- Reception of the deposit in branch etc.

According to the positions, acting in bank, is determined, what documents are formed for each type of operations:

All types of operations are integrated in one array Operation - directory of operations allowed to application.

To each type of operations in an array Operation the unique identifier Oper _ Type is appropriated.

Performance for each of Oper _ Type is the combination from Doc _ Type of an array DOCUMENTS.

4. The description of types of services

The types of services are standardized within the framework of activity of one bank according to the normative documents НБ РК.

As an example it is possible to consider two such as services:

- Granting of the credit for the period of 3 months with monthly settlement of percents and main debt (U1);
- Reception of the deposit contribution for the period of 3 months with payment of compensation and capital amount in an extremity of term (U2).

According to the acting positions is defined, of what operations these services consist.

All types of services are integrated in one array SERVICE - directory of services allowed to application.

To each type of services in an array SERVICE the unique identifier SERVICE _ Type is appropriated.

Performance for each of SERVICE _ Type is the combination from Oper _ Type of an array Operation.

5. Description of the bargains

The customers present bank the requests on granting of services. All requests are integrated in one array. In an array the check on availability of the acting bargains with datas by the customers is made. By presence of the acting bargain the logic monitoring on a possibility of granting of required service is conducted within the framework of the acting bargain. The monitoring is carried out on items:

- The direct costs under the bargain should not exceed the spefication NORM1;
- The sum of represented service does not exceed the spefication NORM2;
- The resource of the bargain supposes granting the given service

After realization of these checks, the service is included in the acting bargain and the fulfilment will be actuated.

If the acting bargains with datas by the customer is not present, shaping the new bargain begins.

From an array SERVICE the approaching type of service is selected.

- The resource of service performance is underlined.
- The logic monitoring is made.
- The direct costs on required service are determined.
- The costs on selected resource are determined.
- The income of the formed bargain settles up.
- The net profit from the bargain settles up.
- The profitability of the bargain settles up.

In case of a positive solution the bargain is fixed as acting, and the service is grantiven to the customer.

6. The analysis of the bargains

Having in availability an array of the acting and completed bargains, the good bargains are determined most. There is a possibility to define the interest rates on engaging and accommodation of resources as as a whole on bank, and on regions. The restrictions NORM2 for separate types of services are determined. Shaping a financial outcome of work of bank on any instant is possible. Because of of obtained outcomes the strategic policy of development of bank is created.

Alongside with the analysis fullbanking activity the realization of researches in a slit of regions, in a slit of the customers is possible.

Analyzing various types of services, which were not realized within the framework of the bargains, shaping new types of services is possible.

Thus, such construction of an information model of bank enables of operating decisionmaking without a full solution of a problem of an operational day of bank, with of beforehand specific parameters of profitability activity of bank as a whole.

The Development Problems of Student Information Automatized Systems for Results Forecasting

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Statistical analyses of information about students results and the forecasting of possible students` elimination at the end of semester by means of computer with the giving of recommendations concerning studying process organizing improvement are the actual task of high education institute activity evaluation. On the bases of created scientifically grounded mathematical model of studying process organizing and planing, it is suggested to decide the automatized systems of administrating development questions [1,2,3].

The principles laid into the new knowledge multi-numbered rating control system promoted the continuation of works on previously created model improvement.

It is suggested to widen data software, and essentially develop software of existed subsystems (AMSHET), to work out the packet of applied programs (PAP), which will take into consideration results of theoretical researches specificity of operational systems, possibilities of up-to-date systemized data base directing (SDBD) and will automotive session results treatment to supervise studying process, to forecast results, to calculate students contingent with regard to possible students elimination at the end of semester.

It is mentioned, that the working out must be based on the original ideas combined with well known methods thus creating possibilities of applications and the PAP itself must be notable, like the majority of up-to-date computer settlements, for mature comfort for usurers, must not require deep and detailed knowledge of programming languages operational systems, concrete PC and various methods of statistics and numerical analyses.

It is necessary to foresee several conditions of work with the new system, including the conditions that allows to make tests on a subject, to supply administration in a dialogue rate with true efficient information that is necessary for the current activity as at the inquiring and advising information level, so as at the alternative decisions level.

Elaborated data base of ASIA ought to seize not only personal, social and academic information about the student, his current semester's results, but a massive of marks for the previously studied disciplines, specialty, curriculum plan, in other words this data base must contain the data on each subject about it's title, connection with other disciplines and student contingent, course, session number, examinations passing, type and sort of the making tests etc.

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SECTION
"INFORMATION TECHNOLOGY IN MATHEMATICAL MODELING"

NEW INFORMATION TECHNOLOGIES IN OIL-AND-GAZ INDUSTRY

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Abstract.

In the report presented automatic information system for processing the information flows нефтегазодобывающих месторождений, conduct of databases and passports of bore holes, buildings of structured cards and profiles of terrain, as well as some packages for deciding of direct and inverse marginal problems of theory to two-phase filtrations.

Keywords. *Oil-and-gaz Industry, information system, mathematical model, database, passport of bore hole, differential equations, two-phase filtration, marginal problem.*

Introduction. Today, information technologies become main forming operations of any objects, enterprises and organized technological and other processes and organisms. Particularly effectively introducing the information technologies in large organizations and association activity, where happens to to deal information flows with enourmous arrays of. Oil-and-gaz Industry of any country is composite by the system, uniting in itself ensemble of intermix enterprises, in which appear a broad spectrum of different problems, commencing from economic and ecological, finishing geological, technological and transport. Introducing the information technologies allows to raise a quality of executable work, technological processes, management deciding и.т.д. Today in Kazakhstan with tempestuous, dinamic development геолого-разведочных work on stages beginning of development of oil and gas field, so and on rest stages of functioning (working) necessary efficient programme products, which with quantitative mathematical methods, intended for automations and optimization of criterions of functioning (working) oil-field.

Development of oil and Oil-and-gaz field, as a complex technological process, needs for well-timed effective checking, analysis and regulation, which begin from comissioning the first bore holes and continuously last before the end of usages field, cover all stage of their development, from which hang high efficiency of process and end oil. So, in Oil-and-gaz industry appears a greater amount of problems, for deciding which reasonable and effectively using the information technologies, developped on the base of mathematical modeling of corresponding aplication domains.

Depending on the sort of activity (directions of activity) objects of considered industry appearing problems possible to classify on following classes:

1. Geological and geophisical;
2. Technical;
3. Technological;
4. Field-performance;
5. Transport;
6. Economic;
7. Ecological;
8. Conversions (chemical);
9. Management and decision makings and the others.

Research institute mechanical engineers and mathematicians under КазГУ им. scarlet-Фараби in last 8 years concerns with a basic research of filtration processes and making the information technologies in Oil-and-gaz industry. In particular, on the agreement with SC «Мангистаумунайгаз» it created package of applied programs for automations and analysis of processing the information flows. Received new models to filtrations, offered numerical algorithms for deciding of direct and inverse tasks (parameter identification) development field.

Oil field Kazakhstan have no a due processing multiple data, which appear from a moment of development Oil-and-gaz field and are accumulated in the process of its development. Meantime undertaking an efficient analysis and using the possibilities of computer information handling by means of mathematical methods allow far easier to keep a check on multiple factors, which define efficiency under development field.

Today we should like to tell on our last results and demonstrate some programme packages, developped by us in recent years.

The First task, which we have putted (deliver) before itself, - was an undertaking an analysis of current condition of oilfield and gas.

Database field. Database - not only suitable type of keeping information on all bore holes and on the whole field as a whole, as well as instrument for operative evaluations of condition of development field. Supplied by processing program system, database allows to decide tasks an prediction of mining an oil on the prospect, interactions gaining and force bore holes, on revision of geological feature of object and many others.

Database is considered as a large independent block in the general computerization system of deciding the problems of development oil field. It is a central section, in many defining functional features of system as a whole. Main carrier information is a bore hole, for which are indicated: geology-physical features (bore hole number, horizon number, areas or area number, appointment of bore holes (extractive, force, control and etc), porosity, oil-saturation, bed pressure (initial), type of bore holes, fund of bore hole, category of bore hole); commercial features (debet of bore hole on liquids, debet of bore hole on oils, total mining an oil from the bore hole, total mining a liquid from the bore hole, total mining a gas from the bore hole, current value of bed pressure and others.). In the process of entering information are formed derived features (spares of oil, initial and current watered bore holes, balance spares for the whole object etc.).

Structure initial extracted spares. Program a structure initial extracted spares allows to calculate an available balance spare of oil and gas in field different methods: three-dementional, springy, water tower, count spares of free gas on falling a pressure and define a factor of extraction of oil. Possible remove a diagram of sharing the extracting spares on horizons.

Analysis of production of spares. Program an analysis of production of spares is intended for an ing of quantitative and qualitative analysis of gaining liquid on horizons and on bore holes. Button «mining an oil» shows an amount mined oils annual and accumulated on the horizon and on bore holes. Button «rate of selection» shows a rate of selection (annual mining an oil divisible on initial extracted spares) and degree of production field (accumulated mining an oil divisible on initial extracted spares).

Interaction of bore holes. Program «interaction of bore holes» calculates on available in the database to operative data a factor to correlations between gaining and force bore holes (if this possible) and shows them in the manner of diagrams. Possible also look pair (vapour)s of bore holes between which count of factor to correlations impossible.

Passport of bore holes. The Following stage of our functioning was a creation geological natural reservoir models. For realization of this functioning was required full information, being kept in passports of bore holes.

Regrettably, even processes of simply keeping information in the electronic type on field for a present-day day practically do not exist. Meantime information, which is kept in passports, very it is important. Its keeping in the paper type can cause, eventually (on known reasons) loss important information on the object.

Structure of passport. Passport field consists of several subdivisions. The First from they are kept general data. It includes such features as an attribute of bore hole field and region, bore hole number, tectonic element II order, category and status of bore hole and some other features.

The Second subdivision of passport was conditionally named "litology". It is kept in itself given for litology feature of dissected cut, buildings of structured cards, geological profiles. This subdivision is kept in itself following tables: "Table spacing (on bore holes) soles of horizons", "Table spacing (on bore holes) to roofings/soles of productive horizons", "Table spacing (on bore holes) to roofings/soles of layers-collectors of natural reservoir bed oils", "mini bed", "Disagreements", "Additions". Table "Additions" is kept on well given on efficient and oil-saturation to the thickness, porosity on kernel and on geophisical data, permeability and factor oil-saturation.

The Following subdivision of passports of bore holes is identified "Wiring", containing information on designs of bore holes. Two last subdivisions of passports of bore holes are identified accordingly "Test" and "Mastering". The First from they are kept given tinned as a result пластоиспытаний, second as a result a testing in the pillar.

Structured cards and profiles. With using a mathematical device, on visual programming language Delphi Client/Server company Borland International is built geological profile field.

In the stage of building of geological profile is taken scaling into account, accomodation of sought bore holes along horizontal axis. On screen planes is postponed vertical scale, showing corresponding partitionning the absolute mark. Are they Then chosen interesting You bore holes from the correspond database, where is kept information on all available bore holes. Hereon stage a program builds стратиграфические subdivision неоген-jurassic a postponing. Information on he undertake from the database on стратиграфическим subdivisions. Moreover different subdivisions correspond a different colour. At user can as a matter of convenience change a palette of colours. With using one of the above-mentioned functions is beaten off roofing and sole of productive horizon.

Proposed software package with use and using the mathematical methods is intended for the building of litology profiles Ю-VIII horizon through cuts of bore holes. Package allows automated to interpret given geological, oil-and-gaz studies in the manner of graphic presentations.

Program allows to choose a necessary amount of bore holes from the correspond database and places them on planes of screen. For this is conducted horizontal line to which are postponed distances between chosen bore holes. Indicated and is inflicted scaling both on horizontal, and on vertical axis.

Along each numberred bore holes lay-out downwards vertical line (projection of stem of bore hole) before the depth, overlaying sole of productive horizon. Program shows on литологическом a profile intervals of clays, and where required lay-out them.

Software package allows in litology a profile to take into account and show a power of layers and nature of their spottiness, position of water-oil contact (WOK), as well as possible development data - positions забоев bore holes, intervals to perforations, a testing, oil-saturation on geological bore hole studies, influxes of oil and water on results seamtest, considering color palette of background of painter of geological sorts.

Building of structured geological cards. Package with programme modulas, based on mathematical methods, such as interpolating, approach by harmonic functions allows with sufficient efficiency to build structured cards. Is it Herewith Taken spottiness of into account discrete values, sharply denominated scattered nature numeric features of geological signs, floors.

For recovering the required floors in structured cards are attracted trend-analysis, taking measurement errors into account, optimum filter Kolmogorov-Viner, based on use differences in spectrums of separating signals.

Either as in preceding buildings is taken scaling into account, are revealled anomalies - isoline under the insufficient amount of corresponding data, required for the building.

Model Muskatte-Leverette. Speech marginal task to two-phase filtrations in two-dimensional and three-dimensional events. Program is written in the ambience Visual Basic. It allows to assign a free amount force and gaining bore holes. On the move of calculation possible visual to observe эпюры pressures and force in free horizontal and vertical sections of layer.

Identification ground conductance layer. Speech inverse task to two-phase filtrations for identifications ground conductance layer on available additional information on the amount of extracting liquid from gain bore holes.

Conclusion. Thereby, executed broad circle of studies on problems of mining an oil in real field.

THE INFORMATION TECHNOLOGY IN THE MATHEMATICAL SIMULATION OF ETHANE OXIDATION

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Resume.

The results of mathematical simulation of stability of the work of chemical reactor. Two dimensional mathematical model and simplified zero-dimensional model are considered. Qualitative analysis of stability of the stationary regimes oxidation was accomplished on zero-dimensional model and then used for the planning of the computing experiment on initial model. The results of theoretical investigation were compared with experimental data of ethane oxidation noted from paper [1].

Keywords. *Ethane oxidation, theoretical investigation, mathematical simulation, analysis of stability of the stationary regimes.*

Introduction. Kalthoff and Vortmeyer [1] experimentally found the region of non-unique of stationary states of ethane oxidation in the fixed bed reactor. Non-unique and self-oscillation stationary regimes of ethane oxidation, and also probable responses of the process on external periodic disturbances were theoretically analyzed in the paper [2]. Comparison of computing results with experimental data had shown it agreement. In this paper, as in [2], two-dimensional pseudohomogeneous model of heat and mass transfer was used. But in contrast to [2], the non-uniform distribution of velocity flow and dependencies of density and viscosity of reagent from temperature were taken into consideration in mathematical model. More precise definition allows hoping for improvement of agreement between experimental data and theoretical results.

Mathematical formulation of problem. The catalytic oxidation of gas mixture in a wall cooled fixed bed reactor is investigated. It supposes that catalyst pellet and gas have equal temperatures. The diffusion in the catalyst pellets is absent. Heat and mass transfer is characterized of the effective coefficients of diffusion and heat conduction. Irreversible exothermal chemical reaction in the gas phase with type $A \rightarrow B$ is considered. The radial distribution of porosity of catalyst layer is taken into account. Representative for the ideal gas temperature dependencies of density and viscosity are realized. Process is described by two-dimensional pseudohomogeneous model of heat and mass transfer and Brinkman's equation. In the dimensionless variable the problem is formulated by following system of equations:

$$\mathrm{Fo}>0:\ 0<x<1,\ 0<r<1,$$

$$\frac{\partial\theta}{\partial Fo}\left[\varepsilon\,\tilde{\rho}+(1-\varepsilon)\gamma\right]+\tilde{\rho}\,\mathrm{U}\frac{\partial\theta}{\partial x}=$$
$$=n\frac{\lambda_r^{ef}}{\lambda_{G_0}}\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial\theta}{\partial r}\right)+\frac{\lambda_x^{ef}}{\lambda_{G_0}}\frac{\partial^2\theta}{\partial x^2}+$$
$$+qDa\cdot\tilde{\rho}\cdot y\cdot\Gamma(\theta);$$

$$\tilde{\rho}\frac{\partial y}{\partial Fo}+\tilde{\rho}\,\mathrm{U}\frac{\partial y}{\partial x}=$$
$$=n\left[\frac{1}{r}\frac{\partial}{\partial r}\left(rLe_r\,\tilde{\rho}\frac{\partial y}{\partial r}\right)\right]+ \qquad (1)$$
$$+Le_X\left[\frac{\partial}{\partial x}\left(\tilde{\rho}\frac{\partial y}{\partial x}\right)\right]-$$
$$-Da\cdot\tilde{\rho}\,y\cdot\Gamma(\theta);$$

$$\tilde{\rho}\frac{\partial U}{\partial Fo}+\tilde{\rho}U\frac{\partial U}{\partial x}=$$

$$=n\,\mathrm{Pr}_0\left[\frac{1}{r}\cdot\frac{\partial}{\partial r}\left(\tilde{\mu}r\frac{\partial U}{\partial r}\right)\right]+$$

$$+\mathrm{Pr}_0\left[\frac{\partial}{\partial x}\left(\tilde{\mu}r\frac{\partial U}{\partial x}\right)\right]+$$

$$+P-A\cdot U\cdot\tilde{\mu}-B\cdot U^2\cdot\tilde{\rho}$$

With initial conditions:

$Fo=0{:}\quad \tilde{U}=\tilde{U}_{H},\quad y=y_{H},\quad U=0.$

Boundary conditions describe heat and mass transfer and movement of the mixture on the entrance of reactor, smoothness of profiles on the exit of reactor it symmetry relatively axis of the pipe, heat and mass change with environment and adhere mixture on the reactor's walls.

$$Fo>0:0<\mathrm{r}<1,$$

$$\mathrm{x}=0,\ \mathrm{Pe}(\theta-\theta_{ex})=\frac{\lambda_x^{ef}}{\lambda_G}\frac{\partial\theta}{\partial x};$$

$$y=y_{ex};\quad \mathrm{U}=Pe,$$

$$\mathrm{x}=1,\ \frac{\partial\theta}{\partial x}=0;\ \frac{\partial y}{\partial x}=0;$$

$$\frac{\partial U}{\partial x}=0;\ \ 0<\mathrm{x}<1,$$

$$\mathrm{r}=0,\quad \frac{\partial\theta}{\partial r}=0;\ \frac{\partial y}{\partial r}=0;\ \frac{\partial U}{\partial r}=0;$$

$$\mathrm{r}=1,\ -\frac{\partial\theta}{\partial r}=\mathrm{Bi_T}(\theta-\theta_\infty);$$

$$-\frac{\partial y}{\partial r}=\mathrm{Bi_D}(y-y_\infty);\ \mathrm{U}=0. \qquad (2)$$

Results and discussion. Approximated analysis of dynamic behavior of chemically reacting system is realized on the base of zero-dimensional model, which obtained from initial by means of replacement two dimensional differential operators for finite-difference in three points with accounting of boundary conditions [2]. Coordinates of stationary states of the system are defined from the system of algebraic transcendental equations by means of bifurcation diagrams. It was established that for all meanings of parameters, which are not bifurcation, it is possible from 1 to 3 stationary regimes ethane oxidation. Low-temperature regime of slow oxidation and high-temperature with high rate of chemical reaction and unstable middle-temperature regime, which realized in practice only forced. Calculation shows that phenomena of ignition/ extinction appear under lesser values of the time mixture stay in reactor and disappear with it increase. Equations of boundary of non-unique of stationary states on the plain were obtained from equation of bifurcation diagram and conditions of existence of its extremum. Boundary of non-unique for this case is presented on fig. 1 (line 1). In the same place are shown boundary of non-unique obtaining when heat-physical properties of reagent are constant, and velocity of flow changing only in radial direction (line 2). Line 3 corresponds to the case when heat-physical properties of reagent and velocity of flow are constant. One can see, all three boundaries recovering but locate with relative displacement. Non-uniform velocity distribution greater influences on critical conditions of ignition then on extinction one's (lines 1 and 2). Calculations, realized for non-unique flow velocity distribution both in radial and axial directions with variable density and viscosity lead to decrease of region of non-unique stationary states, and it displacement aside more low values of effective temperatures (line 1).

Boundaries of non-unique of the plane "inlet temperature" – "velocity flow" were obtained by means of graphic constructions from boundaries of non-unique on the plane "heat of reaction" – "inlet temperature" (type of line 1 on the fig. 1), which calculated for the various values of flow velocity. Comparison of these regions with experiment [1] was obtained for the invariable flow velocity region. It was found that calculating (inside line 3) on the fig. 1 and obtaining one's from experiment recover, there is best agreement between calculations and experiment observing under lesser intensity of heat irradiation throw reactor's walls (lesser values of heat number Bio).

Linear analysis of stability of stationary regimes of oxidation. The stability of stationary regimes of oxidation was investigated by first method of Liapunov. It was found, that parametric equations of boundary on non-unique coincide with determinate one's when determinant of matrix of linear transformation was equality zero. The parametric equations of boundary neutral stability were obtained. The regions of various regimes oxidation self-oscillation, non-unique and unique without oscillations are conditioned by mutual location boundary of non-unique (wedge) and boundary of neutral stability (line with loop) on the plane "reaction hear" (q) – "inlet temperature". It was found that boundary of non-unique is displacing with increase of Bio number aside more high values of reaction heat. Increase of Prandtle number leads to decrease boundary of non-unique. It was obtained that boundary of non-unique displacing thus, that ignition and extinction occur with more high heat of reaction "q" and low values inlet temperature. The boundary of self-oscillation regimes oxidation is increased. Later is connected with increase of difference of effective rates admission matter and remove heat with growth surface heat-irradiation.

Numerical solutions of the problem. Prognoses of approximately – analytic solutions to determination stationary values of temperature and concentration, number of stationary regimes and it stability were verified by comparison their results with experiment [1] and numerical solution of initial model. The regime corresponding to parameters of experiments [1] of ethane oxidation was calculated (point A on the fig. 1). On the fig. 2 measuring in the experiment (points) and calculating (continuous lines) stationary distribution of temperature are

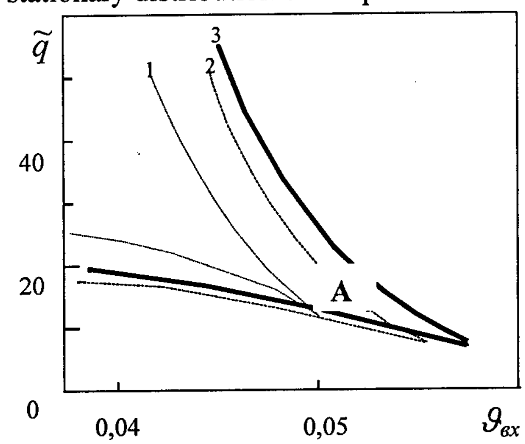

Fig. 1. Boundaries of non-unique of stationary regimes. Point A is corresponded of the process of ethane oxidation.

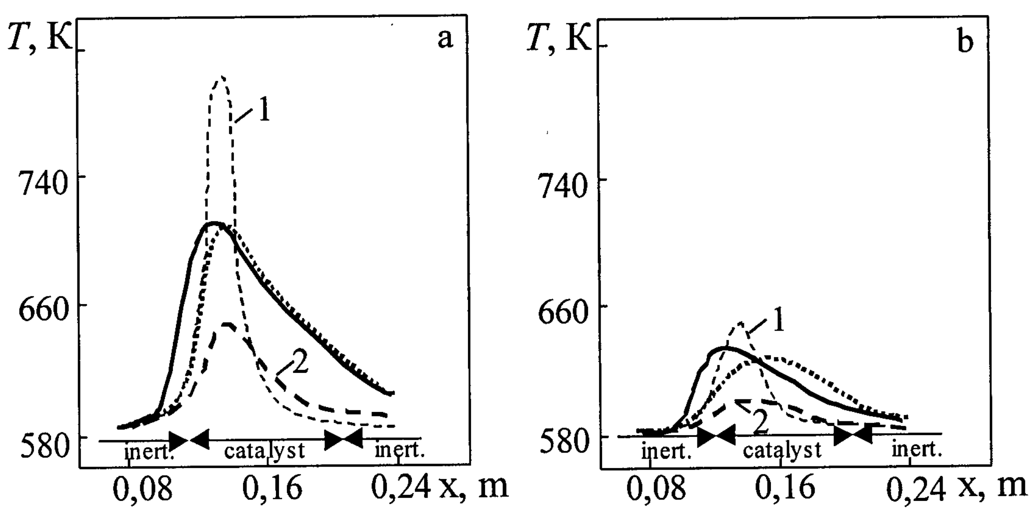

Fig. 2. Temperature distribution on reactor length on the axis (a) and on the wall (b).

shown. Obtained earlier distributions of temperatures in the case of solution problem for variant A by constant flow velocity, density and viscosity of reagent [2] are marked on dotted line. Apparently, in this case, determinate profile is located between calculating for high-temperature (lines 1) and low- temperature regimes (lines 2). One can see that accounting of non-uniform flow velocity distribution and variable physical properties of gas has been lead to displacement regions of various regimes oxidation (fig. 1). Point A locating in the region of non-unique stationary states now corresponds to unique stable regime. It obvious that profiles of temperatures on the length of reactor (continuous lines) get more filling and agreement with experiment improves.

Implant of external periodic disturbances on predicted analytic and numerically realized asymptotically stable stationary regime was also investigated in the computing experiment. Resonance takes place by low-frequency disturbance of primary stable regime. High-frequency disturbances do not impact on oxidation regimes.

Conclusion. Preliminarily zero-dimensional analysis of the process of catalytic oxidation has been allowed to predict parameters, characters of stationary regimes, their stability and in complex with numerical experiment to research impact fluctuations and external periodic disturbances on the process. More precise definition of the mathematical model has been improved accordance of the theory and experiment.

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COMPUTER TOMOGRAFPHY FOR PETROLEUM INDUSTRY

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Decision of inverse problems an seismoexploring for recovering the characteristics of porous ambience has an important practical value for computer tomography in petroleum industry.

Problem an сейсморазведки is concluded in deciding an inverse problem for the system of equations of theory of bounce, i.e. on the known displacing vector on given surfaces to define density of ambience and springy parameters Lame l(h) and m(h). On last possible to define velocities longitudal Vp and transverse Vs waves. Velocities Vp and Vs give already sufficiently greater information on the structure of under investigation ambience.

Mathematically, specified above inverse problem is such, either as an inverse problem of theory of dissipation. Inverse problem of theory of diffusing is concluded in finding of potential q(x) in equation

$$\Delta\varphi + \lambda^2\varphi = q(x)\varphi \quad x \in R^n$$

on the known asimptotic φ where $|x| \to \infty$, deciding j under satisfying conditions radiating Zommerfeld.

Known that physical characteristics, connected with spreading in the ambience of springy waves, reflect a nature of issue of energy from one part of ambiences to the another and on its nature are characteristics dynamic. So as mathematical models, reflecting spreading the springy waves in анизатропной to ambience (springy characteristics of ambience different in all directions), choose wave equation of following type

$$\frac{\partial^2}{\partial t^2}u(x,t) - \frac{\partial^2}{\partial x^2}u(x,t) = q(x)v(t), \quad (1)$$

where

$$v(t) = \int_R q(y)u(y,t)dy, \ x, y \in R, \ t \in R. \ (2)$$

From physical considerations is required to find such function q(x) that

$$q(x) = \begin{cases} 0, & \text{if } x < 0, \\ q(x), & \text{if } x \geq 0, \end{cases} \quad (3)$$

provided that known condition

$$\frac{\partial}{\partial t}u(x,t)\Big|_{x=0} + \frac{\partial}{\partial x}u(x,t)\Big|_{x=0} = f(t), \ t \in R. \quad (4)$$

Will Immediately specify that function q(x) must satisfy the following conditions:

$$(1+|x|)q(x) \in L_1(R) \cap L_2(R), \quad (5)$$

$$\frac{\partial}{\partial x}q(x) \in L_2(R). \quad (6)$$

Conclusion. Received following results:

· Decision of direct problem for the wave equation (1) in the statement of the problem Koshi denominated through deciding a stationary problem;

· Received evident presentations for S-matrixes, elements which possible consider as reflecting factors and passings;

· Found that own values Ej are defined from experimental-measured data, as which emerges a condition of inverse problem (4);

· Conducted численное modeling of inverse problem for the wave equation (1).

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SIMULATION OF THE DEFLAGRATION TO DETONATION TRANSITION IN A TUBE

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One of the general mechanisms responsible for the transition to detonation of a flame is the turbulence generated by the tube wall, and probably by the flame itself. The focus of this study is the role of the turbulence and pressure waves in the acceleration of stoichiometric hydrogen-oxygen flame propagating in a tube and how it affects the transition processes.

The interaction between the wall and the flow behind the leading shock wave generates turbulence in the whole flowfield, starting at the wall and propagating toward the center. Correspondingly, as known from experimental data, the leading point of the turbulent flame is in the vicinity of the wall and this determines the flame velocity. Therefore, we consider the characteristics of the turbulence near the wall as the controlling factor of the whole turbulent combustion in the tube.

The present study of the problem is based on the assumption that the bulk flow in the detonation tube is one-dimensional. This is a simplified representation; in real situations a transverse propagation of pressure waves and their reflection from the wall are very important. But 2 or 3-D simulation of this phenomena is certainly difficult, at least time-consuming, and in this study the effects of the wall on the main flow were incorporated through boundary conditions, as well as by turbulence models for the mixing and reaction rates.

The predictions are based on numerical solutions of the Favre-averaged, one-dimensional, non-steady set of the conservation equations for individual species, mass, and total energy in the conservative form.

The turbulence model consists of two elements. The first is a simulation of diffusion processes by the wall and by flame generated turbulence using eddy viscosity formulation. The turbulent viscosity μ_t is computed using a $k-l$ model of turbulence $\mu_t = C_k \rho\, l\sqrt{k}$. The system of conservation equations is closed by including the balance equations for the turbulent kinetic energy k for the premixed flame.

The second element of the simulation of the turbulence is a simulation of turbulence combustion.

The numerical procedure for solving the set of equations is based on a two-step, time splitting technique for the different physical processes. In the first step, the shock wave propagation is found by solving Euler equations using an explicit TVD scheme with Roe's average. At the second step, the diffusion processes is solved by a Cranck-Nicholson scheme and the kinetic terms are solved fully implicitly.

The behavior of DDT is demonstrated clearly, where the combustible mixture was ignited at some distance from the closed end of the tube. The first reflected pressure wave from the closed end accelerates the flame, but it is weak and DDT does not occur. When the stronger second wave reaches the flame front, then both waves move together for some time (about 50 μs). This system of coupled waves is unstable and after a few pressure oscillations the DDT is achieved.

TWO-DIMENSIONAL PROBLEM OF NON-ISOTHERMAL FILTRATION

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One of actual problems in oil extracting is the displacement of high-viscosity oils. The thermal recovery methods are used for high-viscosity oils displacement. The special concern is steam-thermal effect. It is explained by the fact that steam contains a lot of energy, than hot water. The temperature rise of a layer decreases viscosity of oil, and it influences in turn movability of oil. The mathematical model of a displacement process of oil by steam injection is described by a complex system of thermal-hydro-dynamical equations. The two-dimensional problem of a non-isothermal filtration of three-phase incompressible fluid in view of sources is considered.

$$m\frac{\partial(\rho_\alpha\sigma_\alpha)}{\partial t}+div(\rho_\alpha \mathrm{v}_\alpha)+N_\alpha=Q_\alpha$$

$$\mathrm{v}_\alpha=-\kappa\frac{f_\alpha}{\mu_\alpha}(gradp-\rho_\alpha g)$$

$$\sigma_1+\sigma_2+\sigma_3=1$$

$$div(\lambda\, gradT)-div\sum_{\alpha=1}^{3}\rho_\alpha \mathrm{v}_\alpha i_\alpha -$$

$$-\frac{\partial}{\partial t}\left(m\sum_{\alpha=1}^{3}\rho_\alpha\sigma_\alpha i_\alpha+(1-m)\rho_4 i_4\right)=Q_T$$

$$i_\alpha=c_\alpha T,\quad \alpha=1,2,4;\quad i_3=c_3T+r(T)$$

1. Converting these equations, we shall obtain equations for pressure, saturation and temperature. The boundary and initial conditions are stated. We shall obtain consistent solution of one-dimensional equations along lines and columns from two-dimensional system of equations. The difference schemes of Peesman-Recford are received with the help of a integral-interpolation method. The thermal-hydro-dynamical process of oil extraction in view of steam-thermal effect is analyzed against the results of a numerical solution. The graphs dependence of a field of pressure, saturation and temperature in accordance with time of exploitation are built.

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INFORMATION PROVIDING FOR SCIENTIFIC RESEARCH

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On the base of between quantity of heat and quantity of information the concept of information entropy is introduced.

Often scientists themselves govern of the information sources, but, do it not with due level, as a rule. Automatized searching systems not always leads to desirable result, because of necessity continuously to adapt to it. The process of the work will be more productive if information providing is under the authority of specialists, that have grounded in selection of initial materials. It should be also taking into account that necessary continually to fill up data base. Special knowledge is required for this. Without special education and practice there is nothing to think about serious information providing. So, scientist depends from inter-mediary-specialist of informatics. This mediation not only necessary, but it is inevitable.

Information for conducting scientific research includes journal papers, technical reports, extraction from books, correspondence, annotations, etc. In time this list is extended, transformed, divided into fragments and multiplied. Most of user's time is spent by initial stages of providing with identification and estimation of materials.

So for the successful work is required thought-out control of information flows and professional service. For providing effectiveness this service is also necessary skilful use of electronic computers resources. It demands in one's turn presence of specialists of informatics, providing connection between the investigator and information system. For same time, the following conditions must be accomplished: additional treatment of information search, continuous perfection of data base with estimation of it obsolete.

For phenomena of heat exchange energy measures is quantity of heat *dQ*. It should be noted, in this case potential is served temperature *T*, and co-ordinate – entropy *dS*

$$dQ=T\,dS.$$

Arise problem about possibility presentation elementary quantity of information, as it adopted in thermodynamics:

$$dQ_n=T_n\,dS_n.$$

The first factor is T_n - information potential, the second factor - information entropy S_n, which connected with obsolete of information. Rightfull of this presentation may be confirmed by experiment only. Now science arranges of volume of experimental data, which confirm this statement. Information becomes the same product as any other goods. It self information not able to increase quantity of material and cultural values. It will be of use only when it will be incarnated in technology, new practical knowledge will allow to do subsequent generalizations, etc. More over relatively science it is necessary mean two contrary effects:

a) Exponential increase of papers in time;
b) Obsolete coefficient of papers after publication.

Expansion of entropy concept on information opens new horizon for investigators and gives hope this definition will be carried to biology, chemistry, economics and other science sections [1,2].

Conclusion. Use of this concept may improve effectiveness of science research by way of skilful management of information flows.

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COMPUTER DESIGN IN MODELLING PROCESSES OF AERODYNAMICS AND HEAT-MASS EXCHANGE

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The researches of aerodynamics and heat-mass exchange in catalytic reactors with motionless granular layer (MGL) are necessary for solution of applied problems of chemical technology, nuclear power, recycling of departing gases of an industry, reburnings of emissions of a vehicle etc. In flat (radial) reactor of constant width 2H there is a movement of a gas mix to temperature and concentration. At the initial moment of time t=0 temperature of mix and concentration of reagent on an entrance reactor instantly change and get values. The concentration of an oxidizer is necessary superfluous. The share reagent in total amount of a mix is rather insignificant (within the limits of 5 %)/. Owing to, low temperature the course of chemical reaction only on catalytic of a surface H3C is supposed. The active zone represents the porous insert, established across the channel, of the given thickness. Reagent and oxidizer being filtered through MGL, adsorpted on a surface

The mathematical model of the given process represents complex system, taking into account aerodynamics, heat-mass transfer turbulent movement. System of equations was solved by a numerical method.

For evident performance of results of the numerical account the graphic package Surfer (Win32) of corporation Golden Software (fig. 1) was used, where there is an opportunity, to show contours of temperature, concentration, function of a current, vortex and other volumes. One of advantages of the given program is the visual performance, where it is possible to notice, that light image shows increasing value of researched size. Also it is possible to present the three-dimensional image of sizes, which evidently shows all process in reactor. For more complete description of processes of flow in catalytic reactor graphically have represented profiles of values at the fixed value by one variable and change another in a graphic package EXCEL97.

Therefore, for improving investigation of transfer processes in porous media use many achievements of computer technology.

NUMERICAL SOLUTION OF THE PROBLEM OF NON-PISTON FORCE OUT OIL THROUGH WATER

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In the contemporary conditions of development of Kazak oil industry the complex of problems concerning to mathematical description of the oil extraction process and to numerical solution of the filtration problem is of particular importance because only using of mathematical methods and of CS secures high quality and period reduction of the oil fields projecting.

The problem of non-piston force out oil through water described by two-dimensional differential equations Bacley- Leveretta [1] has considered in this work. It assumes that the oil-keeping stratum is thin. It allows restricting by setting its physical characteristics in plane configuration. It is necessary to arrange number of the oil-extracting drill-holes (sewers) and the drill-holes forcing water in a stratum (sources) on the plan of the oil field so that forcing out oil from a stratum would maximum effective.

As an essential economical characteristics defining efficiency of elaboration shoûld notice such as the oil-extracting volume within given time and the pumped up water volume.

The difference scheme was built for the initial differential problem [2]. The method against the flow was used in order to infer difference equation for water-saturation.

It was investigate the order of approximation and the stability of difference scheme.

The difference scheme was computed by two ways. The first way is: at the beginning, the pressure is computed at the fixed water-saturation through iterative method of alternate directions then the water-saturation is found evident. In the second way, to compute the pressure on every iterative layer uses the method of paralleling of skip [3]. There it is necessary to take into consideration possibility of conducting parallel solving of the subproblems on computers and the presence of programming language facilities, which allow the programming of parallel computing algorithm.

It was conducted the analysis of numerical calculations and built graphics for water-saturation and for pressure and also graphics of the pumped up water number and of yield oil.

Calculations were conducted for different installation schemes of pumped and taken drill-holes.

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USE OF INFORMATION TECHNOLOGIES AT MODELING THE PHYSICAL PHENOMENA

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Modeling physical processes is considered on the basis of special computer system 2x2. As examples the tasks about the own and compelled fluctuations, resonant phenomena in electromagnetic systems, about movement of the charged particles in homogeneous electrical and magnetic fields, about standing waves are resulted at fluctuations of a string (fig. 1).. The modeling is executed on the basis of the analytical and numerical decisions of the differential equations in ordinary or private derivative. However computer experiments do not require knowledge of mathematical models of process and methods of their research.

In computer system for each task the set of entrance parameters is resulted which the experimenter can change according to the purpose of research. The course of process is illustrated by a window of so-called statistics. In this window the change of physical sizes describing a condition of system is shown. The results of modeling are studied with the help of various functional dependencies. The experimenter chooses from the offered list physical sizes, which change in time (and in space) is interesting for investigating, and will carry out(spend) experiment on influence of parameters on dynamics of investigated process. It is necessary to note, that is possible to deduce on the screen at once some diagrams in one window or various dependencies - in different windows.

Accounts "is invisible are connected" to dynamic illustrations investigated process. Frequently together with researched process the similarly proceeding process in system of other physical nature is shown. The dynamic illustrations are deduced on the screen simultaneously with graphic illustrations of process. To each task there is a prompt, which adjusts the user on study of the concrete phenomenon. The executed experiment promotes understanding of a physical picture of the researched phenomenon.

The offered complex of computer physical experiments can be extended. It can be used as a demonstration material at a statement of especially complex themes on physics in high school, technical school and school, and also students and schoolboys at independent study of the physical phenomena.

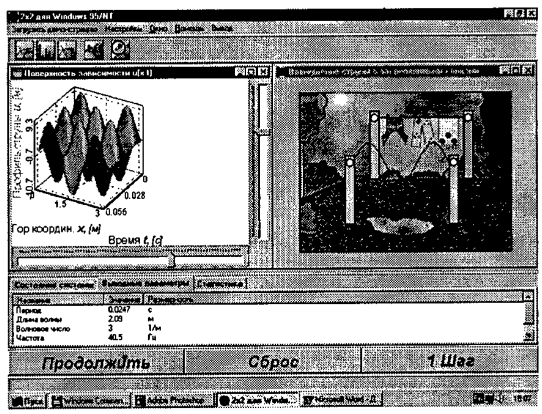

Fig.1. Dynamics of fluctuations of the string with the fixed ends in space and time.

COMPUTER MODELLING OF THE PROPAGATION AND INTERACTION OF SEVERAL FLAMES

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Numerical simulations of several methane-air flame in closed vessels with a square cross-section 10·l x 10·l and length L=30·l are presented solving the Navier-Stokes equations in the low Mach number limit given by Majda [1] for reactive systems, where l = 0.5mm is the flame thickness. A single step, irreversible reaction of Arrhenius type [2] is used,

$$d\,[CH_4]/dt = -C\;[CH_4][O_2]\exp(-T_a/T),$$

where C =2 .4 ·10 10 m^3 /(mol ·sec) and T_a =24370 K^0.

The numerical algorithm is the following: In the first step of the computation the temperature and mass fraction of the fuel are calculated from the conservation equations and solved by a Crank-Nicolson scheme. The thermodynamic pressure is also calculated from the conservation equation, and density is obtained from the equation of state. In the closing step, velocities and the dynamic pressure field are found using a projection method [3]. The Poisson equation for pressure is solved by an SOR-method.

A series of computations for a Reynolds number of $Re=U_n \cdot l/\nu=12.5$ shows the effect of flame number on flow fields, where U_n =0.4 m/sec is the burning, ν is the viscosity coefficient.

A several line igniters with circular cross-section, placed at the several positions of the vessel, initiates the combustion in a stoichiometric mixture of methane and air. The results show an increasing flow effect with increasing flame number.

The propagating flame due to its baroclinic behavior generates vorticity. Before the flames reaches the side wall and each other, the shape of flames is convex and vorticity is being formed into sheets arranged ahead and behind of the flame with opposite signs. After reaching the side wall and each other the flame becomes in places flat and vorticity sheets brake in o few vortex pairs with alternating signs. Those vortices deform the flame surface making it wrinkled and larger, indicating that superposition of this voritcal flow on the dominant expansion flow results in a rather complex behavior of flame. This numerical technique was also applied o cases where the combustion initiates inside and/or at a few positions inside the vessel simultaneously. The generation a vortical flow by several flames as well as interactions of those flows, the deformation of one by others, and also the flame shape as well are investigated.

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ABOUT DEFINITION OF A VARIABLE PERMEABILITY OF OIL BED ON ACTUAL DATA

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At exploitation of oil-fields collector property of oil bed frequently change. The purpose of the present work is the refinement of a variable permeability of oil bed. Also we offer a way of usage of the updated data for the forecast and optimal regulation of oil extracting. The outcomes of researches can be utilised for obtaining cards having collectoring properties of oil bed, and also for address geologic models offered in work [3].

The equation for pressure at an elastic mode of a filtration in two-dimensional case can be written as

$$\frac{\partial P}{\partial t} = \operatorname{div}(\chi(x,y)\nabla P), \qquad (1)$$

The boundary conditions preset on boundaries $\partial\sigma_j$ of each well and on an outer boundary of oil bed $\partial\sigma$:

$$\frac{h}{\mu\beta}\int_{\partial\sigma_j} k(x,y)\frac{\partial P}{\partial n}dl = q_j,\ j=\overline{1,M}, \qquad (2)$$

$$\frac{\partial P}{\partial n}=0, \quad \text{for } (x,y)\in\partial\sigma \qquad (3)$$

Where M - quantity of wells. For short closing of model the pressure in an initial instant is added:

$$P(x,y,0)=P_0(x,y). \qquad (4)$$

Besides the additional boundary conditions are set

$$P(x,y,t)=\widetilde{P}(x_j,y_j,t) \text{ for}$$

$$x=x_j, y=y_j, \qquad (5)$$

Where (x_j, y_j) — of coordinates of wells; $\widetilde{P}(x_j,y_j,t)$ — the actual data in miscellaneous instants.

Let's construct a functional as follows:

$$J=\sum_{j=1}^{m}\sum_{i=1}^{n_j}\left[\widetilde{P}(r_j,t_i)-P(r_j,t_i)\right]^2, \qquad (6)$$

Key feature of the tendered approach is that on each iteration it is required to decide only two partial equation irrespective of number of defined parameters, number of wells and spatial step of a grid. The role of control variable is played by an obscure permeability k (x, y), which one is determined so that to minimize criterion of quality (6).

The numerical experiments are conducted with usage of the actual data on an oil-field Karazhanbas [3]. On an offered technique it is possible to define other filtration parameters with reasonable accuracy, and then under the obtained data to execute demanded forecasting calculations.

INTERVAL STABILITY OF THE ELEMENTARY IMMUNOLOGICAL MODEL

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Now in immunologic, which is a part of a subject domain of mathematics, the theoretical researches are conducted. The analysis of dynamic properties of mathematical immunological models promotes knowledge of a nature and laws of simulated processes. The immunologic mathematical systems can be related to a class of the objects functioning in conditions of limited uncertainty, belonging to the given sets.

The elementary model [1] of immune reaction of organism on intrusion of viruses is considered.

The system has two stationary regimes.First of which is treated as a healthy condition of organism, second — as chronic disease.

The behaviour of system in a vicinity of stedy-state points is considered.

The characteristic equation, that was linearized in a vicinity of X_{II} [2] is given.

The parameters of system are interval meanings.

The parameters of system are inexact, so it is necessary to investigate an arrangement not one quazi-polinom , but the whole family such quazi-polinoms and all allowable meanings of parameters.

In work [3] the conditions ensuring asymptotic stability of system at all allowable meanings of parameters of system are found.

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THESIS OF THE ARTICLE "CARTOGRAPHIC AND MATHEMATICAL MODEL OF SOIL PARTICLE TRANSFER"

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This report is about a program that gives quantitative and qualitative picture of solid particle transfer in any number of iterations for the specified relief and the topsoil density.

The program offers to

- Get quantitative and qualitative evaluation of solid particle transfer in specified number of rains or snow melting days
- Create cartographic and mathematical model that estimates a rate of topsoil area changes with regard for time and morphometric relief features.

To work with the program it is necessary

- To create a data file (file of the denudation zone) in MS Excel or Surfer. In the file the first column is an X coordinate, the second column is an Y coordinate, the third column is a Z coordinate, and the forth column is a specified topsoil distribution. Note that data of first two columns have to be given with an even step.

To start the program you should run "pollut.bat" file that is in the same catalog where the data file is.

Output data of the program are solid particle accumulation files in which first two columns are similar to first two columns in the data file, and the third column is a topsoil distribution corresponding to a specified iteration. Except for computational data the program gives created by Surfer file-maps that are two- and three-dimensional models.

To approve the program country between two rivers – the Talgar and the Issyk - was chosen.

Iteration *is a period equal to a rain or a snow melting day within which a particle (a mineral) travels a road from the "starting" point to the ultimate one (point of temporary or constant denudation basis)*

In the model 2000 iterations were calculated. Data output was yielded in the 400^{th}, 800^{th}, 1200^{th}, etc. steps.

The described model and designed on its basis program can be widely used in evaluation of experts ecologically unstable areas such as oil product extraction regions, territory of former nuclear polygons, as well as find a use in researching geomorphologic processes, etc.

NEW APPROACH TO THE NUMERICAL SOLUTION OF THE PROBLEM OF FORECASTING THERMOHYDRODYNAMIC PROCESS IN A POROUS MEDIUM

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In this work the process of nonisothermal filtration of two incompressible immixing fluids is described by a system of three partial differential equations, where unknown functions are pressure, water saturation and temperature. It is assumed, that initial pressure, saturation and temperature profiles are known. Depending on particular version of mining different combinations of boundary conditions which have to be preset at bed boundaries, operational and injection wells are possible [1, 2].

The flow version of the numerical calculation is suggested for the solution of the formed boundary value problem. The calculation sequence order is connected with physics of thermohydrodynamic process which takes place in the bed. Perturbed state of the filtrational flow depends on pressure. Heat flow is an immediate characteristic of the temperature. Then mathematical model can be supplemented by a system of three linear equations, thereby improving thermohydrodynamic forecasting of expulsion of oil with the heat-carrier.

The set of linear and non-linear equations is solved by two-step finite differences method. As a result we have a system of linear algebraic equations with scalar matrix. Problems of stability and convergence of difference networks are considered [3]. The main practical yardstick of time-step selection is limitation of value of maximum change of saturation and temperature for one time-step. Numerical calculations for a concrete oil deposit where heat-carrier is hot water are made.

The main difference of above-stated model is the formed algorithm of thermal and filtrational flows calculation. Thus computing scheme is simplified and the consideration of temperature effect on parameters of oil expulsion by hot water is better forecast.

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SIMULATION OF DYNAMICS OF A TUNNEL IN WATER-SATURATED MEDIUM

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The model problem of effect of periodic loads on a tunnel is considered which is in the porous saturated medium. The tunnel is supported thin cylindrical shell, on which the periodic moving load operates. The task of seismic effect on a tunnel is reduced to a load, moving with supersonic speed. As a model water-saturated of medium the model M. Biot - two-phase system a fluid - rigid body considered as the uniform dynamic system is selected. The moving of shell is described by the classical equations of the theory of thin shells [1]. The contact between a shell and enclosing massif is supposed rigid, that is the offsets of a shell are equal to offsets of the array on boundary, and the shell is considered water-proof. The task is decided(solved) by a method of a separation of variables in a sliding coordinate system. The moving of an elastic skeleton and liquids in the environment M.Biot are represented through potentials of volumetric and shift waves [2]. Solution of the equations satisfying to conditions fading on infinity, are the Fourier - Bessel series with indeterminate constant coefficients, which are defined with the help of boundary conditions. The components of moving of a shell and component of a vector of a load are decomposed in Fourier series. From boundary conditions the resolving linear infinite system of the algebraic equations is obtained which is decided(solved) by a method of reduction.

The software package of definition of moving both powers of the environment and shell on the FORTRAN language is composed.

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PROGRAM REALIZATION DEFINITION OF INTERACTION FORCE OF WELLS

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The petroleum deposits of Kazakhstan have no due processing of the numerous data, which arise from the moment of development oil&gas of a deposit and collect during its development. Between that the realizations of the effective analysis and use of opportunities of computer processing of the information with the help of mathematical methods allow much more easy to watch the numerous factors, which determine efficiency of a developed deposit.

The tasks connected to study of dependence's between researched technology factors, distinct from strictly functional, are rather various by development of petroleum and gas deposits. At the appropriate statement they get more certain kind and can be solved within the framework of mathematical-statistical research.

Such separate cases, when the dependence obviously is not functional, are studied by device of the correlation analysis.

With reference to the correlation theory count, that for each object, interesting for us, of research are supervised and are measured simultaneously two attribute.

Supervision are pair of numbers, and the results of measurements represent n of pairs of meanings(importance) $(x_1, y_1), (x_2, y_2), \ldots, (x_n, y_n)$, which can be interpreted as realization casual of a vector (X, Y). From the theory it is known, that the information on character of communication of sizes X and Y will be given by(with) selective factor of correlation r_{xy}.

As well as for casual size for a casual vector (X, Y) the basic numerical characteristics are selective average $\bar{x}$ and $\bar{y}$ and disperse S_x^2 and S_y^2.

SECTION
“INFORMATION TECHNOLOGIES
AND INDASTRIAL CONTROL”

Extension Method for Allocation of Resources in Parallel Structure Systems

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Resume.

The work proposes a simple and detailed procedure for solving some optimization problems with possible, but not required near singularity of a constraint matrix. This procedure solves the original problem by a directed transition to the optimal solution from the point corresponding to the optimal solution of a simpler problem with an expanded set of feasible solutions.

Keywords: *Parallel structure systems, optimization, extension method, small parameter*

Introduction. In applied work one often encounters optimization problems in which a homogenous resource, or load should be distributed optimally between different competing uses (or parallel objects). Limitations and special characteristics of these competitive uses determine a set of linear constraints on a feasible set of solutions. There are many ways to solve the problem directly. However, if the different competing uses (parallel objects) have very similar characteristics then the system of constraints may have a near singular matrix. If this is the case, then the usual methods of mathematical programming give unstable and, therefore, unreliable solutions. In addition, the direct methods of solving such problems involve significant computational difficulties. A.N. Tihonov [1] considered the problem of finding approximate solutions for systems with singular matrixes. Then, his ideas were applied for solving optimization problems with near singular constraints matrix. For instance, A. A. Pervozvankiy [2] proposed the Method of Disturbances for optimization problems. The essence of the method is that one should start from finding an approximate solution of a problem with a singular constraints matrix, which is derived from the original problem by treating small differences in constraints as disturbances, and ignoring them on this first step. After the approximate solution is found, the characteristics of the derived problem are usedto estimate the effect of the disturbances on the optimal solution. Although this method has a valuable theoretical significance, its computational procedure requires formidable restrictions on the nature of singularity and gives only very approximate solutions. Our work proposes a simple and detailed procedure for solving some optimization problems with possible but not required near singularity of a constraint matrix. This procedure solves the original problem by a directed transition to the optimal solution from the point corresponding to the optimal solution of a simpler problem with an expanded set of feasible solutions. The advantage of the procedure is that it is not only insensitive to singularity of a constraint matrix, but it is also more efficient compared with standard methods of mathematical programming used for solving this class of problems.

General structure of the relationship between solutions of the original and expanded problems

Let us formulate the problem of resource allocation (PRA) among parallel aggregates with the objective of maximizing some output of the system.

$$\max F = f(\mathbf{x}), \qquad (1)$$

subject to the constraints

$$g(\mathbf{x}) \le S, \tag{2}$$
$$E\mathbf{x} = S_m, \tag{3}$$
$$V \le \mathbf{x} \le W, \tag{4}$$
where E is $1\times n$ raw vector of ones, $f(\mathbf{x})$ and $g(\mathbf{x})$ are continuously differentiable functions which may be written as follows: $f(\mathbf{x}) = f_0(\mathbf{x}) + \varepsilon f_1(\mathbf{x})$; $g(\mathbf{x}) = g_0(\mathbf{x}) + \varepsilon g_1(\mathbf{x})$

Let us introduce an auxiliary expanded problem of resource allocation (PRA), obtained from the original problem by disregarding constraint (2).
$$\max F = f(\mathbf{x}), \tag{5}$$
subject to constraints
$$E\mathbf{x} = S_m, \tag{6}$$
$$V \le \mathbf{x} \le W. \tag{7}$$
Now it is necessary to find the relationship between solutions of the original (1)-(4) and the expanded (5)-(7) problems. This will allow us to find a solution to the relatively complex original problem by solving the simpler expanded one.

The value of the objective function (5) of the expanded problem at its optimal point is the maximum possible value of the objective function (1) of the original problem, because feasible set $\mathbf{X}$ of the original problem is a subset of feasible set $\mathbf{X}^P$ of the expanded problem $\mathbf{X}\subseteq\mathbf{X}^P$. That is why, a movement from point $\mathbf{x}^P\in\mathbf{X}^P$ to another point $\mathbf{x}\in\mathbf{X}$ will decrease the value of the objective function, or, in other words, this movement will be a "descent" from $f(\mathbf{x}^P)$ to a lower value of the objective function. The general procedure for solving the problem with the "extension" method is as follows:

I. Solve the expanded problem.

II. Check whether this solution satisfies constraint (2) of the original problem. If it does, then it is optimal. If it is not, then go to the next step.

III. Chose the direction and the distance of a descent.

IV. Shift to the new solution.

It is obvious, that the new solution, obtained as a result of the shift, will be optimal, if the descent in the chosen direction leads to the least possible change in the value of the objective function compared with other directions.

The Extension Method for solving nonlinear optimization problems

Let us explore the extension method for solving nonlinear optimization problems using an example with a quadratic objective function.
$$\max F = (\mathbf{cx} + \mathbf{x}^T\mathbf{Dx}), \tag{8}$$
$$\mathbf{Ax} \le \mathbf{S}, \tag{9}$$
$$E\mathbf{x} = S_m, \tag{10}$$
Assume that the matrix **D** is a negative definite matrix. The expanded problem is:
$$\max F^e = (\mathbf{cx} + \mathbf{x}^T\mathbf{Dx}), \tag{11}$$
$$E\mathbf{x} = S_m, \tag{12}$$
This problem can be solved with the Lagrange multiplier method.
$$\frac{\partial L}{\partial x_i} = \frac{\partial F(\mathbf{x}^e)}{\partial x_i} - \lambda = 0, \tag{13}$$
are determined from the following formula
$$\frac{\partial L}{\partial \lambda} = \sum x_i - S_m = 0. \tag{14}$$
Solving the system of equations (13) - (14) we can find $\mathbf{x}^e$ and λ.

Now we expand the function $F(\mathbf{x})$ into a Taylor series of order two about the point $\mathbf{x}^e$:
$$F(\mathbf{x}) = F(\mathbf{x}^e) + \nabla F(\mathbf{x}^e)\mathbf{h} + 0.5\mathbf{h}^T\mathbf{Hh}. \tag{15}$$
Consider the second and the third terms of (15) separately
$$\nabla F(\mathbf{x}^e)\mathbf{h} = \left(\frac{\partial F}{\partial x_1},\dots,\frac{\partial F}{\partial x_k},\dots,\frac{\partial F}{\partial x_l},\dots,\frac{\partial F}{\partial x_n}\right)\times\begin{pmatrix}0\\ \vdots\\ -h_{kl}\\ \vdots\\ h_{kl}\\ \vdots\\ 0\end{pmatrix} =$$
$$= 0 + \dots + \left(-\frac{\partial F(\mathbf{x}^e)}{\partial x_k} + \frac{\partial F(\mathbf{x}^e)}{\partial x_l}\right)\times h_{kl} + \dots + 0.$$
But from (13) it follows that
$$\frac{\partial F(\mathbf{x}^e)}{\partial x_k} = \frac{\partial F(\mathbf{x}^e)}{\partial x_l} = \lambda,$$
then $\nabla F(\mathbf{x}^e)\mathbf{h} = 0.$

$$0.5\mathrm{h}^T\mathrm{Hh} = 0.5(0,\ldots,-h_{kl},\ldots,h_{kl},\ldots,0)\times$$

$$\times\begin{pmatrix} 2d_{11} & \ldots & d_{1k} & \ldots & d_{1l} & \ldots & d_{1n} \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ d_{k1} & \ldots & 2d_{kk} & \ldots & d_{kl} & \ldots & d_{kn} \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ d_{l1} & \ldots & d_{lk} & \ldots & 2d_{ll} & \ldots & d_{ln} \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ d_{n1} & \ldots & d_{nk} & \ldots & d_{nl} & \ldots & d_{nn} \end{pmatrix} \times \begin{pmatrix} 0 \\ \vdots \\ -h_{kl} \\ \vdots \\ h_{kl} \\ \vdots \\ 0 \end{pmatrix} =$$

$$= (d_{kk} + d_{ll} - d_{kl})h_{kl}^2.$$

Then the formula (15) can be rewritten as follows

$$\mathrm{F}(\mathbf{x}) = \mathrm{F}(\mathbf{x}^e) + (d_{kk} + d_{ll} - d_{kl})h_{kl}^2.$$

Due to linearity of constraints, we can substitute the value of h_{kl}:

$$\mathrm{F}(\mathbf{x}) = \mathrm{F}(\mathbf{x}^e) - (d_{kl} - d_{kk} - d_{ll})\frac{(S_t^e - S_t)^2}{(a_{tk} - a_{tl})^2}.$$

Postulate. The point $\mathbf{x} = \mathbf{x}^e + \mathbf{h}$ is a solution of the problem (8) - (10) if and only if, the parameters t, k, l in the formula $h_{kl} = \frac{S_t^p - S_t}{a_{tk} - a_{tl}}$. are determined from the following formula

$$\beta = \max_{t\in I_H} \min_{(j,j+p)\in N_B} \left\{ (d_{kl} - d_{kk} - d_{ll})\frac{(S_t^e - S_t)^2}{(a_{tk} - a_{tl})^2} \right\}.$$

This postulate can be proved in the same way as the Postulate for linear PRA [3].

The structure of the algorithm for solving the quadratic PRA is similar to that one for the linear PRA.

Step 1. Solve the expanded problem (11) - (12).

Step 2. Check whether the obtained solution $\mathbf{x}^e$ is in the feasible set of the original problem. If the solution satisfies all the constraints (9) then it is optimal. Otherwise go to the step 3.

Step 3. Calculate

$$\gamma_{kl} = d_{kl} - d_{kk} - d_{ll},\ k = 1,2,\ldots,n,$$

$$l = k + m \quad \forall m = 1,2,\ldots,n-k$$

and determine a set of possible directions N_B of a descent from the following

$$N_B = \{(k,l) \mid \gamma_{kl} > 0\}.$$

Step 4. Determine the optimal direction of a descent (k^*,l^*) from the following condition

$$\beta = \max_{t\in I_H} \min_{(k,l)\in N_B} \left(\gamma_{kl} \frac{(S_t^e - S_t)^2}{(a_{tk} - a_{tl})^2} \right).$$

Step 5. Calculate the value of a descent in the selected direction

$$h_{k^*l^*} = \frac{S_t^e - S_t}{a_{tk^*} - a_{tl^*}}.$$

Step 6. Shift to the new solution $\mathbf{x} = \mathbf{x}^e + \mathbf{h}$ and go back to the step 2.

Conclusions. Unlike other methods of mathematical programming, the proposed procedure for solving optimization problems of resource (load) distribution makes it possible to find precise and stable solutions even when the matrix of linear constraints on a feasible set is a near singular one. Other advantages of the procedure such as simplicity and relatively fast convergence decrease computational costs of finding an optimal solution.

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Application of Decision Making Theory for Forming a Scientifically-Jostled Curriculum specialty

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Annotation.
In work are considered the matters of application of a theory of coming to decisions for forming the curriculum of the speciality. There is shown that the variety and inconsistency of requirements to the curriculum, necessity of the registration of large number of the heterogeneous factors at working out a curriculum of the speciality, boundedness of temporary resources on preparation of the specialists do the problem rather complicated, labour-consuming and badly formalized.
The forming of the curriculum is considered as process of coming to decisions on a set of alternatives and restrictions in a class of problems with fuzzy conditions.
Keywords: *a curriculum, alternatives, coming to decisions, matrix of the connection of disciplines, function of belonging, a mathematical model.*

Introduction· The raise of the quality of preparation of the experts with higher education in modern conditions of the transition to market economy, of the perfecting of an engineering and technology, is the most important task of high schools. Alongside with the tasks of improving educational process, the primary value gains a problem of forming of scientifically justified curriculums of specialities, on which the preparation of students is carried out. The curriculum of a speciality is the basic educational-methodical document, defining quality of preparation of the students in high school, and making up in the correspondence with the established standards on the basic of qualifying requirements to the expert as populations of knowledges, gained by him, skills and experiences. The compiling of a curriculum can be represented as the iterative procedure of a sequential choice of disciplines and order study of its, content and volumes (in hours) lecture, practical and laboratory occupations with allowance for of temporal and other restrictions. The last science technical reachings, tendencies and perspectives of development of the given field of knowledges, and also practical requirements of the potential customers (science, education, commercial production) to the graduates of high schools should be taken into account for forming a curriculums.

Earlier in work [1], there was well-founded and was formulated a task of making up of the scientifically-justified curriculum of a speciality by authors. There is shown that the variety and inconsistency of requirements to the curriculum, necessity of the registration of large number of the heterogeneous factors at working out a curriculum of the speciality, boundedness of temporary resources on preparation of the specialists do the problem rather complicated, labour-consumed and badly formalized.

The process its decision was represented as the procedure of a decision making on a set of alternatives of a choice of educational disciplines, definition of a content and volume of an investigated material in hours on all aspects of occupations, assigning of control measures at a set of restrictions represented by a sequence of study of disciplines and a temporary load of the students. For a decision of the task, the function of the purposes for installation by the order on a set of alternatives and permitting to compare, its should be given. This is to evaluate a prize (or loss) as a result of choice of this or that alternative. In this case it is possible to speak about searching an optimum decision in a sense of its maximum on a set of variants of a curriculum.

In general case, the criterion of an optimality should reflect quality of preparation of the speciality , which is offered for evaluating by a total of knowledges, skills and experiences, gained by the graduate of high school. Therefore forming a curriculum was conducted on the basis of qualifying requirements to the specialist, which is defined by the operating standards of education. Further with engaging of the qualified teachers was composed the full list of knowledges, skills and experiences, necessary to specialist as totality of disciplines, their sections and separate subjects. For this purpose, there is offered a multi-stage procedure of the sequential construction « of a hierarchical tree » of the purposes of tutoring - from the common "outputing" requirements for the graduate to concrete knowledges, skill and experiences which he should acquire by studing of all disciplines of a curriculum. As a rule, a degree detailings is limited by volume of theoretical knowledges, which can be given to the student for one academic hour of the lectures one hour of practical and laboratory works can be given and similarly for skills and experiences. For each unit of discipline, the appropriate sections of adjacent disciplines were indicated. On the basis, the matrixes $A = (a_{ij})$ and separate columns of logical connection of disciplines and their sections were constructed. The elements of a matrix a_{ij} accept a value 1 or 0 on intersection of i-that line and j-that column, if the informations from j-that discipline are used in i-that discipline. On basic of it, of analysis of the interconnection of sections of disciplines in the correspondence with [2] the matrixes of degrees of connection of sections, factors d irect and inverse of using of sections of disciplines were defined. With allowance for it, and also with engaging of the experts from industrial firms, research, educational and design organizations the degree of importance of those or other knowledges and skills for the specialist of the given profile was determined. The quantitative evaluation of importance of those or other knowledges is offered to be realized with use « of rules of an indistinct conclusion », offered by Jger, putting in the correspondence to it some number (from 1 up to 0), appropriate it «is "extremely necessary" for linguistic concepts from up to « there is no necessity ». Moveover, evaluation of a degree of importance of knowledges, skills and experiences volume of hours of an educational load (lecture, practical and laboratory occupations) on the given section of educational discipline posed in the correspondence forming this knowledge and which was identified with such linguistic concepts as "«maximum full" and "«minimum necessary" assimilation of a subject. Accordingly, there were determined the ranks a degree of importance of disciplines for forming the expert of the given profile and the necessity of inclusion in a curriculum of course works and projects, availability of examination and (or) offset posed to it in the correspondence.

The conducted preliminary work has allowed to formulate statement of the task of a determination of a «optimum" curriculum. At what has appeared, that it is expedient for realizing in a class of the tasks of a decision making in fuzzy conditions. It is explained by two circumstances. On the one hand requirements to a curriculum have a fuzzy character - « the greatest possible meeting requirements to knowledges, skills and experiences », « the educational load of the students should make $T_{min} \leq T \leq T_{max}$ of hours per one week », the amount of examinations and offsets in a semester etc. On the other hand, choice of function of preferability is similar, installation of strict order on a set of alternatives with allowance for systems of restrictions and the construction of the procedure of searching meets serious difficulties. While in theory decision makings in fuzzy conditions [3], criterion and the restrictions are set as functions of a membership, and the resulting decision is received by intersection of all specific purposes and restrictions, that considerably simplifies statement and solution of the task.

In general view, if X = {x} set of alternatives, where x in our case is identified with disciplines, their sections characterized by correlation, as some ordered sequence and volumes of hours, and also some number χ smaller unit, defining importance of datas of sections of disciplines for a curriculum, function of a membership for criterion $\mu_G(x)$ was generated as:

$$\mu_G(x) = \begin{cases} 0 \text{ если } \chi(x) < \chi^0 \\ (1+(1-\chi(x))^2(\chi(x)-\chi^0)^{-2})^{-1} \quad (1), \\ \text{если } \chi(x) \geq \chi^0 \end{cases}$$

where χ^0 - is set by a face accepting a decision at calculation of variants of a curriculum and determines a low bound of a degree of importance of disciplines and sections which are included in an curriculum.

The function of a membership for restriction $\mu_C(x)$, for example, on an amount of hours of a week educational load of the students looks like:

$$\mu_{C_1}(x) = (1 + a(\sum_i \sum_j \sum_m q_{ijm}(x) - T)^{\alpha})^{-1} \qquad (2)$$

where q_{ijm} - amount of hours of tutoring on i-that discipline, that aspect of an educational load in m-ном a semester; a - normalizing positive number and - the positive even number selected so that to transmit a sense, in which is necessary to understand « an approximation to an interval T_{min}, T_{max} ».

The functions of a membership and for other restrictions are similarly noted.

In the correspondence from 3 fuzzy solutions, or the decision is simplis is determined as a fuzzy set R in space of alternatives obtained in an outcome of intersection of the specific purposes G and restrictions C.

$$R = G \cap C. \qquad (3)$$

Thus the function of a membership for a product of sets $\mu_{G \cap C}(x)$ is set by a relation

$$\mu_{G \cap C}(x) = \mu_G(x) \wedge \mu_C(x) \qquad (4)$$

If there is several restrictions function of a membership to fuzzy area of solutions will be noted as:

$$\mu_R = \mu_G(x) = \mu_G \wedge \mu_{C_{11}} \wedge \mu_{C_2} \wedge \ldots \wedge \mu_{Ck} \quad (5)$$

The searching of variants of a curriculum because of the equations (1), (2), (5) was carried out with the help of of heuristic algorithm realizing iterative procedure of deriving of variants of a plan with inclusion in a plan of disciplines and their sections in the correspondence with their significance level at various specific values . 0, and consequent evaluation of a plan the experts. For a decision of the task the program complex including a mathematical model of a purely educational plan P, which, in common as is represented as follows was developed:

$$P = \Gamma * Q * D * E \qquad (6)$$

Where Γ $\{r_{jnm}\}$ - graph of the educational process, where r_{jnm}- a logic variable (1 or 0) defining availability in n week m of a semester of a curriculum of j-that aspect of the educational process, in this case this theoretical tutoring, examination session, vacation; practice etc.;

Q $\{q_{ijm}\}$ - volume of an educational load, where q_{ijm} - amount of hours of a week educational load on i to discipline, j- to a that aspect of an educational load in m a semester;

D $\{d_i\}$ - enumeration of disciplines;

$\{r_{jnm}\}$ - distribution of examinations, offsets, course projects and works of disciplines on semester, where r_{jnm} - logic variable (1 or 0) defining availability in an educational plan of examinations, offsets, course projects or works;

(*) - conditional operation appropriate to join of sets.

The offered approach was used for shaping and adjustment of a curriculum of a speciality 3603 «Automation of technological processes and productions ». At the first stage the task was decided for a cycle of special disciplines of emiting faculty. In particular, with engaging of the experts the practical necessity of magnification of an amount of hours of tutoring in course TAR till a digital control system was detected in connection with broad application in an industry of microcontrollers. Therefore new discipline « Digital control systems » is entered into a curriculum the introduction in a curriculum of discipline « Program - engineering complexes of disrtibuted control systems on basis of microcontrollers » is similarly justified.

The program complex of shaping of an educational plan of a speciality is developed in an environment space Visual FoxPro, within the framework of created in КазНТУ computer is informational - controlling systems of university (subsystem of coordination of the educational process).

Inference. In work are considered the matters of simulation of processes to decision forming of a curriculum of a speciality, as the tasks specific in fuzzy conditions with an indistinct criteria evaluation. The offered approach allows to automize activity of a face accepting a decision, that has enabled is justified to develop a curriculum on an example of a concrete speciality.

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Mathematical Models of Collective Behavior of Robotic Systems by Methods of Discrete Analysis

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Resume

The methods of construction the mathematical models of robotic systems' grouping plan was devised by means of the mathematical apparatus of R-function application. The task of construction the grouping plan was formulated as the optimization task. The algorithm of it's solution was propounded.

Keywords: *the robotic system, the grouping plan, the robot, the workspace, the trajectory, the manipulator, the gripping mechanism, the kinematic junction, the R-function, the degree of mobility.*

Introduction. Effectiveness of robotic systems (RS) in many respects depends on correct choice and construction of the grouping plan (GP) [1].

Modeling is the effective instrument which permits to investigate RS's properties without resorting to the real designing on a stage of the avanplanning It is essential especially in cases of joint industrial robots (IR) to the technological processes, the technological equipment (YE) with invariable mutual disposition and arrangement

Elements of RS's GP are geometrical objects, IR with the manipulator (M), the base and the workspace (WS). TE situated on a selection of the robotization within accessible zone is also the element of the GP.

The task of the GP construction consists of determination IR's and the TE's mutual disposition when the following conditions are executed:

- the trajectories of motion, necessary for execution of the robotizated operation (RO), have to enclose IR's WS;
- TE and IR mutual determination has to provide the incollision of the manipulator's (M) links with the TE's surfaces during the RO.

Account the elements GP RS which represent the geometrical objects, usually with complicated arrangement is possible using graphic and analytic methods [2].

Application of graphic modeling leads to necessity of construction complicated modeling algorithm. Account of spatial figures by the analytic geometry in space methods, as the totality of second sequence plans and surfaces crossing, comes to unwieldy and complicated analytic expressions. The expressions represent significant complication while programming.

When logical expressions in particular the mathematical apparatus of R-function is used, the condition of analytic formulas and procedure of their program realization are essentially simplified. The mathematical apparatus of R-function allows to use all advantages of logic algebra in the classical mathematical analysis.

Arrangement of any geometrical objects can be represented as an aggregate of crossed elementary surfaces. The aggregate can be described as a logical expression:

$$D_1 L D_2 L \ldots L D_r = 1 \qquad (1)$$

where D_i $(i=1,2,\ldots,r)$ - is the logic variable determined by the following expression:

$$D_i = \begin{cases} 1, \text{if } D_i(x,y,z) \geq 0 \\ 0, \text{otherwise} \end{cases}$$

where $D_i(x,y,z) \geq 0$- is a i-th part of space restricted by the elementary surface. This surface is accounted by the simplest inequality, which determines the border of the

geometrical object;
r- is a number of the elementary surfaces;
L- is a symbol of the logic operation (conjunction, disjunction, negation).
On the base of (1) R-function, which describes the geometrical object, have to be made:

$$(D_1(x,y,z) \geq 0)L^r(D_2(x,y,z) \geq 0) \\ L^r \ldots L^r(D_r(x,y,z) \geq 0) = 1 \qquad (2)$$

where L^r -is the symbol of the logic operation.
Let's consider A_j ($j=1,2,\ldots,\ell$) are points with the coordinates $(\overset{*}{x}_j, \overset{*}{y}_j, \overset{*}{z}_j)$. This point can be turned out dividing the trajectory of movement, necessary for the RO execution, on segments with $\Delta\ell$ length. (ℓ-1) is equal to number of $\Delta\ell$ segments on which the trajectory is divided. Let's call A_j points as characteristic.
The condition of enclosing of the workspace trajectory of IR can be represented by the following expression [4]:

$$((\forall A_j(x_j^*, y_j^*, z_j^*), j = 1,2,\ldots n : (R_1(x,y,z) \geq \\ \geq 0)L^r \ldots L^r(R_r(x,y,z) \geq 0) = 1) \qquad (3)$$

where $R_i(x, y, z) \geq 0$ ($i=1,2,\ldots,r$) - is an inequality, which determines the border of the WS by analogy with (1).
Position of the IR's gripping mechanism defines by the generalized coordinates, which have q_i degree of mobility (DM). Moreover, q_i have the restrictions, which are determined by an expression:

$$q_i^H \leq q_i \leq q_i^B, \ i=1,2,\ldots,n \qquad (4)$$

where q_i^H, q_i^B - are the lower and the upper limits of the generalized coordinates of the i-th DM;
n- is a number of DM.
The workspace (WS) of the IR can be divided on subspaces $P_n, P_{n-1},\ldots,P_1$. The arrangement of the subspaces are determined by the kinematic structure of the manipulator (M) and by the restrictions (4). If numeration of the DM was made step by step, beginning from the kinematic junction, which joins M with the IR's base, the P_i subspace is the WS. It is so on condition that the DM with number n,n-1,…,n-i are used for the manipulation. A volumetric arrangement of the manipulator's links was given with help of the border points x_{ik_i}, $i=1,2,\ldots,n$, $k_i=1,2,\ldots,m_i$, where
n- is a number of the manipulator's links, which are used for designation of the i-th link's volumetric arrangement.
If the type of the kinematic junction is known (usually rotation or transference), then dependence of the x_{ik_i} points coordinates from the i-th generalized coordinate can be determined as:

$$x_{ik_i} = f(q_i)$$

Let's propose that the value of the $q_{i,j}$ ($i=1,2,\ldots,n$) generalized coordinates is known, (n- is a number of the DM ,when the gripping mechanism of the manipulator is situated in the j-th distinctive point $A_j(\overset{*}{x}_j, \overset{*}{y}_j, \overset{*}{z}_j)$--- and the condition (3) executes. The task of alternation laws' synthesis while movement between j-th and (j+1)-th distinctive points, if the obstacles (the TE surfaces in the accessible zone) can be determined by an expression:

$$E = \sum_{j=1}^{\ell-1} \sum_{i=}^{n} C_i (q_{i,j} - q_{i,j+1})^2 \rightarrow \min \qquad (5)$$

if the condition (3),(4) and the restriction (6) are executed.

$$((\forall x_{ik_i}, i = 1,2,\ldots,n; k_i = \\ = 1,2,\ldots,m_i : (T_1(x,y,z) \geq 0)L^R \\ L^R(T_2(x,y,z) \geq 0)L^R \ldots \\ L^R(T_R(x,y,z) \geq 0) = 0 \qquad (6)$$

where $T_i(x,y,z) \geq 0$, $i=1,2,\ldots,r$- is the inequality, which defines the border of the i-th surface of the TE;
r- is a number of the elementary surfaces, which define the arrangement of the TE.
The restriction (6) determines the condition of the incollipse the manipulator's links with the surfaces of the TE, which is situated in the IR's accessible area;
C_i is the weighting coefficient, characterizing the consumption necessary for movement using i-th DM from the point A_j to the point A_{j+1}.
So, the solution of the task (3),(4),(5),(6)

determines change of the generalized coordinates $\Delta q_i = q_{i,j} - q_{i,j+1}$ $(i=1,2,\ldots,n)$, while movement from the point A_j to the point A_{j+1} with minimum of power supply expenses.

In the serial IR, as a rule, the following condition is executed:

$$C_1 \rangle C_2 \rangle \ldots \rangle C_n \qquad (7)$$

Propose that the step of discretisation of the generalized coordinates' change was chosen that:

$$\Delta q_i = | q_{i,j} - q_{i,j+1} | = \mathrm{const} \qquad (8)$$

when $i=1,2,\ldots,n$, $j=1,2,\ldots,\ell-1$; where n- is a number of the DM; $(\ell-1)$- is a number oft he characteristic points, which are approximating the trajectory of movement TM.

Then, by substitution of (7) and (8) into (5) we have an expression:

$$E = \sum_{j=1}^{\ell-1}\sum_{i=1}^{n} C_i (q_{i,j} - q_{i,j+1}) = \Delta q_i$$
$$= \sum_{j=1}^{\ell-1}\sum_{i=1}^{n} C_i = \Delta q_i \sum_{j=1}^{\ell-1} C^j \qquad (9)$$

where $C^j = \sum_{i=1}^{n} C_i$ (10)

Execution of (10), taking into account (7), can be provided by the decision of the next task:

$$C^j = \sum_{i=1}^{n} C_i \to \min \qquad (11)$$

if:

$$A_{j+1} \in P_k \qquad (12)$$

where P_k - is the subspace, which represents the WS of the IR, if the DM with numbers $n, n-1, \ldots, n-k$ are used for the manipulation.

The decision of (11),(12) can be represented as the following stepwise algorithm:

Step 1. $i=1$, pass over to step 2.

Step 2. $k=i$, check the condition (12). If it executes, then pass over to step 3, otherwise to step 4.

Step 3. To define q_i $(i=1,2,\ldots,k)$ when the manipulator gripping mechanism is situated in the point A_{j+1}, pass over to step 5.

Step 4. $i=i-1$, pass over to step 2.

Step 5. Check the condition $j+1=\ell-1$. If it executes, then pass over to step 6, otherwise to step 1.

Step 6. The end.

Conclusions. The devised model of the grouping junction of robotics systems can get wide application on a stage of prascheme researches while the robotization of the technological manufacture. The robotization can be done as in the traditional for the robotics branches of manufacturing (machine-building production) so in the little-known from the point of view of the robotization (metallurgy, chemical industry, mining industry).

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Simulation of Thermo-Stressed of an Oil Layer in the Vicinity of a Well

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Resume.
By using the mathematical models of thermoelastic media the condition of oil collector in vicinities of a bore hole and bore hole system under action of heat flow and pressure at them are simulated. Some results of calculation of temperature, displacements and stress-strain state in the thermoelastic media have been brought.
Keywords: *bore hole, oil collector, ther-moelastic media, heat conductivity, heat capacity*

Introduction. Development of oil industry in Kazakhstan requires elaboration of new technologies of oil gaining, basing on speciality of oil collectors. It's known that oil in Kazakh- stan contains the high quantity of paraffin, which viscosity obstructs its gaining. This is required to conduct intensive warming of array in vicinities of bore holes on the preliminary stage, that reduces the viscosity of oil and improves its motion in the direction of bore holes [1]. This process is little studying. Calculation of number of bore holes, temperature of liquids and pressure in bore holes has an experimental nature and based on the experience and existing traditional technologies, which do not enough take to account the properties of the concrete oil collectors. Generally this is stipulated with impossibility to provide the many experiments for optimisation of oil gaining, which are very expensive.

Main relations. Isotropic thermoelastic medium is characterised by 5 parameters: density ρ, elastic constants of Lame (λ, μ) and thermoelastic constants η and k, what define through factors of line heat expansion, heat conductivity and heat capacity. State of mediums in vicinities of holes is written by system of equations:

$$\begin{cases} (\lambda+\mu)u_{j,ji}+\mu u_{i,jj}-\theta_{,i}+F_i=\rho\ddot{u}_i \\ \theta_{,jj}-\frac{1}{\kappa}\dot{\theta}-\eta\dot{u}_{j,j}+\frac{1}{\kappa}Q=0 \end{cases} \qquad i,j=1,2 \quad (1.1)$$

Here u_i $(i,j=\overline{1,N})$ - is components of displacement, F_i - a mass power; Q is a power of the heat source, $\theta=T-T_0$ is a relative temperature, T is absolute temperature. For definition of stresses tensor in array (σ_{ij}) we are using the equations of Duhamel-Neumann:

$$\sigma_{ij}=\left(\lambda u_{k,k}-\gamma\theta\right)\delta_{ij}+\mu\left(u_{i,j}+u_{j,i}\right) \qquad (1.2)$$

Initial conditions by $t=0$:

$$u_i(x,0)=0,\quad x\in(S^-+S),\qquad \dot{u}_i(x,0)=0,$$

$$x\in S^-\ \theta(x,0)=0,\quad x\in(S^-+S). \quad (1.3)$$

The follow boundary problems are investigated:

Problem 1. On the boundary surfaces S acting loads and heat flow are known:

$$\sigma_{ij}(x,t)n_j(x)=p_i(x,t),$$

$$\frac{\partial\theta(x,t)}{\partial n}=\frac{\partial\theta}{\partial x_j}n_j(x)=q(x,t),\qquad x\in S$$

Problem 2. The displacements and temperature on S are given:

$$u_i(x,t)=u_i^S(x,t),\quad \theta(x,t)=\theta^S(x,t)$$

Problem 3. The displacement and heat flow on S are given:

$$u_i(x,t) = u_i^S(x,t),$$

$$\frac{\partial\theta(x,t)}{\partial n} = \frac{\partial\theta}{\partial x_j}n_j(x) = q(x,t), \quad x \in S$$

Problem 4. The the loads and temperature on S are given:

$$\sigma_{ij}(x,t)n_j(x) = p_i(x,t),$$

$$\theta(x,t) = \theta^S(x,t), \qquad x \in S$$

At the beginning for given models the temperature field is determined, whereupon we find the stresses and displacements in the media. Hereon it is possible to calculate the pressure inside array $p = -\sigma_{ii}(x,t)$.

Hereinafter, velocity of oil filtration is defined with using of Darsy's low:

$$V(x,t) = \frac{\chi}{\nu} grad\ p(x,t)$$

where χ is permeability of media, ν- viscosity of oil. Here it is possible to take into account the dependency of oil viscosity from the temperature, as far as field of temperatures becomes known.

For using these models it is necessary to know of thermoelastic coefficients of oil collectors.

1. Definition of temperature and elastic coefficients of oil collectors. *Heat capacity* of multy components body has been defined on the principle of additivity [2]:

$$C_{np}(T) = \left[m(\rho_H s_H C_H + \rho_B s_B C_B) + \rho_{SP} C_{SP}\right] \left[1 + 0{,}0007(T - 300)\right] \quad (2.1$$

where C_{np} - is heat capacity of every components, m is a coefficient of porosity of body, s_H, s_B are factors of oil and water saturating accordingly, T - an absolute temperature; ρ_{SP}, ρ_H and ρ_B are the density of solid components of media, oils and water accordingly; C_{SP}, C_H and C_B are their heat capacities.

Coefficient of heat conductivity:

For dry sandstone with porosity 13-18%

- by $5 \le \rho_{ws} \le 55$ MPa, $0{,}1 \le s_B \le 1{,}0$ we take

$$\frac{\lambda(\rho_{ws}, T, s_B)}{\lambda_{sp}} \cong \left(1{,}22 + 0{,}15\ln\frac{\rho_{ws}}{5}\right) (1{,}39 - 0{,}0013T)\left(1{,}15 + 0{,}03\frac{s_B}{0{,}1}\right) \quad (2.2)$$

- For water saturated sandstone in the same interval of porosity

$$\frac{\lambda(\rho_{ws}, T, s_B)}{\lambda_{nas}} \approx 1{,}07(1{,}45 - 0{,}0015T)s_B^{0{,}09} \quad (2.3)$$

where factor 1,07 takes into account of influence of the rock pressure upon heat conductivity.

For the determination of elastic parameters of media it's need to use the methods of seismic flexing of oil collector, which give the possibility to define velocities of volume and shift waves. Last ones and average density of array uniquely define the all elastic characteristics.

2. Model of bore hole. Let an axis of bore hole to direct along the axis x_3=*z*, the radius of bore hole is R.

We bring here the solution of problem 1 for boundary conditions:

$$\frac{\partial\theta}{\partial r} = H(t), \quad \sigma_{rj}(x,t) = 0, \quad j = r, \theta \quad \text{by}$$

$$r = R = 1,$$

The solution of this boundary value problem in the space of Laplace transformations is follows:

$$\bar{\theta}(r,p) = \frac{K_0\left(r\sqrt{p/k}\right)}{p\sqrt{p/k}\,K_1\left(R\sqrt{p/k}\right)},$$

$$\frac{\partial\bar{\theta}}{\partial r} = \frac{K_1\left(r\sqrt{p/k}\right)}{pK_1\left(R\sqrt{p/k}\right)}$$

$$\bar{u}_r(r,p) = c_1K_1(pr) + c_2I_1(pr)$$

$$\bar{\sigma}_{\theta\theta}(rp) = \left(c_1^0 + c_1\right) \left[-\beta pK_0(pr) + (1-\beta)K_1(pr)/r\right] + \left(c_2^0 + c_2\right)\left[\beta pI_0(pr) + (1-\beta)I_1(pr)/r\right] - \gamma A(p)K_0\left(r\sqrt{p/K}\right)$$

$$c_1(r,p)=\gamma F(p)\int_1^r I_1(p\tau)K_1(h\tau)\tau d\tau$$

$$c_2(r,p)=-\gamma F(p)\int_1^r K_1(p\tau)K_1(h\tau)\tau d\tau$$

$$c_1^0(p)=\frac{B_1(p)}{B_2(p)}-\frac{\gamma F(p)}{B_2(p)}*$$

$$\begin{cases}(hK_0(h)K_1(p)-pK_1(h)K_0(p))/(h^2-p^2),h^2\neq p^2\\ h\left(K_0^2(h)-K_1^2(h)\right)+2K_1(h)K_0(h),h^2=p^2\end{cases}$$

$$c_2^0(p)=B_1(p)-B_2(p)c_1,$$

$$F(p)=1/pK_1(Rh)$$

$$B_1(p)=\frac{\gamma A(p)K_0\left(R\sqrt{p/k}\right)}{pI_0(pR)+((\beta-1)I_1(pR))/R},$$

$$\beta=\frac{\nu}{1-\nu},\quad h=\sqrt{p/K}$$

$$B_2(p)=\frac{-pK_0(pR)+((\beta-1)K_1(pR))/R}{pI_0(pR)+((\beta-1)I_1(pR))/R},$$

$$\nu=\frac{\lambda}{2(\lambda+\mu)}$$

Here I_n, K_n are the cylindrical functions of Bessel and McDonald, $H(t)$ - a function of Hevysaid. For the original building numerical scheme of inverse Laplace transformation is used, based on the Papoulice's method.

For the single bore hole of given diameter the test calculations for hypothetical thermoelastic mediums and oil collector are performed. The results of calculations are given.

Conclutions. In the case of bore system, as the distance between system of bore holes are many more then their diameter, the influence between them we can neglect. Then temperature field and field of pressure are computed by adding fields from each bore hole.

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Problems of Construction of Models on the Basis of the Thermodynamic Approach

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Resume.
This document outlines problems of creation of mathematical models of continuous manufacturing processes oriented for the management purposes. The mathematical model construction technique is based on implementing the principles of a non-equilibrium thermodynamics.
Keywords: *system, object, technological process, thermodynamic approach, systems analysis, model, external environment.*

Introduction. The process of construction of continuous technological process's mathematical model is substantially connected to the features of the processes, such as: multifactor, poor organization of internal structure in terms of vague display of causal relations, irregularity of properties. In this respect it becomes necessary to consider a special methodological approach to research, analysis and modeling of such processes.
All this is determined within the concept of causal relations and poor organizations of internal structural communications to conduct special researches aiming at synthesis of topology of technological process models. Thus the procedure of model construction should correspond to the principles of system approach, purpose and problem systematization.

The problem of selecting forms of management system model representation is very important. While creating a management system model we can base it on different approaches of its description. During construction of a model it is necessary to divide an object (system S) into a system that we're modeling and an external environment. Then for the system S it is possible to assume, that M_s is a model of the system S, M_u is a model of the environment on input, M_y is a model of the environment on output, M_{su}, M_{ys} are models of system connections with the environment on input and output. The disclosure of uncertainty of the system's model is possible with determination of structure of communication operators between variables. The structure of the operator is defined as a level of a determinacy, when the operator is presented in the parametric form.
One of effective solutions, connected with construction of models is based on thermodynamic approach [1], which allow layout of coordinates vector of technological process model according to unified formalized method. With this purpose each subsystem interaction considered as an energy exchange between these subsystems, is represented by a final set of typical, a priori known thermodynamic phenomena.
Transition of system from one condition (let's name it 1) into another (name it 2) can be characterized by value of internal energy U, which depends on initial and final states of the system and general interaction with environment as work A (carried out by the system itself and over the system), heat Q and energy of weight carriage M. And this sum for reversible processes does not depend on paths of transition from a condition 1 in a condition 2. In other words, there is a ratio U2-U1=A+Q+M.
The problem of determining coordinates of

any technological process's model is important in creating models intended for management problems, and the quality and efficiency of controlling the technological process relies on the way it is resolved. From the thermodynamics point of view the technological process determined by spatial and time coordinates, can be rendered as a system consisting of a limited number of subsystems of different kinds of energy localization. These subsystems interact with each other and with environment via mass-energy exchange. Applying a function-purpose assigning principle to a limited number of thermodynamic phenomena which describe an energy condition of the given technological process, we can highlight the set of subsystems and function-purpose interactions between them, which will make the space of the model.

Consideration of specific features of management procedure as function-purpose property of the model designed for management procedure can be made in the following way. We'll formalize technological process's control procedure as a temporary procedure of coordinate extraction into a demanded zone in limited time. To solve this kind of problem we need a model which can describe in the interactive conditions both the behavior of subsystems, including the controlling subsystem, and their condition. In such case we should see the purpose of control as an achievement of a demanded condition of one of subsystems due to interactions of subsystems between themselves.

Let's enter A_{mn} as set of interactions between subsystems S_m and S_n; $Z_m = \{z_{mk}\}_{k=1}^{km}$, $Z_n = \{z_{nk}\}_{k=1}^{kn}$ set of coordinates of a condition of subsystem m and subsystem n; Φ_m, Φ_n set of interactions inside subsystem m and subsystem n respectively. Then the model of a system should be interpreted as

$$M_s = \left\{\{Z_m \cup \Phi_m \cup A_{mn} \cup \Phi_n \cup Z_n\}_{m=1}^{N}\right\}_{n=1}^{N}, \quad (1)$$

and behavior model $\{A_{mn}\}_{mn}$ at the thermodynamic approach should be interpreted as the operators of interaction between separate thermodynamic coordinates. On the basis of behavior model we can form the control algorithm (dynamic control). The condition model shows the properties of separate subsystems in static state. On the basis of a condition model the purpose of controlling should be stated. In this sense the model of a condition can be based upon integrated set of generalized forces x and flows f. In case $\frac{dx}{dt} \neq 0$, $\operatorname{grad} x = 0$, interactions between forces x, coordinates y, flows f and between models of behavior and condition can be shown in the following way (fig. 1).

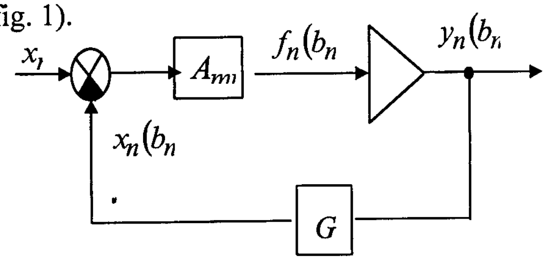

Fig. 1

Here $\Delta x_{mn} = x_m(b_m, t) - x_n(b_n, t)$ is a difference between vector x_m of generalized forces of the subsystem S_m, which perform in a specific point of this subsystem b_m, and vector of generalized forces x_n of subsystem S_n, performing in a point b_n. A_{mn} is an operator of generalized force effect from the subsystem S_m to the flow of the subsystem S_n; $G_n^{\int}$ is integral interplay of a pair of a generalized flow f_n and force x_n of the subsystem S_n. In an analytic form we can put it out in the following way

$$\begin{aligned} &A_{mn}\{x_m(b_m, t) - x_n(b_n, t)\} = f_n(b_n, t) \\ &x_n(b_n, t) = G^{\int} \{f_n(b_n, t)\}. \end{aligned} \quad (2)$$

It can be clearly seen from the structure (the fig. 1), that the thermodynamic views demonstrate, that the condition model executes feedback in general model of the subsystem and its interaction with another subsystem. Indeed, gradients (temperatures, potentials, concentrations, etc.) trigger flows (warmly, currents, weight etc.) in a system, which are trying to reduce the causing gradients to zero point, i.e. in thermodynamics language the system is trying to achieve an equilibrium (maximum entropy). The extension of the concept of the mechanism of generalized thermodynamic interaction between two subsystems (2) allows us to offer the following structural model for relations (2), which correspond to non-steady, but equilibrated interaction (fig. 2).

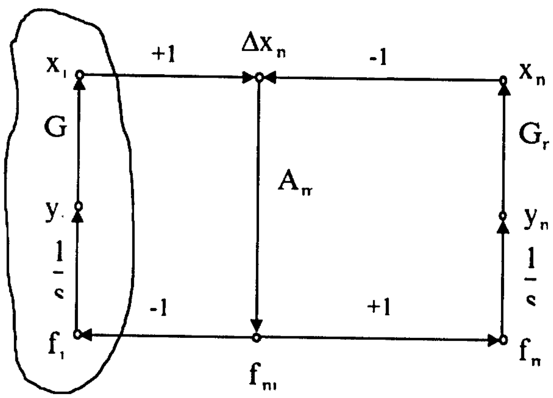

Fig. 2

Thus the allowances are made that the gradients of generalized forces that perform between subsystem m and subsystem n can be replaced with $\Delta x_{mn} = x_m - x_n \ (x_m > x_n)$. Enabling possibility of representation of interaction processes, we can replace operators A_{mn}, G_n and G_m with transmission factors a_{mn} and q_m, q_n. Physical meaning of these factors, taken as parameters of the considered structure, is as follows. The factor a_{mn} corresponds to generalized conductivity, which one characterizes the "channel" interacts between subsystem m and subsystem n. Factors g_m and g_n are inversely proportional to generalized capacities of systems describing a capability of accumulating a generalized charge in each subsystem (coordinates) y_m or y_n.

For the taken standard structure which has no connection with external environment (the vector of exposures u=0) a set of equations can be obtained:

$$\dot{x}_n = -a_{nm}g_n x_n + a_{nm}g_n x_m,$$
$$\dot{x}_m = a_{nm}g_m x_n - a_{nm}g_m x_m. \quad (3)$$

In case of a non-autonomous system, i.e. in case of a system including interactions with the environment $(u \neq 0)$, the set of equations (3) can be converted into the following

$$\dot{x}_n = -a_{nm}g_n x_n + a_{nm}g_n x_m - k_n a_{nm} g_n u_n,$$
$$\dot{x}_m = a_{nm}g_m x_n - a_{nm}g_m x_m + k_n a_{nm} g_m u_m. \quad (4)$$

Thus, for the taken standard structure (the fig. 2) a set of equations can be obtained

$$\dot{x} = Ax + Bu, \qquad z = Cx,$$

which satisfies to categories of state space.

Conclusion. In this document the methodological principles of research of a generalized (standard) technological process, its functional structure, nature of phenomena of the different physical nature, used in it, are shown. The procedure of technological processes research was implemented during creation of heat treatment models of concrete [2], which contents is the formation of function-purpose properties, allocation of technological process subsystems, realization of thermodynamic state and interactions of subsystems.

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Automatic Control of Processes of Power Transmission

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Resume.

For the act of present work includes constructing mechanical self-regulation, to do automatically, irregularly without any stage changes, parameters used in motions in the order of resistance by the movement of working instrument.

Keywords*: Automatic self-regulation.*

Introduction. In the present moment for transformation of motion from a engine to the working instrument is used a transfer in the form of a mechanism with one degree of freedom. This type of the transmission transfers a fixation significance of parameters of motion – a power of movement and a speed (frequency of rotation) by constantly quantity of the working instrument output power.

In many cases working instrument works in conditions by a changing resistance of the movement, for example, drill the boring machine, that is a question of the direction by a used power parameters.

For this purpose works mechanism provided the change of the transmission ratio, for example, a gear-box of the automobile

Automatics box of transfers of a automobile now has received a distribution is hydraulic. However, such box of transfers only upgrades a management by it, ensures automatic switching of transfers on stages.

It results in a deriving bulky and unreliable construction.

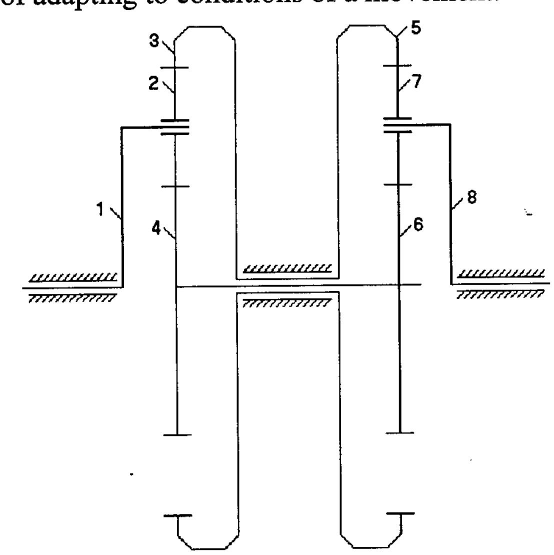
Structure and kinematics particular types a mechanical self-regulation written in the works [1, 2]. Here general theory of a self-regulation offered.

The automatic regulation of out power parameters made up by a mechanism with two degree of freedom realizing a division of an entranse of power stream with constant parameters in two streamswith variable parameters with next their connecting in an exit stream of power [1, 2].

In correspondence with this idea the construction of automatic gear transmission (pic. 1) made of two mechanisms, differential and adapter.

Differential – it is a mechanism with two degree of freedom, servicing a division a power stream at two directions. It consists entering carrier 1, satellite 2 and central gear wheels 3 and 4.

Adapter – it is a mechanism, servicing fora association two streams of a power with aim of adapting to conditions of a movement.



Picture 1. Automatic gear of transmission.

It consists central gear wheels 5, 6, satellite 7 and exiting carrier 8.

On a connecting the differential and the adapter in the gears of automatic transmission their intermediate central wheel 3 and 5, 4 and 6 hard connects. The transmission working as under:

The entranse stream of power N_I with constant by parameters of (torque M_1 and angular velocity W_1) entering from engine to the ranse carrier 1 through satellite 2 divisions in intermediate central wheels 3 and 4 in the type of power streams $N_3=M_3W_3$ and $N_4=M_4W_4$ (where M_3, M_4, W_3, W_4 – appropriate torque and angular velocities – a power parameters.

Power streams N_3 and N_4 on account of two degree of freedom in a differential have a variable power parameters depending from a meet resistance of a movement on the central wheels 5 and 6 of a adapter hard connected with wheels 3 and 4.

Coming from wheels 5 and 6 power streams N_3 and N_4 receives a satellite 7 and thay have been connected on a carrier 8 to a exiting power stream N_8 with change parameters depending from a resistance of the exit motion.

Conclusions. Developed principles of a convey enter rans power in the exiting link by a division a power stream in two ways with variable parameters of a motion allows implement a idea of a automatic adaption an exit link to a resistance its motion and to take a construction of a gear automatic transmission provide a automatic control process of a convey of a motion.

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Traffic/Material Control System for Export Transportations

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Resume.

The problems of creation of the control system of motion of transports and outwards by export transportations in Republic of Kazakhstan (RK) are reviewed , basing on satellite communication facilities. Are rotined a relevance of creation of a similar systems and problems arised at it. Are described a structure and principle of operation of a system.

Keywords: *satellite systems of communication, mobile object, supervisory centre of the control, system of data-transmission, database, local area network.*

Introducing. Object of researches are the systems of information control of mobile objects (SCMO). Conditionally this class of systems can be divided into two views: SCMO of local operating and SCMO of distributed operating. In the given activity the second class of systems is reviewed, namely "SCMO-E" . The development in Kazakhstan of market relations has resulted in formation of a great many of the transport dispatchers and auto carriers independently engaging organization of freight lifts in Kazakhstan and outside. In conditions of the market this process gives freedom of entrepreneurial business in a part of selection by a consigner and by a owner of a transport of ways of organization of transportation [1].

The analysis of foreign experience demonstrates that, despite of financial independence of the transport dispatchers, transport owners and transport corporations, in foreign countries there is in this or that form a centralized operating control by international (export) outward lifts built, as a rule, by a regional principle. The purpose of these organs is organization of high-performance process of freight lifts at the expense of data acquisition on outward and transports, formation of the charts of a mutual loading, control of transportations and organization of clearing between consigners, transport dispatchers and owners of a transport at the expense of usage of the information automated systems. Statistics testifies, that in case of applying similar systems the efficiency of outward by motor transport is considerably increased.

The national control systems and registration of motion of transports and outwards are available and form in countries of Europe, Asia, Middle East, they are designed and in countries of CIS. Last years in USA, Canada and countries of Europe usage of satellite systems for a position determination of the automobile both messaging between an auto carrier and dispatcher ("Omnitraks", "Inmarsat - C", "Evteltraks") is reamed. The similar activities are conducted and in RK.

The contents and basic purposes of a system. The system "SCMO-E" with usage of navigation space systems is intended for wide range of users, and grants capabilities for: provision of the carter by an operating state information of a road network, weather conditions and situation on routs to follow; operating leaving out of consigners and consignees about position and condition of the transports and outwards; granting of the informations тtransport dispatcher and freight corporations about excursion of the transport in concerns of planning of their rational loading in direct and converse directions, minimization of outage, increase of efficiency of transport operations; granting in concerns of transports inspection RK of the information on routes of excursion of the transports and transit periods of outwards; representation of the analytical reports about transportations of outwards state and commercial structures (owners of transports); the cartographical analysis of efficiency of usage of a road network and transport at transportations of outwards and make of the guidelines on their optimization.

The system "SCMO-E" allows: to inform the owners of transports, remailers and receivers of outwards, subjects, accountable for their carriage, on an occurrence and condition of the transports and outwards; regularly to provide the centralized data bank of transportation branch with a state information of a road network, about cargo and transport flows on highways, about originating emergencies, about natural disasters etc., indispensable for operating control and decision making on perfecting and development of branch; notification of regional dispatcher stations and departmental centers of the users on incidents, emergencies and debacles on routes of motion of the transports and transportations of outwards; to grant communication services on routes of motion, including a capability of indispensable documentary exchange, bound with transport operations in points of dispatch (obtaining) of outwards and customs.

It is reached by means of: position determinations of transports and outwards during transport operations; mappings in real time of rout to follow on electronic cards of crt terminals of an operative dispatching service; leaving outs of consigners and consignees about position of transports and outwards; provision of information exchange between the shippers and crews of automobiles; the operating notification of dispatching services on the part of the drivers about emergencies and emergencies on routes of motion [2].

Structure of means and their function. A leading particular of a system is control dispatcher cente (CDC) for the control of motion of the transports and outwards (fig. 1), the basis which one is made by the tracking system behind position of mobile objects on the basis of a satellite system of communication "Inmarsat". Monitored space actuates countries of Europe, Asia and Africa. The information in a system is transmitted from monitored object in a traffic control centre on satellite channels of communication. By means of the same communication channels the information exchange between CDC and crew of a transport means can implement.

Structure of the equipment CDC: station of a satellite communications of system "Inmarsat" the standard - C with the supply unit and offset antenna; a fixed directional antenna with high amplification; 2 computers such as " Pentium II ", integrated in a network; the software for activity with electronic cards and built downlink package; a complete set of electronic cards.

Functions of CDC: formation, management and editing of the database; mapping of position and observation of routes of motion of transports on electronic cards of locales; editing available and introducing of new electronic cards; support of the minutes of activity of a network "Inmarsat"; interplay with mobile objects (transports); formation of the reports, reports and other; interplay with the users of a dispatcher centre.

Structure of the equipment of mobile object (MO - transport): transceiver station "Inmarsat" with an above board of the navigational receiver of a system GPS (Global Positioning System - global space navigation system); the offset antenna of a satellite communications ; the automobile terminal such as Logic; the automobile printer.

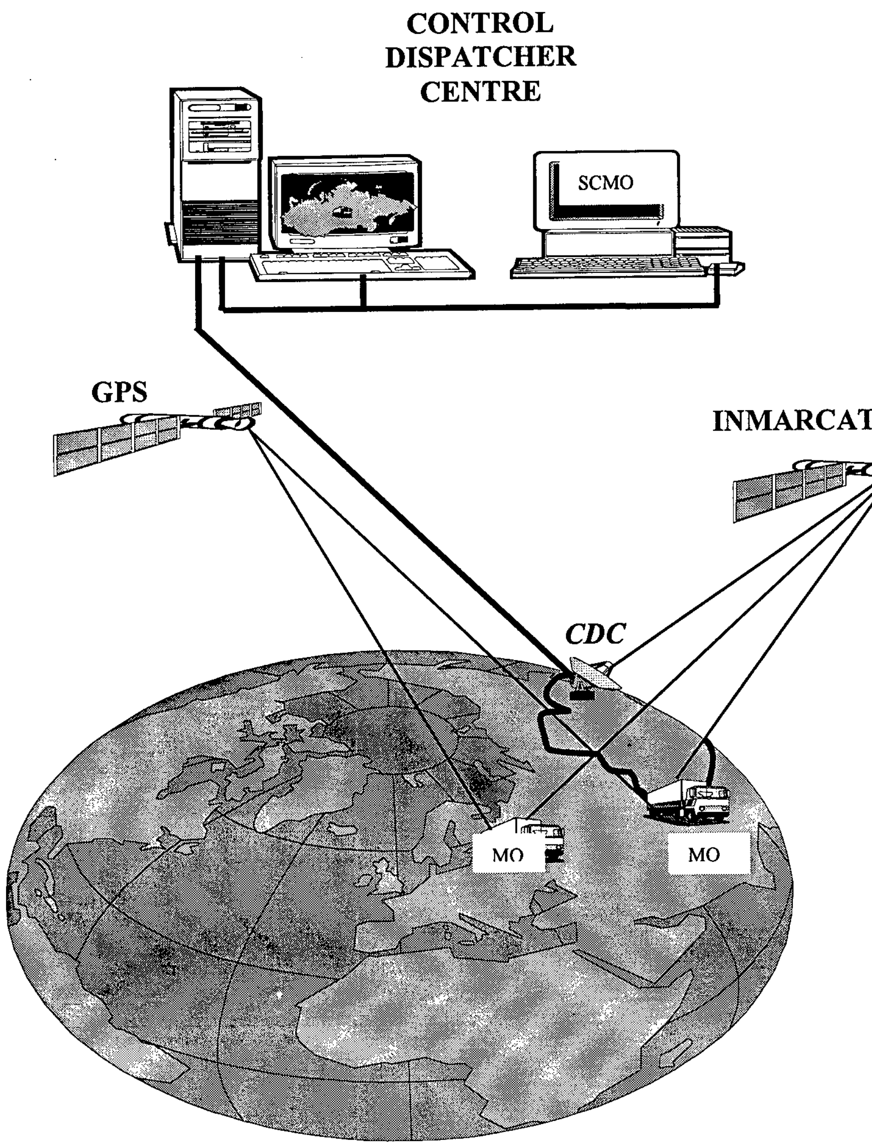

Fig. 1

Functions MO: calculus of position of a transport means with the help GPS of the receiver; formation and regular reporting, including emergency in a dispatcher station; support of the minutes of activity of a network "Inmarsat"; formation of a route of motion under the data of a dispatcher station and his observation on the terminal. Outgoing from executed CDC of functions, the information base of a system is reshaped.

Principle of operation and characteristics of a system. The mobile object (transport means or outwards) is equipped by satellite station "Inmarsat - C" with the built-in receiver GPS. On a given time period or by the inquiry from a dispatcher centre the information on position of the transports (computed with the help of the navigational receiver GPS) in a digital view on a satellite channel of communication acts in centre. In dispatcher centre there is a processing of the information, acting from mobile objects. The position of objects is imaged on electronic cards with a simultaneous entry of the adopted information in the database. The capabilities of activity with station of satellite communications and mapping of objects on electronic cards realised with usage of the special program set on computers such as " Pentium II " (266 MHz) of the standard configuration and higher, working under by an operating system Windows 95 (Windows NT). One of PC will be used as the server and data bank,second for activity with electronic cards.

Concluding. CDC under the applications of the owners of transports (on the basis of the applicable agreements) executes the installation of an on-board equipment on the transports of the customer, registers by their established order and actuates in a structure of objects which are being a subject to the control. In subsequent CDC provides warranty service of established instrumentation and its technical tracking.

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Group Methods of Control of Specifically Dangerous Objects

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Resume.

Worded problem of operative control of specifically dangerous objects with provision for the level problems conditions-governing an object. Offered so named group methods of control, which coming from problems current condition-control OM will assign methods of deciding a problem of cycle of control, target conditions, controlling actions and etc. Revealed structure and composition of group methods of control.

Keywords: *Specifically dangerous objects of control, condition-control, group methods of control, cycle of control, pathological processes.*

Introduction. Amongst potentially possible objects of management to the class of specifically dangerous objects of management (SDOM) possible refer: nucleus reactors of different purpose, energy systems, chemist-metallurgical reactors and stoves and etc. To given class of objects possible to refer transport and other rolling, as well as different dynamic systems. Thereby, given class of objects much width and varied. Particularity of operation of these objects is concluded in that that their operation is bound by probability of breaking a normal mode of operation with the different value, i.e. pathological processes.

In the event of arising the pathological processes from the object operator is required operative decision making for purposes of liquidations of their consequences, otherwise this can bring about breaking a different scale, for instance: 1) to breaking technological mode and stop of object; 2) to the mortality (or breakage) nodes of object; 3) to the emergency stop with losses; 4) to the blast on the object of different scale; 5) to the regional catastrophe with the fixing of threat to the population of this region; 6) to the catastrophe of world scale and etc. Scale of consequences depends on the size OM and type of technological processes, running in him.

Types of damages herewith can be production-technological, economic, morally psychological, ecological, social-political and etc.

In connection with noted, becomes an actual development of identical and efficient methods of deciding a noting problem. One of the possible approaches of deciding a given problem is offerred In work on the base of group methods of control. The Given methods, unlike known, take into account a danger level and difficulties of condition-control OM.

Analysis shows that decision of problem of operative control is bound not only by difficulties of logic of deciding of the most problem, as well as external factors, which essence will show thereby.

At moments of the time t1 Let, t2 on OM appeared to situations, which in the metric scale of measurement can be described thereby: S(t1), S(t2), for which has $S(t1) \neq S(t2)$. Then, more deep analysis shows that for they are executed else number of conditions, in particular: $V(S(t1)) \neq V(S(t2))$, $Tg(S(t1)) \neq Tg(S(t2))$, $G(S(t1 > Tg)) \neq G(S(t2 > Tg))$, where V(S(t1)), V(S(t2)) - levels of danger of condition under S(t1) and S(t2),Tg(S(t1)), Tg(S(t2)) - a time lifes (S(t1) and S(t2); $G(S(ti > Tg))$ - a value of consequence after the outflow of time Tg(.), i.e. $t > Tg$ and $t2 > Tg$ accordingly.

These differences of features of condition-control OM are strategic and in general event their amount is N.

In connection with operative control noted by difficulties of problem of can dare a different image on the different fullness level. This requires different its wording.

Bring one of the variants of wording of problem of operative control, which will name a theoretical wording of problem of operative control.

Theoretical wording of problem expects its wording without from the technology of its deciding comparatively, i.e. from the technology of creation or designing MS, ensuring decision of given problem.

Problem consists of two sections: wordings of conditions of problem of control and wordings to concepts of its decision.

Wording of problem consists of three parts.

I. Information condition description OM. Condition Description OM from a moment of the time t for a time lag $\Delta\tau$ for installed desksides MS is presented thereby:

$$IS = \langle SZ(\Delta\tau), St(\Delta\tau), S^F(\Delta\tau), W(\Delta\tau), PY(\Delta\tau), YD(\Delta\tau)\rangle, \quad (1)$$

where: IS - an information condition PC SDOM; $SZ(\Delta\tau)$ - a given target condition; $St(\Delta\tau)$ - a current condition SDOM; $SF(\Delta\tau)$ - a background condition for the process of control (PC); $W(\Delta\tau)$ - a criterion of deciding On-control (or deciding a problem On-control); $PY(\Delta\tau)$ - a condition of resources of control; $YD(\Delta\tau)$ - a condition controlling influence.

II. Determination of presence of condition-control. At a moment of the time t is considered that has a condition-control, if for IS is met the condition problems YP:

$$YP = \langle(St(\Delta\tau) \not\subseteq SZ(\Delta\tau))\&(S^F(\Delta\tau) \subseteq SK^{F*})\rangle, \quad (2)$$

where SKF* -a class-condition for SF, possible during $\Delta\tau$.

Depending on particularities OM IS can introduce both values of parameters at a moment of the time t, and values of parameters during determined time lag of duration of cycle of control (CC) ΔT: {t1,t2,t3,..tn}.

III. Wording of problem of operative object governing, i.e. wording of requirements to purposes of problem of control and to the process to deciding a problem of operative control.

To Install such target condition ZYi on OM, which must satisfy the following requirements: WZ = {wzi : i=1,n}, where: wz1, wz2 - reliability and safety operations OM able ZYi, wz3, wz4 - production and economic factors OM in the target condition ZYi.

To Install such path an achievement of target condition ZYi on OM, which must satisfy the following requirements: WT = {wtj : j=1,m}, where: wt1, wt2 - reliability and safety operations OM on given paths able ZYi, wt3, wt4 - factors of performing technological mode on given paths, wt5, wt6 - production and economic factors and etc, which must be executed in the process translation OM in ZYi.

Thereby, as a result determinations of components is formulated problems of operative control.

Scheme of deciding a given problem of operative control SDOM consists of three obligatory stages (levels).

1) Choice of method of deciding a problem (i.e. methods of control) coming from the level problems, which will name a group method (GM) - a level 1.

2) Taking the controlling deciding by means of chosen GM - a level 2.

3) Object Control on the base accepted controlling deciding and chosen GM - a level 3.

Process a determination GM for current CC consists of two steps: analysis of condition OM for the determination GM; choice GM coming from current conditions-control OM.

Analysis of condition OM for the choice GM is reduced to the determination of level problems conditions-control (Q) and it has a complex composition: Q=F1(q1, q2, q3,... ,qi,... , qn), where qi - i local factor problems, locating level problems conditions-control OY. As local factors {qi} emerges: but) level dangers of condition-control, b) value of spontaneity or velocities of development of pathological processes under current conditions OY, in) level of danger of translation OM from the condition in the condition on given paths, in) level of difficulty of translation OM from the condition in the condition on given paths. Value of local factors problems is defined on the base of analysis of data, being kept in the composition IS, i.e. qi = F2(IS) and/or on the base of additional data. These primary given on conditions OM will name condition indicators OM.

Problems Is definitively defined on one of molded: $Q=\sum\alpha iqi$, $Q=\Pi\alpha iqi$, $Q=\sum qi=\Pi\alpha iqij$, where αi a weight i local factor problems, qi-i local factor problems, qij- j factor, on the value which is defined value of factor qi-it cartoon by the way.

Coming From IS and level its problems Q is installed such GM, which the most meets the demands quality criterion:

$$Wr(GMi) = MAX\{ Wr(GMj : j=1,n\}, \quad (3)$$

ambiences all GM, as potentially, so and real possible on the base of given bases of elements GM (created in MS). Criterion Wr(.) - ensures necessary conditions for performing WZ and WI, i.e. Wr N (WZ, WI).

Determination GM can be realized by dually image: by shaping from components or by the choice ready amongst given GM. So problem can be a speech dually in "a priori" or in "a posteriori" in current CC depending on the approach to creation MS.

Structure each GM has following. Each GM consists of GK=<Yc,Yp,Yd>, where Moustache, Yc,Yp,Yd-levels GK: strategies, procedures and given models. In the structure GK=< Yc,Yp,Yd> levels execute the following functions. Strategy Level reflects a logician-operation scheme of process of control SDOM. Procedure Level corresponds procedures decision makings, realizing operations of strategies. Given Level consists of knowledge models on OM and its current condition descriptions required for deciding a problem of control.

Hereinafter on the base IS according to the plan of deciding a problem, determined in GMi is realized decision of problem (1-2). Operational procedure of deciding a problem in different GM different: in one GM process of deciding a problem occurs convolute, in other - more unfolded. So will in detail reveal a scheme of deciding a problem of operative control.

On the base IS is required taking such deciding Uri, which consists of ensembles of components or local deciding Uri = (R, Lrij), with the composition in particular:

$$URi = (SZi, MDi, RDi, PRi, RUi, PGi, FBi, ZCi), \quad (4)$$

which greatly satisfies quality of deciding a problem (1-2)

$$W_R(URi)=MAX\{W_R(URj):\forall Urj\in UR\}, \quad (5)$$

where URi - taken (worked out) amongst potentially possible UR, i.e. ambiences all UR available in MS, Lrij -j local decision or component, which bes included in UR, R - an ensemble of relations, assigning sequence of execution Lrij, WR(.) - a criterion of choice of deciding, for which meet the condition $W_R(.)\subseteq(WZ, WI)$.

Components of controlling deciding following: SZi - a target condition of operation OM; MDi - a route of motion OM in the target condition; RDi - a plan (or program) controlling actions or operations (controlling decision); RUi - a facility required for performing a motion OM; PRi - a program of performing the controlling actions (i.e. operations); RUi - a program of motion, i.e. on performing a translation OM from S(t) in SZi; PGi - a program of use (control) resources; FBi - a plan and laws of shaping the controlling commands (influences); ZCi - a program of quality improvement of deciding a task of operative control.

The Following stage of deciding a task is an object control on the base accepted controlling deciding UR. Process of control corresponds a process of realization of controlling deciding on the base of dynamic characteristics (or on the base models or data on the speaker and unsingle-line OM).

On the base models (given) to realization MR is required to realize a taking a controlling deciding UR with the composition (4), so greatly satisfy a quality of deciding a task (1 - 2), i.e.

$$Wp(URi)=MAX\{Wp(URj): j=1,n\}, \quad (6)$$

ambiences all UR available in MS. Where URi - taken controlling decision.

Decision of task (6) is realized on the base of mortgaged laws of control.

Conclusions. Methods of deciding the real tasks of operative control SDOM is reached on the base of stated wording of theoretical task of operative control and methods of its decision. Herewith it is necessary to take into account possibilities of technology of creation and particularities of architecture MS.

Asynchronous Generators of the Wind Power Plants with an Automatic Stabilization of Frequency and Voltage

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Resume.

The cascade of the asynchronized generators for small wind power system is esteemed, which can work at low the frequency of rotation of the arbor wind wheel, providing stability of frequency and voltage output.

Keywords: *a system, asynchronized generator, wind power plant, rotational speed, frequency shifter.*

Introduction. One of leading particulars wind power system is the electricity generator conversing mechanical energy of a wind to electrical energy. The type of an electricity generator, on the one hand, is determined by power and operational modes WPP, and on the other hand determines parameters and quality of the electric power WPP.

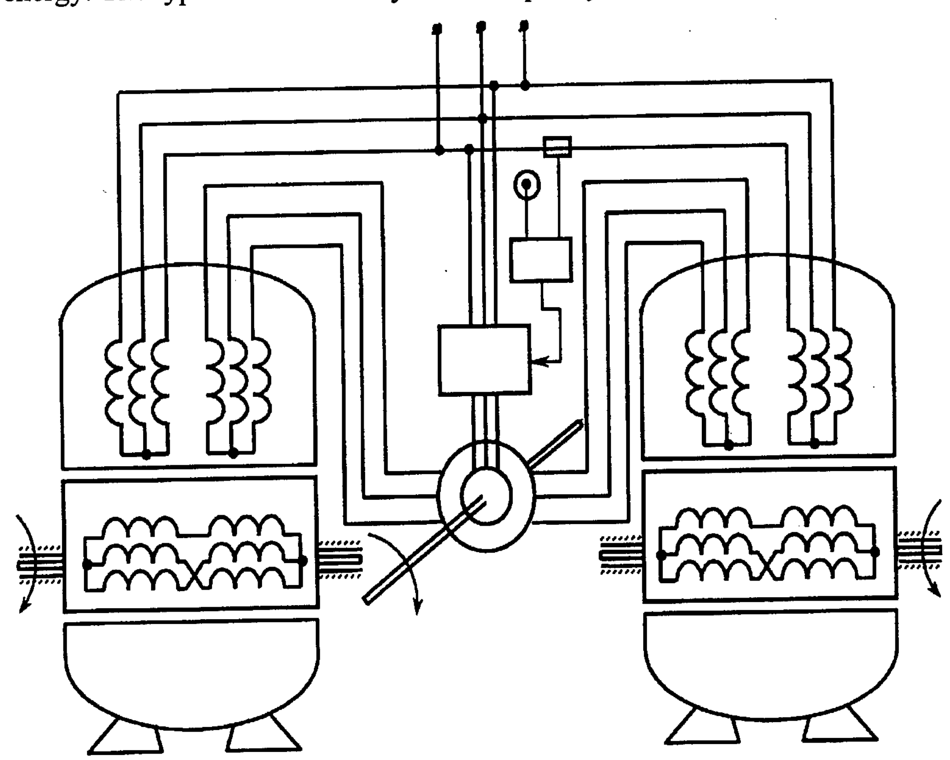

Fig. 1

In WPP a serious problem is the stabilization of frequency and voltage alternating-current, as the rotational speed of a rotor of the generator is not stable because of sizeable fluctuation of wind speed. At presence of a constant wind field it is expedient to aggregate WPP in an integrated power grid.

The stabilization of frequence and voltage output WPP can be executed with the aid of asynchronized machines (AS - machines) [1], which one enable variable rotational speed, and also can supply soft communication between generators [2].

In a fig. 1 the block scheme of a cascade of the asynchronized generators is shown.

For anyone wind power system, where 1 and 2 are accordingly asynchronous machines with the mated three-phase winding on p_l and p_2 of pairs of poles of identical power and equal number of pairs of poles; 3 is asynchronous machine with a phase-wound rotor on p_3 pairs of poles; 4 is frequency shifter (FSh); 5 is regulator; 6 is setting device of an industrial frequency and 7 is sensor of frequency of voltage output.

Let's consider a principle of operation of two AS - generators at parallel operation with the automatic stabilization of frequency of voltage output. As an exciter for two generators the frequency shifter together with the asynchronous machine with a phase-wound rotor presented in rotation from the external drive with rotational speed n_l will be used. The rotors of the mated machines 1 and 2 are rotated also from the external drive with rotational speed n and n' $(n = n')$. The mated of a windings of a stator of this machine are executed on miscellaneous number of poles p_l and p_2 $(p_l \neq p_2)$ for exception of a transformer coupling between a winding on miscellaneous numbers of poles.

The frequency shifter submits voltage U_s with frequency f_s to a rotor winding of the asynchronous machine 3. As the rotor of the asynchronous machine is rotated with rotational speed n_l, then the EMF with frequency:

$$f_2 = n_l p_3 + f_s, \qquad (1)$$

will be is induced in to a winding of the stator of this machine 3. The stator windings on p_2 pairs of poles of the mated machines 1 and 2 are paired sequentially through the stator windings of the asynchronous machine 3, therefore in this stator circuit will flow currents with frequency f_2, forming a rotational magnetic field in the mated machines. This magnetic field in a rotor winding on p_2 pairs of poles will be induced EMF and the current will flow in the circuits of a rotor of the mated machines withfrequency

$$f_p = np_2 + f_2 \qquad (2)$$

The rotor winding of the mated machines paired to return sequence of phases, in the stator winding on p_l the number of poles will be is induced EMF with frequency

$$f_l = np_l + f_p, \qquad (3)$$

from a magnetic field formed from currents of a rotor winding on p_l number of poles.

The frequency f_l voltage output of the mated machines 1 and 2 with the registration (1) and (2) will be peer

$$f_l = n(p_l + p_2) + n_l f_3 + f_s \qquad (4)$$

As it is visible from (4) frequencies of voltage output f_l depends from the rotational speed of a rotor of the mated and asynchronous machine, and also from a frequency of the frequency shift. Besides it, if add up of the number of the pairs of poles of all machines, and it means, that on low frequency of rotation and of the small value of the number of the pairs of poles the machines can be received an industrial frequency of 50 Hz. It is known, that the electric machines with a small number of the pairs of poles have the small mass and dimensions.

To stabilize frequency of voltage output f_l it is possible by frequency f_s in a definite frequency swing of rotation of the rotor of the mated machine or asynchronous machine. From expression (4) follows, that at change n and n_l, and also at simultaneous change them, by regulation of frequency f_s of a frequency shifter it is possible to achieve a stabilization frequency f_l.Stabilization of frequency f_l of voltage output implements as follows. At a frequency drift of rotation of a rotor of the mated machine n or asynchronous machine n_l, the frequency of voltage output f_l starts to change. It will cause that between the setting device of frequency 6 and sensor of frequency of a grid 7 the difference of frequency will appear. The regulator 5 will adjust frequency of the converter 4 up to such value, that the frequency of voltage output of the generator equalled to given frequency. Besides it, a frequency shifter providing stabilization of voltage output U_1 by increase or decreasing of a field voltage U_s.

The parallel operation of generators is well-known, however, in this case, it is necessary to mark, that for generators a general system of excitation and it is favourable influences a frequence control of voltage output of generators.

Parallel operation of generators require, that should be abided following conditions

$$f_1 = f_1'; \ U_1 = U_1'; \ \alpha = \pi, \qquad (5)$$

where α a angle between vectors of the stator voltage $U_1 = U_1'$.

As it is visible from a figure 1, for generators the general system of excitation and on circuits of a rotor winding flows a current of identical frequency f_2, that promotes equalling of frequencies of voltage output of generators.

If rotational speed of a rotor of generators are not peer, i.e. $n \neq n'$, that, accordingly, the frequencies of voltage output of generators same are not peer $f_1 \neq f'$, and on stator circuits of generators will flow circulating currents I_{cc}.

These circulating currents interacting with a field current of a rotor in each generator, will be formed the electromagnetic moment operational on a rotor.

Directions of operating of the electromagnetic moment will be depend from a direction of circulating currents and at $n > n'$ The circulating currents will flow past from the maiden generator to second and at $n < n'$ On the contrary. If $n > n'$, in the mated machine 1 moment will act against rotation of a rotor, braking it, and mated machine 2 on a sense of rotation of a rotor, accelerating. At $n < n'$ operating the electromagnetic moment accordingly on the contrary.

Thus, the originate electromagnetic moment restoring synchronous motion of rotors which one is called as the clocking moment.

It is necessary to mark, that the circulating currents arise and at not an observance of the terms $U \neq U'$ or $\alpha \neq \pi$. Here too there are circulating currents, causing the clocking moment, which one steadies synchronous motion of rotors.

Concluding. The actuation of a frequency shifter between a grid and rotor winding of the asynchronous machine presented in rotation from the external drive, and also connection of the stator windings of all machines in appropriate way, allows simultaneously to regulate frequencies of voltage output of two generators from one device of excitation, that, in the final accounting, the coefficient of efficiency augments.

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Informatization of Teaching Procedure in the INTRANET Environment of the Karaganda State Technical University

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Analysis and teaching procedure control remain one of the most lobourconsuming jobs for the teaching and methodics deportment and the rector's office of the university because it is necessary to control students' progress, to facilitate the work of teachers, chairs and dean's offices. Statistics shows that there from 5 to 7 thous and students at the university. It is easy to imagine the volume of information that should be processed. One mustn't forget that the volume of this information increases on the account of backward students, undisciplined teachers and some unforeseen situations. It will take a human being some weeks or months to process all this information. Such approach to "operating" control of students' progress in the university is unacceptable because it takes much time, therefore it will be rather difficult to imagine a timely picture of students' progress in the period of attesting and examinations. In connection with the development of teaching technologies some new technologies are required to control teaching procedure. Therefore the Karaganda state technical university is creating new technologies and solving problems to improve the old ones.

This problem can be solved by AIS "Teaching activities" which meets all the requirements of the teaching and methodics department and the rector's office of the university. This AIS uses the following workstations: "University entrant", "Dean's office", "Library", "Teaching and methodics department", "Rector", "First vice-rector" and also workstations of " Personnel department", "Materials department", "Stipend", "Accounts department", "Salary and wages".

Data bases of AIS contain necessary information about the student and teaching staff of the university during the whole period of study or work. This approach makes it possible find at any time students' marks in each semester. The programme complex makes it possible to enter, correct and put out data. On the bases of information which has been entered it is possible to produce lists, forms: reports concerning students' progress for a very short period of time (literally in no time). Flixibility and completeness of the reports show tye whole picture of students' progress.

After graduating from the university a student is given a diploma appendix with all his (her) marks according to the curricula of his (her) speciality. The information concerning a university graduate is transfered from the main database to the archive, there it is stored for 25 years.

The programme complex is designed for local entry of data and production of reports and also for use inside the corporative computer net (INTRANET) which allows the access to data on any computer which as connected to INTRANET. The restricton of access rights will provide the integrity and protection of the whole complex.

Main Principles of Realization of MKA in Automated Design Systems

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The development of CAE of objects in machine-building recently is observed. As a rule, such systems include a number of design subsystems. The subsystem of hardening accounts is intended for the analysis of stress-strain state of the main constructive items of object under influence of possible dynamic and static loads. It is based on using of numerical methods of the design object analysis at a microlevel. The finite element method is the most popular method of the decision of regional problems in CAE.

The program complexes that realise the FEM would not have the so large success among the users if meshing of a body on finite elements was realised manually. The information about coordinates of nodes and connection between elements concerns to the main characteristics of discrete model of object.

In the article the automated method of formation of object finite element model is described. The method is the basis of the program complex processor.

The algorithm of the pre-processor work as a rule consists of the following stages:

Stage 1. Drawing of some set of nodes on the given area.

Stage 2. Formation of central connections of a matrix M with the purpose of filling of area by finite elements "of the best form".

Stage 3. Numbering of nodes that minimises width of a structure $\sum \beta_i$ in the factor matrix of the equation system (algorithm of Kathila-Makki).

At automatic drawing of set of nodes on initial area a number of the requirements should be maintained. So the nodes should be condensed in zones where the high concentrations of stresses or temperature gradients are expected. Thus the strains between the next zones should be smooth.

The processor of the PC realises all settlement procedures of the FEM. The equation system of the FEM is formed by consecutive viewing of the list of finite elements of the settlement circuit. After the decision of the equation system of the FEM the calculated values of degrees of freedom are chosen for everyone finite element. The calculated values of common system of coordinates are translated in the local system of coordinates of an element with the help of the matrix of directing cosinus [T]. Knowing the law of approximation of strains on the area of a finite element the values of components of stress-strain state (SSS) are calculated in any point of an element.

The PC post-processor is intended for visualization of the account results with use of tabulared and graphic ways. In particular, the map of stress levels, deformations and strains in the field of the problem decision is complered on the screen of the display.

The algorithm described in the article is realized in the program complex (PC) КЭЛАПС [5, 6], created on the chear of systems of the automated designing of KarGTU and faculty of PK-4 MGTU named by Bauman. The analysis of the received results has shown good convergence with experimental data.

The System Approach to Automation of Metallurgical Processes: Experience and Problems

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The market conditions of managing require acceleration of activities in The savings of resources, increase of quality of production and improvement of an ecology on the basis of use of achievement of modern physics and adopting of automated control systems of technological processes.

In the report is adduced the results of research and change of acoustic methods of the control of a level of slag in the converter, weights - spectrometric methods of the control of a structure and consumptions converters gases, methods and means of the control of temperature of metal etc.

The solution of these problems is considered from system positions which conclude in creation and application of methods of obtaining of the operative information on real-time metallurgical process, account statistical and dynamic characteristics of researched process, account of destabilizing influence of external environment on result of measurement, creation the systems of metrology maintenance and accelerated tests, use of new ways of processing of the measuring information in real-time.

During of research and development is created the complex of techniques, sensors and devices for the control and measurement of a material structure of a blend during of technological process:

- neutron methods for determination of humidity of coke with variable density in bunkers;
- neutron methods for determination of humidity the iron ore concentrate on a surface of a driven conveyor tape;
- radiometric method for determination ashes of hard fuel.

Advantages of listed methods before known consists of correction of results of measurement on density change of substance, thickness and distance of the sensor from a surface of a controllable material.

Development of a complex of physical methods and sensors has allowed to reach creation of informational-measuring systems (IMS) in iron metallurgy.

Use IMS allows to increase qualities and reliability of the received information, to conduct unification and standartization of electron signals and interface systems.

One from the important questions for construction IMS are the scientific and technical aspects metrological maintenance. On a neutron accelerometer of humidity example the verifying scheme integrating technical means and principles of unit moisture content is considered.

On base IMS and decentralization of automation systems the adaptive control system converter smeltingis created oxygen-converter bay of "Ispat-Karmet" is created and handed in operation.

Created IMS and devices of humidity of loose materials, ashes of hard fuel, complex of local control systems, dosage blend of materials, system of the control of temperature contents of metal in it of carbon etc. is deliver on the enterprises of near and distant foreign countries.

Automation of Polysilicon Manufacturing Process on the Basis of a Computer Monitoring-Control System

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The modern production is impossible without automation. But one who had to solve the problem of data gathering and technological process control knows how complicated and multiplan the task is. Specialized software packages –SCADA-systems (Supervisory Control And Data Acquisition) - make its solution essentially easier, and one of them is TRACE MODE package, manufactured by the Russian AdAstra Research Group, LTD firm.

The system allows creating difficult disrtibuted IPCAS (Industrial Process Control Automation System) in general without programming - in the specialized graphics editors using a nomenclature customary for engineer-technologists. A number of labour-consuming operations, which usually hamper development of Control Automation System (CAS), TRACE MODE executes automatically, that reduces periods of development with 5-6 up to 2-3 months [3].

For the polysilicon cultivation technological process (TP) the main parameters of regulation are as follows [1, 2]:

1. the temperature of polysilicon rods (PSR);
2. the speed of feeding initial material - mixture of hydrogen/threechlorinesilicon gases;
3. the molar relation of hydrogen/threechlorinesilicon gases mixture.

The monitoring system and regulations of main process parameters has three levels:

- level of controllers - on the basis of 984 series controllers of Modicon firm;

dispatching level - on the basis of the second personal computers (PC), real time monitor (WIN MPB™), NetLinkRTM™, doubled servers of archives, inexpensive

- documentation server for local network and network printer;
- administrative level - on the basis of the second PC and second Supervisor™.

The introduction outlines of regulation of main parameters process run under the TRACE MODE of the SCADA-system will allow optimize the technological process with the purpose of obtaining high cleanness silicon adequate GOST 2169-69, save the electrical energy, threechlorinesilicon and hydrogen.

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Optimal Process Control of Electrical Purification of Gases with Forecasting of Perturbations

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The process of electrical purification of gases is carried out in dry electrical filters and concerns to the most effective and widespread processes of purification of gas streams from the fluidized fragments [1].

Feature of electrical purification is that the technological process should flow past in the restricted range of allowable modes of operation characterized by voltage corona discharge Uj^{kp}. And to possible modes of a current state of object can be referred:

- a zone of allowable modes - areas without spark discharges $Uj^{kp} < Uj < Uj^{ип}$, and spark discharges $Uj^{ип} < Uj < Uj^{мип}$. The narrow subregion of the single spark discharges of low power and duration also concerns to this zone;
- zone of emergency operation including areas of the powerful spark discharges $Uj^{мип} < Uj < Uj^{пр}$ and the arc breakdowns $Uj > Uj^{пр}$;
- zone of critical modes - area of lock-out of a corona $Uj^{зк} < Uj < Uj^{ип}$ and formation of a converse corona $Uj^{ок} < Uj < Uj^{пр}$.

The origin of critical modes is possible over a wide range modification of operation voltages Uj for j-th of a field of an electric filter, depending on performances of a gas stream and parameters of an electrical mode. The narrow area of optimal modes pre-spark of a zone concerns to area of the greatest efficiency of an electric filter.

Thus, the technological process of a dust collecting in an electric filter is characterized by the qualitatively isolated modes, which one essentially complicate control procedure object.

Proceeding from technological, technical and economic requests presented to management of process of electrical purification of gases and with allowance for of features of object of management the problem of management is formulated, solution by which one connected with forecasting of electrical variables of process for duly parrying of possible emergency and critical modes and with allowance for modifications of performances of a dust-gas stream, maintaining of such condition of object, which ensure efficiency of electrical purification of industrial gases.

The object of management is under influencing of observable external effects, integrated in a vector function: $\chi = \{V, W\}$. Here V - population of command signals $V = \{Uj\}$, W - population of observable perturbations effects $W = \{C_{SO_2}, C_{O_2}, Q, \theta\}$, $C_{SO_2}, C_{O_2}, Q, \theta$ - accordingly concentration of sulphurous anhydrite, oxygen, flow and temperature of a gas stream. At the first stage the valuation of predictablis boundary parameters Uji (j = КР, ЗК, ОК, ИП, МИП, ПР), dependent from external effects, performances of a gas stream and electrical field of a means by an introduced vector function χ (T) is made.

$$\begin{aligned}
&U_j^{KP} = f_{KP}(C_{SO_2}, C_{O_2}, \theta),\\
&U_j^{ЗК} = f_{KP}(Q, U_j, I_j),\\
&U_j^{OK} = f_{KP}(C_{SO_2}, C_{O_2}, \theta, U_j, I_j),\\
&U_j^{ИП} = f_{KP}(Q, \theta, U_j, I_j, U_{j-1}, I_{j-1}), \qquad (1)\\
&U_j^{МИП} = f_{KP}(Q, \theta, U_j, I_j, U_{j-1}, I_{j-1}),\\
&U_j^{ПР} = f_{KP}(Q, \theta, U_j, I_j, U_{j-1}, I_{j-1}).
\end{aligned}$$

Thus, predictor by itself a mathematical model "input - output".

$$Uji\,(t + l) = F\,[l, X\,(t), \chi\,(t, t + l)]. \qquad (2)$$

Where λ - magnitude, defining horizon of forecasting; X (t) - information which is being available in a the present situation of the time t, about the realized signals χ;
χ (t, t + λ) - suspected future significance of

a vector function x in gap [t, t + λ]; F [λ, X (t), χ (n) (t, t + λ)] - function conversing appropriate arguments to the prognosis of those significances Uj^j, which one will appear on an output in the moment t + λ.

At the second stage the conclusion of object in area of allowable modes with the help of the block of logical control is carried out. In this block on calculated forecasting the management is transmitted to significances of boundary of area of emergency operation to the situational block, which one will organize a step by step modification of an operation voltage, and removes a technological mode in area of allowable modes.

For want of detection of suspected lock-out of a corona the logical block parses a technological mode of an electric filter and if $Uj < Uj^{ип}$, the operation voltage is augmented up to magnitude $Uj^{ип}$, if for want of it there was no magnification of a current of an electric filter, is made a decision on a diminution of gas flow rate on magnitude DQ, amount, resulting in to decrease, of fragments of dust acting at an electric filter in unit of time, and accordingly to a current increase.

For want of origin of a converse corona the signal about necessity of temperature rise of gases is issued with the purpose of decrease of specific electric resistance of dust, that should reduce in liquidation of a return corona and simultaneously control action on decrease of an operation voltage $Uj = U_J^{OK} - \Delta U$ is reshaped, for want of which one the return corona is suppressed. If temperature of gases has reached(achieved) threshold significance, the control action on regeneration of electrodes, by means of shaking is reshaped.

For want of shaking of electrodes voltage of a field reduce before voltage

$U_j \leq U_j^{кр}$ of clearing of a corona discharge. For want of decrease $U_j \leq U_j^{кр}$ the current of a corona practically misses, that results in essential decrease of an operation of electrical adhesive forces and for want of shaking of electrodes the minor adhesive forces of triping and dust as large conglomerates are overcome only, falls in bunker. Then voltage increase up to the previous operation voltage.

Further, in the field of normal modes the problem of optimal control of an electric filter is decided, which one is encompass byed choice of such control actions on an operation voltage of fields Uj, for want of which one the maxima of criterion of control of the average profit P (t) on 1 ton of the caught dust is reached.

$$P = N_1\eta - \nu_2 W, \qquad (3)$$

Where ν_j (j = 1,2) - weight coefficients, defined generally by expert way, proceeding from requests of production. The offered criterion has quite definite technological sense. So if to accept $\nu_1 = C_1ZQ$, where accordingly C_1 - cost of the caught dust, Z - source dust content; and $\nu_2 = C_2$ - cost of the consumed electric power, the criterion P is possible to interpret as economic criterion of the profit of plant operation of a dust collecting.

Potency and degree of clearing of gas of an electric filter are defined by following ratio:

$$W = \sum_{j=1}^{m} \rho\ J[n+1]\,Uj2; \quad (4)$$

$$\rho\ J[n+1] = q1j\ \rho\ J[n] + q2j\ \rho\ J[n-1] + q3j\ \rho\ J[n-2]; \quad (5)$$

$$\eta = 1 - (1 - \eta\ 1)(1 - \eta\ 2)\ldots \ldots(1 - \eta\ M); \qquad (6)$$

$$\eta_j = 1 - e^{-\frac{kUj^2}{Q}} \qquad (7)$$

The modification of performances of a gas stream results in a modification a voltage of breakdown and, accordingly, to a voltage variation of a beginning of spark discharges $Uj^{ип}$. Proceeding from the analysis of technology of process of an electrical purification of gases, it is impossible to suppose course of process in a mode of powerful spark discharges in connection with secondary ablation dust and lossy of electric power on spark discharges. Therefore voltage $U_j^{ип}$ is a upper bound of a modification of an operation voltage U_j; in this connection U_j it is necessary to support in limits:

$$Uj_{кр} < Uj = Uj_{ип}, \qquad (8)$$

$$Uj_{кр} < Uj = Uj_{ок},\ Uj_{кр} = Uj = Uj_{зк}, \quad (9)$$

Forecasting of significance Ujкр, Ujок, Ujзк, Ujип, are defined by ratio (1), (2).

The formulated mathematical formulation of control (1) - (9) concerns to problems of conditional optimization and is decided by a method of penalty functions with usage of a method Fletcher-Reeves. The computing circuits differ by an exclusive simplicity and are realized on modern industrial computers interacting to appropriate controllers.

The conclusion. On the basis of the offered approach two stages of process control of an electrical purification of gases the system of automatic optimization of process of electrical filtering is realized. The outcomes of management have shown efficiency of an offered method.

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Optimal Control of a Thermal Mode Reverberatory Smelting of Copper Concentrates

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Reverberatory smelting is the most important link in technology of deriving copper, largely to defining course of processes in next technological bays. Irrevocable losses copper with slags and small, on a comparison with others process stages, the power consumption causes essential influence of the given process to technical and economic parameters of copper production [1].

In conditions of high cost of coal dust fuel, including expenses for its preparation and significant power consumption of process reverberatory smelting fuel expenses are by one of the major making cost price of copper matte, even insignificant in percentage terms economy of fuel gives essential economic benefit, therefore decrease of fuel expenses at reverberatory smelting represents an actual problem.

As a result of burning fuel the plenty of the strongly heated up gases being the basic heat-carrier is formed from which the surfaces of banks, arch of the furnace and surface of a metal pool are heated up. The process of heat exchange in the furnace is carried out in the basic radiation, thus of a surfaces blend and a metal pool receive heat as directly from a gas stream, and from a surface arch and top part of walls [2].

As the practice shows, the size of fuel expenses relation to a unit of quantity smelting of a blend, is defined by the characteristics of the unit, blend, fuel, construction of fuel injector, but first of all by conditions of burning of fuel, i.e. mode of blast into furnace and distribution of fuel between in parallel working coal dust fuel injectors. At an experimental research is established that an efficiency of work of separate fuel injectors is various. It is caused by difference of the characteristics of fuel injectors and orientation them in space of the furnace, unhomogeneous structure of distribution blast for fuel injectors, change of banks of blend and crust in the furnace, heterogeneity of blend structure . Thus, reverberatory smelting as object of control concern to a class many-dimensional, non-stationary, inertial objects with the incomplete information. The control of such objects is usually carried out with use of mathematical model of process.

The experience of operation of reverberatory furnaces shows, that significant inertia of process, for small amplitude of low-frequency components inputs variable exclude the obviously expressed transient modes of smelt. The drift of a number of the factors resulting to non-stationary of process, occurs slowly enough. All this, in a combination to continuity of process allows being limited to construction of static model of object and use of methods of quasi-stationary optimization at optimum control.

Taking into account of results of researches the mathematical model of process reverberatory smelt was under construction as system of the following equations:

$$\left.\begin{aligned} y_1 &= a_0 + \sum_{i=1}^{4} a_{1i} x_i + \sum_{j=1}^{6} a_{2j} T_j \;; \\ y_2 &= b_0 + \sum_{j=1}^{6} b_{1j} T_j + \sum_{l=1}^{n} b_{2l} x_l ; \\ T_j &= c_0 + \sum_{i=1}^{4} c_{1i} Q_i + \sum_{j=1}^{4} b_{2j} g_{j\nu} ; \nu = \overline{1,2} ; \end{aligned}\right\} \quad (1)$$

where y_1 – the contents of copper in waste slag (%); y_2 – quantity of smelting rate of blend (т); T_j – temperature of j^{-th} zone of the furnace; x_i – the contents of i^{-th} component in blend; Q_i – the flow of fuel on i^{-th} to the fuel injector of the furnace; $g_{j\nu}$ – the flow of ν-th blast on j-th fuel injector.

At the fixed chemical structure blend x_i the contents copper in waste slag y_1 and smelting rate y_2 is function from a temperature structure of the furnace. Then the problem of control of process reverberatory smelting is reduced to a problem of control of a temperature mode of the furnace, input variable which the loading of fuel on fuel injectors and flow characteristics of blast, and output - value of temperature in the fixed points of the furnace are. In this case a problem of control can be formulated as follows: to ensure a temperature structure in space of the furnace at the minimal flow of total fuel on all torches at execution of restrictions on: a) to the given temperature structure of flame space of the furnace; b) to limiting value of the flow fuel on separate fuel injectors; c) to a ratio between the total flow of fuel and flow of primary air; d) to the contents copper in slag and smelting rate of blend.

The mathematical statement of the given problem has a kind:

$$\left.\begin{array}{l} [\min\{\left|\sum_{i=1}^{N} Q_i\right| / y_1 = a_0 + \sum_{i=1}^{4} a_{1i}x_i + \sum_{j=1}^{6} a_{2j}T_j; \\ y_2 = b_0 + \sum_{j=1}^{6} b_{1j}T_j + \sum_{l=1}^{n} b_{2l}x_l \\ [y_1^{\min} \le y_1 \le y_1^{\max} \\ y_2^{\min} \le y_2 \le y_2^{\max} \\ T_j = c_0 + \sum_{i=1}^{4} c_{1i}Q_i + \sum_{j=1}^{4} b_{2j}g_{j\nu}; \nu = \overline{1,2}; \\ T_j^{\min} \le T_j \le T_j^{\max}, \quad Q \in \Omega, \quad g \in G\}] \end{array}\right\} \quad (2)$$

where Ω, G – areas of allowable value of fuel and components of blast; $T_j^{\min}, T_j^{\max}$ - accordingly minimum and maximum value of temperatures of j-th zone of the furnace.

The conclusion. The research of a thermal mode of the reverberatory furnace that was conducted with the help of models have shown a possibility of decrease of total flow of fuel on 10 % below than its average value. And the economic benefit of introduction of a system is equal 110.000 $ of USA.

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Modeling of Electric Smelting Lead Containing Dusts of Copper Production

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The processing industrial products of copper production specially dusts, which containing heavy, rare-earth, trace-rare, noble metals now is rather important and is urgent. The complex processing of these materials reception of commodity products: lead, noble and rare metals.

By most perspective, ecologically pure, is industrial mastered, which allow receiving high technical and economic parameters, is the electrothermal way of processing lead containing dusts of copper production. A dust of copper production - difficult material for break-down, which containing basic components of lead, sulfur, copper, zinc, rhenium, gold and silver.

The processing dust of copper production with use electrothermal smelting substantially depends on structure blend, mode of thermal processing, of a mode of submission reagent and provides heat treatment at the presence of salts of alkali-earth metals, restore, iron chip.

In process of smelting leaden dusts copper the following chemical reactions [1] proceed:

$$\left.\begin{array}{l} PbSO_4 \to PbO + SO_2 \\ PbSO_4 + 4CO = PbS + 4CO_2 \\ PbSO_4 + PbS = 2Pb + 2SO_2 \\ PbO + CO = Pb + CO_2 \\ PbS + Fe = Pb + FeS \end{array}\right\} \quad (1)$$

The equations (1) the describing basic chemical processes are fixed in a basis of synthesized mathematical model of electrical smelting of lead containing dusts of copper production.

At construction of mathematical model of electrical smelting of lead containing dusts the following assumption are accepted:

-smelting of blend occurs at the expense of heat received from moved through electrodes of the electric power;

- division of melt on two phases: the crud lead and matte-slag is carried out with distribution of melt components between them;
- sources of receipt of heat in the electric furnace are warmly, selected at the expense of passage of an electrical current through smelt and exothermal reaction;
- a heat lost at the expense of departing gases which are let out by issued crud lead and matte- slag and as a result of losses through walls and bottom;
- the productivity smelting rate of blend is defined by capacity of the furnace.

In view of the accepted assumptions the mathematical model of process the smelting of leaden dusts copper can be submitted by set of the differential equations of material and thermal balances on reacting connections of matte-slag and gas phase determined by dependences between concentration of connections with reactions (1).

The equations of material balance the following:

$$\left.\begin{array}{l} V\rho \dfrac{dc_{PbSO_4}}{dt} = \Phi^{ux}_{bSO_4} - k^1 \dfrac{1}{4} \dfrac{\mu_{PbSO_4}}{\mu_{CO}} \Phi^2_{CO} - \\ - k^2 \dfrac{\mu_{PbSO_4}}{\mu_{PbS}} \Phi^3_{PbS}; \\ V\rho \dfrac{dc_{PbO}}{dt} = k^1 \dfrac{\mu_{PbO}}{\mu_{PbSO_4}} \Phi^1_{PbSO_4} - \\ - k^4 \dfrac{\mu_{PbO}}{\mu_{CO}} \Phi^4_{CO}; \\ V\rho \dfrac{dc_{PbS}}{dt} = k^2 \dfrac{1}{4} \dfrac{\mu_{PbS}}{\mu_{PbSO_4}} \Phi^2_{PbSO_4} - \\ - k^3 \dfrac{\mu_{PbS}}{\mu_{PbSO_4}} \Phi^3_{PbSO_4} - k^5 \dfrac{\mu_{PbS}}{\mu_{Fe}} \Phi_{Fe}; \end{array}\right\}$$

$$
\left.
\begin{aligned}
&V\rho\frac{dc_{Pb}}{dt}=k^3\Phi^3_{PbSO_4}\frac{\mu_{PbS}}{\mu_{PbSO_4}}-\\
&-k^4\frac{\mu_{PbO}}{\mu_{CO}}\Phi^4_{CO}-k^5\frac{\mu_{PbS}}{\mu_{Fe}}\Phi_{Fe};\\
&\frac{dG_{Pb}}{dt}=\Phi_{шх}(c^{шх}_{PbSO_4}+c^{шх}_{Pb}+c^{шх}_{S})-\\
&-(\Phi^{SO_2}_{Pb}+\Phi^{CO_2}_{PbS}+\Phi^{CO_2}_{Pb})-\Phi_{FeS};
\end{aligned}
\right\} \quad (2)
$$

Where V - volume of smelting zone; ρ - density of matte-slag emulsion; $\Phi^{шх}_{PbSO_4}$ Φ_{Fe} - flows of $PbSO_4$ with blend and iron chip that acting on smelt accordingly; Φ^i_j - flows of j-th substance on i-th reaction; $c^{шх}_j$ - concentration of j-th components in blend; c_j - concentration of j-th substance; μ_l - molecular weight of l -th substance; k^i - distribution coefficient of j-th substance on i-th reactions.

Thermal balance is described differential equation determining change of quantity of heat in the furnace, as difference of heat, coming and leaving flows, which can be submitted as:

$$
\begin{aligned}
&\frac{dT}{dt}=\frac{1}{c_\rho V_\rho}[Q_{вх}-Q_{вых}\pm\\
&\pm\sum(\pm q^i_p)k^j_p c^j-\lambda F(T-T_н)]
\end{aligned}
\quad (3)
$$

Where $Q_{bx}=\Phi_{шх}c^{шх}_p T^{шх}+\sum_{l=1}^{L}Q^l$ - thermal flows of input products; Q^l - is heat, which turns out as a result of an electrical current on l -th phase;

$$
\begin{aligned}
&Q_{вых}=\Phi_{шт-шл}c^{шт-шл}_p T+\\
&+\Phi_{Pb}c^{Pb}_p T+Q_{от.г}+Q_{исп}+Q_{дис}
\end{aligned}
$$

thermal flows of output products; $\Phi_{шт}, \Phi_{шл-шт}, \Phi_{Pb}$ - mass flows of blend, matte-slag and crud lead; c^j_ρ - heat capacity j - flow; $Q_{от.г}, Q_{исп}, Q_{дис}$ - is heat, carried away with departing gases spent for vaporization acting with blend of a moisture, acting with, maximum sulfides accordingly; $T, T^{шх}, T_н$ - accordingly temperature smelt, blend and outside wall of the furnace, λ - coefficient of a heat transfer; F - surface of heat exchange.

The third and fourth members of the equation (2) accordingly characterize the output heat or loss at chemical reactions and carried away cooling system.

Heat, which turns out as a result of an electrical current on everyone l -th phase, is defined with the help of the following expression [2]

$$
Q^l=\int_0^T[u^l(t)]^2\cdot R^l(t)dt \quad , \quad (4)
$$

where $u^l(t)$ - voltage of l -th phase; $R^l(t)$ - resistance of a conditional conductor at passage of a current

$$
R^l(t)=\frac{d_{эл}\cdot K^l\cdot H^l_{эл}}{\rho\cdot\ell_2} \quad , \quad (5)
$$

where $d_{эл}$ - diameter of an electrode, ρ - specific resistance of matte-slags, $H^l_{эл}$ - depth of immersing of electrodes to - th a phase, K^l - coefficient of proportionality; ℓ_2 - distance between electrodes.

The quantity of smelting rate of blend is defined with the help of the equation

$$
\Phi_{шх}=\sum_{д=1}^{L}\frac{Q^l}{T_{пл}\cdot c_{шх}} \quad , \quad (6)
$$

Where $T_{пл}$ - temperature of smelting blend, $C_{шх}$ – heat capacity of blend.

Besides it the mathematical model includes the following restrictions such as inequalities:

- Under the charge of blend

$$
\Phi^{min}_{шх}\le\Phi_{шх}\le\Phi^{max}_{шх}; \quad (7)
$$

- On temperature

$$
T^{min}\le T\le T^{max}; \quad (8)
$$

- On a voltage of l -th phase

$$
u^l_{min}\le u^l\le u^l_{max}. \quad (9)
$$

Given mathematical model (2-9) allows to make accounts of conducting process at various modes of operations and to define power charges on electrical smelting lead containing dusts of copper production.

The conclusion. The imitating researches with model help, have allowed revealing basic mode parameters of technological process. On the basis of these researches was received the data that used at designing half-industrial equipment. By results of the carried researches are doing outline project of the industrial equipment and function chart of its automation is developed.

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Modeling and Optimization of Solutions Granulation Processing The Pseudo-Liquefied Layer

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The granulation processes of solutions in the pseudo-liquefied layer (PLL) are considered in three aspects: makro - and microkinetics, warm - and weights exchange, and also balance of particles number. Makrokinetics property of similar processes are taken for information when the model with the concentrated parameters is made. The following assumptions are adopted at the description of a microkinetics : the growth rate of granuls does not depend on their size, and depends from a full surface of particles in a layer.

Thus, the mathematical description of process is reduced to a ratio for balance of particles number with account its makro - and microkinetic properties. The mathematical model, known from the scientific literature, was used for research of the physical gear of the phenomena and analysis of process in laboratory conditions. In practice such model cannot be applied, because the information about of kinetic constants of splitting is unknown. Therefore was made the mathematical model which is possible for using in real industrial conditions for assessment of a layers granulometrical structure that determine stability of granulation processes and can't be automatically measure.

The received mathematical model is represent as the following set of equations:

$$\Pi_j = \begin{cases} a_1[1-a_2(h_{сл}-a_3)](2R_j^2 - a_4 2R_j)\Delta t + a_5\Delta t^2, \\ 0, \quad if \quad j=3,2,1, \end{cases}$$

$if\ j = 6,5,4$

$$\rho_{j-1} = \rho_j \cdot \frac{\lambda - \Pi_j \cdot \dfrac{(j-1)^3}{j^3}\Delta R}{\lambda - \Pi_{j-1}\Delta R - \Delta R\left[K - \dfrac{3\lambda}{\Delta R(j-1)}\right]},$$

$$\sum_{j=6}^{1}\rho_j = 1, \quad \Delta t = \frac{t_{сл} - t_{кип}}{t_{кип}},$$

Where Π_j - probability of a particle splitting ; $a_1 \ldots a_5$ - are process parameters; hсл - a layer altitude; tкип - temperature of a solution boiling; Rj - particles radiuses; ρ_j - weight share of a j-th fraction; ΔR- width between radiuses step ; To - constant of a speed unloading; λ - growth rate of particles; tсл - temperature of a pseudo-liquefied layer. On this model was calculated the optimum of technological mode of process that allowed considerably to increase productivity of the PLL furnace.

The Automated Monitoring and Control System of main Processing of a Metallurgical PGV Package on BMZ, Corporation "Kazakhmys"

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During control process of principal processings of PMM package (coal and mixture charging facilities, feed system of oxyair mixture (OAM), water-cooling system) technological features of their operation should be taken into account.

Monitoring and control of PMM package is carried out by the automated system of the ASC PPM created on the basis of modern measuring, microprocessor and computer devices and put into operation in July, 1999. The system platform of ASC PPM is based on the engineering software of Siemens Corporation.

Control of melting at the PMM package is carried out from automation-equipped working places (AEWP) by the master of shift, PPM controller and operator of the recovery boiler on the basis of experience and analysis of the instrumentation indications mapped on appropriate fragments of mimic panels of results of chemical analysis of melting products and the items of information from the work staff.

Control of the processing of the VF system also is realized with the help of AEWP by change of the tasks (settings) given to local systems of automated regulation (SAR) or to regulating devices of an air-flow rate, mixture, fluxing stones etc. in a mode of local and remote control.

User interface of the ASC PPM is realized in traditional style for modern Windows applications and ensures possibility of prompt monitoring and control of processes on the PMM package from a workstation (WS). Basis of the interface is SCADA - WinCC system. The information on processes in PPM is displayed on the workstation screens as mimic panels located in Windows panels. Basic set of mimic panels of the ASC PPM provides visualization of the on-line data both all over the system and on separate processings.

Except for the main ones there is a series of supplementary mimic panels together with auxiliary windows permitting to realize scanning and correction of the abnormal and technological boundaries settings, to change scales of data units, to form and to print the shift diurnal records, diagrams of parameters variations, to control remotely by actuators and state of the equipment. The structure of the window for the base mimic panels is strip-chart unified. In its top part the buttons of call of the mimic panels which are not mapped in the given moment on the screen are located. Middle part contains alone mimic panel, and in lower are respectively the buttons: the system, alerts, trends and signal system.

The base concepts fixed in a basis of designed and put into operation of the first stage of ASC PPM package give an opportunity of widening and modification of its functions, to improve the user's characteristics of the system based on the experience of its maintenance and to carry out integration of a ASC PPM with the system of works management.

Monitoring and Control of an Integrated Power Complex of PGV at Balkhash Integrated Mining-And-Metallurgical Works

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Processing of pool melt (PPM) of Balkhash integrated mining-and-metallurgical works (BMIW) is the main package of metallurgical treatment of copper sulfide raw materials on the plants of KAZAKHMYS Corporation.

As an object of monitoring and control PPM package is characterized by considerable persistence, numerous input and output variables, by their correlation and difficulty to be measured continuously, influence of perturbations, presence of transport delays. Monitoring of processing of PPM package is carried out on the basis of information from more than 180 measuring devices (concerning temperature, pressure, flow etc.) and state estimation of the equipment of metallurgical system (more than 250 state data units).

Maintenance of preset operation parameters of the metallurgical system that provide its rational operation (from the point of view of maximum extraction of copper in a matte smelting, trouble-free operation of the processing equipment, at a preset specific capacity) is carried out due to of coordinated control of basic technological process stages of the PPM package.

Functions of monitoring and control of the given technological object are realized by means of the computerized monitoring and control system, which is designed and put into operation in June - August, 1999.

System basis of an ASC PPM are constituted by the engineering software of the Siemens Corporation.

The functional and technical structure of the automated system can be described as two-level one, lower level functions of which (reception of data from data units describing a state of the technological system, primary data processing, output of control actions to actuators etc.) are realized on controllers Simatic S7-400 and object couplers (OC) Simatic S7-300. Top level functions of ASC PPM providing prompt interaction of technological staff with the system and supporting decision making on control of separate units and technological system of PPM as a whole are executed by workstations.

Program implementation of top level functions of ASC PPM is realized on the basis of SCADA - system WinCC (joint product of Siemens and Microsoft), the implementation of monitoring and control algorithms on a lower layer of the system is carried out by software tools system Step7.

The works carried out on creation and putting into operation of the first stage of the automated monitoring and control system of PPM package characterize the first stage of construction and development of ASC PPM. Broadening of functions of the system and improvement of its characteristics will be carried out on the basis of experience of the system maintenance and users recommendations.

Simulation of the Operation of Mining Transport Systems in Conditions of the Trains Traffics Transformations

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The peculiarity of the open-cast mining in the former soviet countries is the development of useful mineral deposits mainly by the large end middle quarries with applications of auto, trains and combined auto-trains transport. This is conditioning the high complicity and dimensions of the mining-transport systems. In this conditions and particularity for so large mining country as Kazakhstan, the development the methods and the informative technology of operative managing by these systems is the effective and actual direction in the development of the mining production.

At the open-cast mining with application of railway transport the transformation of the trains traffics have your place at the necessity the transportation of extracted ore to the moved away factory. The mining-transport system with the moved away factory represent the internal quarry party, which distinguish not from the systems analogous in the ordinaries conditions, and exterior, including as a rule a number stations, posts and sidings connected one with another successively. As the particularity principal of the mining-transport system functioning in conditions of the moved away factory is the transformation of the trains traffics coming to the specialized station from the quarry and factory.

The work of the stations, where the forming and disbandment of trains are realized, have enough essential specific peculiarities different from the ordinary stations.

All of the specific peculiarities make practically impossible application the methods generally accepted and the already having program and information complex of optimization of the open-pit's mining-transport systems.

Conclusion. In results the direction connected with the development of the informative technologies of management by mining-transport systems on quarries received yours development. For the first time the data bases, detailed algorithm and complex of program of reproduction of work of mining-transport system, functioning in conditions of transformation of the trains traffics are going to the moved away the quarry factory, were developed.

Application of Standard Software Packages in Development of Gas and Oil Fields

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Now rises of blow-down recovery widely apply to an intensification of crude oil production and a way of maintenance of reservoir pressure by out of contoured and inside of contoured water flood, the performance which one substantially depends on reliability of the prognosis of production activity of fluid in time under the applicable calculated method of applications.

However at stages of compiling of the updated projects of development, analysis, check and the regulations of engineering process of oil and gas fields are essentially indispensable more exact hydrodynamic accounts which are taking into account a number of the factors, for filtering, defining an oilpainting: multitabular nature of operation objects, zone and laminated(stratified) discontinuity of benches, them view of lens and discontinuity, interference of individual wells, nature of movement of oil-in-water outlines at the various order of input and shutting down of wells. The solution of the task of expulsion of oil by water in view of the enumerated factors requires conducting accounts of twodimensional currents.

The method of applications, depicted in operation, of account of indexs of water flood can be successfully used for problem solving of optimization and current handle of engineering processes of oil and gas fields, as allow to inflect modes of operations of a well, to include or to cut off wells in a displacement process. Besides it is not required, as it is accepted at posing the given tasks, a priori supposition about an invariance of a matrix of coefficients of influencing in a researched spacing of exploitation of oil and gas fields.

The tasks of filtering, about which one there is a speech, have a lot of particular features handicapping, and standard numerical methods, frequently doing(making) to impossible applying, well recommending itself for other classes of the tasks. Therefore it is important to understand, what features are connected to an entity of the source physical tasks, and what are introduced by choice of mathematical model. Already at this stage we collide with necessity of all-up learning of two links: the physical phenomen — mathematical model. The further analysis results in necessity of learning of links for links: mathematical model — algorithm and algorithm — the program on the computer. Thus we come to necessity of learning and optimization of all technological chain of modern calculus mathematics:

the physical phenomen — mathematical model — algorithm — the program on the computer.

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Mathematical Modeling of Installation of "Klaus 400"

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The problem of slipshod optimizing of control of «Klaus 400» setting is considered.

Technological scheme of the setting consists of the following technological assembleys comfustion chamber, gas heater, three Klaus reactors, utilization system of reaction heat, and system of collection and pumping liquid sulphur out.

Products of the «Klaus 400» setting are elementary sulphur and tail gas, that used as a row material for «Klaus 500» setting. The purpass of the sulphur removing from the oil is the receiption of elementary sulphur y1.

Expenditure of acid gas x1 and expenditure of air x2 are bacic forces influenced on the sulphur output. Control parametress are the temperatur of first layer x3, the temperature of the second layer x4, the temperature of the second layer x5.

Comfustion chamber and Klaus reacrors were choosed for the control of elementary sulphur output. Further investigations have shown, that qualitative indexes should be under the as elementary sulphur received from Klaus setting is the material for consumption.

The problem of optimizing of Klaus 400 setting consists in determinationof control variables x3,x4,x5 that provide maximum output with given values of influence forces x1 and x2.

Mathematical problem is formulated as following:

$$y=f(x1,x2,...,x5)\rightarrow\max$$

with limitations:

$$y=\varphi_1(x1,...x5)\geq B1;$$

$$x_i^{\min}\leq x_i\leq x_i^{\max}$$

Mathematical Formulation of the Optimal Control Problem of Power System Machinery Working in Parallel Scheme

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Automatic system regulation (ASR) of power complex is one of the most important elements of the entire energy regulation system setting out its economic characteristics providing reliability and safety at aggregates working in different conditions which oceure in the course of exploitation of energy complex. In order to put (ASR) in operation and receive certain info of its working functions, there is a task of modeling of a system of objects and elements of system control. Based on that it would enable us to determine parameters of regulating effects. In differents stages of regeaxces a scholar may get interested in various characteristics and qualities of the object. In principle, in this situation there may be used either one universal model encompassing all range of qualities in question, or a series specialized models each of which targeted to solving a particular range of problems and flows focus on only those characteristics of the object that are necessary for such purposes. When setting a task, over universifying a model should be avoided, because it may resulting considerable increase in difficulties connected with such modeling, and as a result goes down when using a computer accuracy of research. Power objects have certain particular features determining a particular type of regulation and managing task such peculiarities are non-homogeneous material flow, and also changing nature of the two main parameters of the mathematical model of. When doing research on modeling of optimal management system it was required to do the following:

1. Elaborate mathematical model of redistribution of pressure in the system of parallel monotype technological operations;
2. To elaborate a new from existing and easily operational method of pressure redistribution for parallel technological operations their monotype nature;
3. Based on such method, to elaborate algorithm of managing a pressure redistribution;
4. To create a system of management of energy complex as a problem.

Redundancy Management of Computer System With Multiplexes

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Suppose system consists of seven elements, and each element failure does not depend on the rest element failure. Failure probability of the element is listed in a Table.

Table

Element number	1	2	3	4	5	6	7
Failure probability (q_i)	0,013	0,037	0,052	0,009	0,047	0,066	0,075
Faultless work probability (p_i)	0,987	0,963	0,948	0,991	0,953	0,934	0,925

It is required to find a failure probability of X system elements in a fixed period of time.

Define $q_i(x)$ as an unknown quantity. To find it we'll use Puasson law in independent test scheme with different probabilities. Then, if create a product as follows

$$\prod_{i=1}^{7}(q_i\xi + p_i x) = (q_1\xi + p_1 x) * (q_2\xi + p_2 x) * \ldots * (q_7\xi + p_7 x), \quad (1)$$

it will be equal to expansion

$$q_7(0) + q_7(1)\xi + q_7(2)\xi^2 + \ldots + q_7(7)\xi^7, \quad (2)$$

where ξ is non-computing parameter, $q_7(i)$ is a simultaneous failure probability of i elements of 7.

Make a product

$$(q_i\xi + p_i x) = (0.013\xi + 0.978) * (0.037\xi + 0.963) * (0.052\xi + 0.948) * (0.009\xi + 0.991) * (0.047\xi + 0.953) * (0.066\xi + 0.934) * (0.075\xi + 0.925).$$

After binomial transform we get

$$q_7(0) + q_7(1)\xi + q_7(2)\xi^2 + q_7(3)\xi^3 + q_7(4)\xi^4 + q_7(5)\xi^5 + q_7(6)\xi^6 + q_7(7)\xi^7 = 0.7352 + 0.232\xi + 0.029\xi^2 + 0.002\xi^3 + 7*10^{-5}\xi^4 + 15*10^{-7}\xi^5 + 10^{-8}\xi^6 + 5*10^{-11}\xi^7.$$

Thus, system faultless work probability makes $q_7(0) = 0.735$, $q_7(1) = 0.232$, $q_7(2) = 0.029$, $q_7(3) = 0.002$.

Practically, failure of three system elements is a hardly probable event. Therefore, thrice-repeated redundancy for the described system is considered to be sufficient.

Principle of majority redundancy on micro-level has been suggested. This principle works on the level of elementary cycle operation execution when failure probability in two devices (in the same cycle of the computer system) is a minimum possible magnitude. Generally, probability of getting in correct result is found as multiplication of a word length in bits by number of task execution cycle.

Solution Methods of Network Configuration Synthesis

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Let $I=\{1,2,...,n\}$ be a large number of net vertices, x_i - a characteristic vector of i-vertex condition ($i \in I$); u_r - a characteristic vector of independent governing influences condition. Its dimension is q_r, $r \in R$, $R=\{1,2,...,m\}$. If the i-vertex's condition depends on j-vertex's conditions, then let it be designated $j \in I_i^+ \subset I$, and $r \in R_i^+ \subset R$; f_i - a vector function is nonlineal in a general case. Let a large number of net vertices of entrance be designated I^0, $i \in I^0=\{j \in I: I_j^+=\varnothing\}$; the conditions x_i^0 of net vertex's of entrance are given: $x_i=x_i^0$; f is a given purposive function, $u \in E^q$ $u \in E^q$, $q=\sum_{r \in R} q_r$, $x=\{x_i: i \in I\}$, It is required to solve the problem:

$$f(x, u) \to \min, \quad (1);$$

$$x_i=f_i(x^i, u^i), i \in I, \quad (2);$$

$$x_i=x_i^0, i \in I^0, \quad (3);$$

$$x^i=\{x_j: j \in I_i^+\}, \quad u^i=\{u_r: r \in R_i^+\}.$$

It is necessary to find the vector of governing influences u and the corresponding vector of conditions-x, connected with correlations (2), (3) and giving a function minimum (1). It is supposed that f_i functions are differential comparatively with their arguments, and that Jacobian vector of f_i function is not degenerated in admissible sings of governing influences. It means that x_i conditions of i vertices are simply determined. The limitations on x vertices condition and governing influences u are possible.

For the solution of a given problem we've got the calculating formulae of gradient and matrix derivatives of the 2nd order of a purposive function. Besides, we took into consideration a net character of the problem. It allows us to use for the solution of a given problem the methods of the 1st and the 2nd order, in particular such effective methods as the ones of gradient's projection, possible directions, etc.

The supposed approach and calculating formulae are generalized in case of quasi-differential functions. For getting corresponding calculating formulae is used a quasi-differential device.

If there are limitations of equality and inequality to governing influences and conditions of object in a given problem the components of function limitation's gradients sought are determined. In that case the effectiveness of calculations can be greatly improved at the expense of matching component gradients of a purposive function with function limitations.

For the solution of a given problem we can use the method of Lagrange. From the necessary minimum's conditions in respect to Lagrange function are determined such functions which can be used to find the gradient of Lagrange function for free governing. Besides, Lagrange's factors must answer certain conditions.

Information/Monitoring System of the Mobile Machinery of Mining Operation

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The object of research is a system of information control of mobile objects (ICMO). The system is intended for an automatic transmission of information from mobile objects (miner trucks) about the carried quantity of the extracted mineral in conditions of underground mines eliminating participation of the man (inspector).

The system consists from:

- airborne equipment set on mineral-carriers, consisting from a microcomputer, repeater and receiver of a command signal,
- automated monitoring points, set on mineral chutes consisting of the transceiver device with the antenna, unit of processing of adopted signals and shaping unit of signals for transfer through the modem on a dispatcher station for processing and registration,
- of a dispatcher station consisting from IBM PC with the screen monitor and the printer and the software of a system, consisting from the database both package of special handlers and rendition.

For the extension of functional capabilities of a system it is possible to apply in an airborne equipment the control of a condition of mobile object (for example, weight characteristics, burn-time, covered distance and etc.).

The intrusion of the given system will allow to control transportation of the extracted mineral (or other product), excepting participation of the man. It is necessary to mark, that the system can be utilised not only in conditions of underground workings, but also in open-cast minings.

SECTION
“THE SYSTEM CONCEPTS AND APPLICATIONS IN EXPLORATION OF EARTH’S RESORSES”

Underground Constructions Reliability Assessment

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Resume.
In the report made attempt to offer an analytical method of the prognosis of reliability of underground constructions.
Key words. *Reliability, underground structures, probability of destruction.*

Introduction. While exploitation solid mineral resources by underground method a complicated system of underground constructions is created, represented by extended mine workings, differently in space, chambers of various sizes, in pillars and other minings. The net of mine workings or any pit together with winning section (ws) represents a complicated engineering construction which naturally needs the estimation of it' reliability level in the time-interval of of function for mining the mineral resources. It's clear that quite a high reliability level of underground mine workings' level, which provides their normal condition even beyond the term limitsof trial of a deposit T, isn't necessary and costs too expensive. On the other hand, a deficient reliability level of the same workings at the period of trial the deposit T drives to reduction of mining reliability, to accidents and traumatism of workers. First of all it's necessary to be able to predict a symptom of catastrophic faults while underground mining the solid mineral resources. To a number of famous and more dangerous catastrophic refusals in underground mining the followed are reffered:mountaint impacts, sudden discharge of rocks, implosions of gas-and-dust overhead mixtures, endogenous fires, water and fluid inrushes into the mine workings, sudden falls of rocks and termination of supporting constructions.

Though nature and physical process, which occur under noticed catastrophes are different, but in spite of it they depend on common regularities: these processes carry out stochastic character and therefore they can not be predicted absolutely deterministically, they depend on environmental peculiarities too much – rock management by technological process of mineral resources mining.

The most destructive power belongs to mountain impact, which can cause people victims.

For a predict of mountain impact symptom probability in a sevvage of plenary working the following condition is executed.

$$\sigma_X^o \geq \sigma_p, \qquad (1)$$

where - σ_X^o is normal voltage to stopes surface, MPa.

Observable $\overline{\sigma}_X^o$ is recommended to determine with suggested by us formula:

$$\overline{\sigma}_x^o = \overline{\gamma} \cdot \overline{H}\left(Sin\overline{\alpha} + \frac{\overline{\mu}}{1-\overline{\mu}} \cdot Cos\overline{\alpha} + \overline{k}_T \cdot Cos\alpha + \overline{k}_c \right) \quad (2)$$

The loose of statement of the massive attached to the contour is prognoses in a way of crossing odd observables $\psi(\sigma_H)$, $\varphi(\sigma_p)$: functions of distribution of voltages, that are perpendicular to stope's front and walls of mine workings, and also rock's strength to brakage. The probability of roof's rocks disturbance is determined by analogous way:

$$\psi(\sigma_H) \geq \varphi(\sigma_P) \qquad (3)$$

Let's see further algorithm of catastrophical and ordinary refusals sympthom probabilities while crossing of examined upper occasional observables massif and intensity of management.

Let's mark right-hand parts of.Inequalities (1), (2), (3) of functions of probabilities φ(S) distribution density, and left-hand with function ψ(S), then all probable outcomes of reliability determination underground workings will be formulas:

$$\hat{\sigma}_{H} < \check{\sigma}_{p};\ P_{H} = 1; \tag{4}$$

$$\hat{\sigma}_{p} < \check{\sigma}_{H};\ P_{H} = 0; \tag{5}$$

$$\check{\sigma}_{p} > \check{\sigma}_{H};\ \hat{\sigma}_{p} > \hat{\sigma}_{H};\ 0 < P_{H} < 1; \tag{6}$$

$$P_{H} = 1 - \left\{ \left[\int_{\check{\sigma}_{p}}^{\hat{\sigma}_{H}} \psi(\sigma_{H}) \cdot \int_{\sigma}^{\hat{\sigma}_{H}} \varphi(\sigma_{p}) \cdot d\sigma_{p} \right] \cdot d\sigma_{H} + \int_{\check{\sigma}_{p}}^{\hat{\sigma}_{H}} \psi(\sigma_{H}) \cdot \varphi(\sigma_{p}) \cdot d\sigma \right\}$$

$$\check{\sigma}_{H} > \check{\sigma}_{P};\ \hat{\sigma}_{H} > \hat{\sigma}_{P};\ 0 < P_{H} < 1; \tag{7}$$

$$P_{H} = 1 - \left\{ \begin{array}{l} \left[\int_{\check{\sigma}_{H}}^{\hat{\sigma}_{P}} \psi(\sigma_{H}) \cdot \int_{\sigma}^{\hat{\sigma}_{P}} \varphi(\sigma_{P}) \cdot d\sigma_{P} \right] \cdot d\sigma_{H} + \\ + \int_{\check{\sigma}_{H}}^{\hat{\sigma}_{P}} \psi(\sigma_{H}) \cdot \varphi(\sigma_{P}) \cdot d\sigma + \int_{\hat{\sigma}_{P}}^{\hat{\sigma}_{H}} \varphi(\sigma_{H}) \cdot d\sigma_{H} \end{array} \right\}$$

We've produced universal methods for calculating the observable for the normal law of distribution $\sigma^{2}_{\sigma_{H}}$ and σ^{2}_{P}.

The institute of mining engineering NAS RK has a software of solving noticed problems programmed on Personal Computers.

Conclusion. The computer system of the prognosis of reliability of underground structures is offered.

Simulation of Explosion Effects from Extended Cylindrical Charges

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Resume.

The questions of simulation of explosive affectings from extended cylindrical charges are reviewed. The expressions for fields of offset and stresses from the massed source of a type flat center of expansion are received.

Key words. *A mining massif, camera, pillar, field of stresses, field of offsets, explosive charge, detonating, dynamics.*

Introduction. Many relevant problems arising on practice are reduced to mathematical models and are described by the differential equations in proprietary derivative. The search of a solution of these equations with preset conditions compounds a class of tasks known as regional tasks. The solution of regional tasks is possible to reach by various methods. For bodies having complex(difficult) geometry of boundary, complex regional conditions to construct analytical solutions it is not obviously possible and then the numerical methods are used. Here we shall illuminate questions of use of a numerical - analytical method - method of the boundary integrated equations for problem solving of mining geomechanics.

In manufacturing practice горно-добычных to operation the extraction of mineral resources is made chisel explosive by methods and thereof there is a necessity of simulation of dynamic processes having a place at explosive affectings. Математически the explosive sources can be described by the massed impulsive functions. It is quite lawful, first, owing to no many of a diameter of a built up cylindrical charge in comparison with other geometrical sizes of developments. Secondly, the analysis of physical processes at detonatings demonstrates, that gases the explosives, formed as a result of combustion, form huge stress on a surface of a cylindrical cavity, in which one the charge is placed, causing breaking downs of a mining massif in neighborhood of a charge. The time of affecting of these gases is estimated by fractions

Owing to … the dynamic affecting of an explosive charge located in the beginning of the chosen reference system mathematician is possible to describe by the massed mass force such as " flat center of expansion ", reductants by which one

$$F_i(\mathbf{x},t) = -D\frac{\partial\delta(\mathbf{x})}{\partial x_i}f(t) \qquad (1)$$

∈Here D- power of a charge, □ $(\mathbf{x})$ - delta function Diraka, $f\ (t)$ - function depicting temporary behavior on some preset interim, $\mathbf{x} = (x1, x2)\ R2$.

In the homogeneous isotropic linearly elastic not disturbed mining massif the mass forces (1) spawn a field of offsets u (x, t) the reductants which one are [1]

$$u_i(\mathbf{x},t)=\frac{Dr_{,i}}{2\pi\rho c_2^2 r}\left(\frac{r^2}{c_1^2}\int_{r/c_1}^{t}\frac{f(t-\tau)-f(t-r/c_1)}{V_1^{3/2}(r,\tau)}d\tau-\frac{tf(t-r/c_1)}{V_1^{1/2}(r,t)}\right) \qquad (2)$$

And field of stresses $(\mathbf{x}, t)$

$$\sigma_{ij}(\mathbf{x},t)=\frac{DC_{ijkl}}{2\pi\rho c_1^2 r^2}\left[\delta_{kl}\left(\frac{r^2}{c_1^2}\int_{r/c_1}^{t}\frac{f(t-\tau)-f(t-r/c_1)}{V_1^{3/2}(r,\tau)}d\tau-\frac{tf(t-r/c_1)}{V_1^{1/2}(r,t)}\right)\right.$$

$$+r_{,i}r_{,k}\left(\frac{3r^4}{c_1^4}\int_{r/c_1}^{t}\frac{f(t-\tau)-f(t-r/c_1)+(\tau-r/c_1)\dot{f}(t-r/c_1)}{V_1^{5/2}(r,\tau)}d\tau+\right.$$

$$+\frac{t(2t^2-3r^2/c_1^2)}{V_1^{3/2}(r,\tau)}f(t-r/c_1)+\frac{r(2t^2+2tr/c_1-r^2/c_1^2)}{c_1(\tau+r/c_1)V_1^{1/2}(r,\tau)}\dot{f}(t-r/c_1) \qquad (3)$$

Design given, received as a result of a solution of a dynamic task, correspond to an instantaneous blasting of 30-35 kg of of seconds.

The received formulas (2) and (3) allow to determine values of fields of movements and stresses in any dot to endless linearly elastic environment (untouched massif) at the any moment of time. These formulas have the large practical value, as till now at accounts the approximate formulas are used, which one work only in the determined range of spacing interval from an explosive source. Practically all of them are suitable only for the account of the max values of stresses and do not give a temporary oilpainting of process. Here it is necessary to note, that in the formulas of stresses for an any dot of environment we have a square of spacing interval from it(her) up to a charge, which one characterizes an extent of descending of stresses at removal(distance) from a charge.

$f(t) = te^{-\alpha t} \to \infty$At conducting accounts as function specifying behavior of process in time the function was used, where a time interval on which one the mass force grows and then descends aspiring to zero point at t.

Under the formulas (2,3) the values of stresses for concrete values of an elastic constant mining massif were instituted. As audit values spacing interval from an explosive charge equal 5 ì and 20 m got out for which one there are experimental data received in mine conditions.

Two were esteemed Interplay influencing reservoirs located on depth 200 ì from a daylight area. The cameras of the upper and bottom reservoirs are laied out is on line from each other and contain till 8 cameras everyone. Width of interchamber pillars (МКЦ) d=8 m, altitude h=10 m.

The untouched mining massif is esteemed as homogeneous isotropic half space with the following technical-mechanical performances: E=1104 MPa - modulus Ung, G=0,4104 MPa - modulus of shear, μ=0,25 - coefficient Puassona.

At the maiden stage the numerical experiment was held for untouched repetitive improvement of desks with thickness Between seams, equal 20 m).

The mathematical simulation consistently learns process of forming of a dynamic field of stresses in members of an extraction chamber (pillar, a roof) and at contact a massif depending on time (elective value of dynamic stresses are given for explosive in one slowing-down in rock with decrement of occluding of seismic α=0,5.

Let's esteem a case dynamic нагружения of model, where the extraction of a boundary pillar from the upper reservoir is produced, when the power between seams minimal and is equal Δm=5 m. In an incipient state for pitches on time t=3 (6 m) and t=5 (10 m) from which one it is visible, that to dynamic affecting is subject between seams and roof of cameras located in the bottom reservoir, it is possible to dedicate two centers of concentration of dynamic stresses. One center with value 133 MPa is laied out at center between seams, that gives the basis to consider(count) this field(area) practically broken down, the second center with the max vertical stresses equal σ_{yy} =109 MPa is on an outline of an immediate roof of the camera. Thus, at breaking a support pillar by detonating will be broken down or will lose bearing capacity between seams, at lay to выемочному to a pillar and most part of a roof of cameras located in the bottom reservoir. Further at a temporary pitch equal $t=7$ (14 m), i.e. When the front of seismic waves was distributed on 14 m, there is a field of dynamic stresses, which one is laied out on center МКЦ, taking place under выемочным wholly. In this field of a stress reach σ_{yy}=20-30 MPa. The direction of operating of these stresses from center to a side surface of a support pillar, that promotes formation of tensile stresses capable to manufacture откол or a serial having broken away. In mine conditions at blasting a fan of wells, the condition circle of dynamic affecting is constructed, that the field(area) can feed by energy, which one will construct conditions for multiple having broken away.

By consideration of a pitch $t=14$ (28 m), when the dynamic field of stresses encompasses some cameras and most part between seams, in two pillars of the bottom reservoir there are zones of the spacing interval 2 m, at $Vp=5000$ м/сек). unstable state the most part of a fulfilled lease. Specially it is necessary to stop on a pitch 1, that corresponds to time 0,4 mcek or on, fronts, one of which moved on top of oil horizon - pillar, another - on ground a pillar. Such interplay of dynamic surges can promote originating of a resonance, which one constructs a condition to formation of the max tensile stresses in a horizontal plain [2].

Now we shall esteem an oilpainting of dynamic stresses, when the boundary extraction of a pillar is made at power between seams, equal Δ m=10 m. An original oilpainting of reallocating of seismic stresses around of mine workings at a pitch t=3 (6 m); 5 (10 m); 7 (14 m) is similar to that, which one was observed at power between seams Δm=5 m. The difference is encompass byed volume. That the front of dynamic stresses encompasses only pillar, broken(fallen) by detonating, and part between seams. The front of dynamic surges approaches to top of oil horizon of the bottom cameras only at a pitch t=9 (18 m). Numerical values of dynamic stresses in 1,5-2 times below similar at Δm=5 m. It is necessary to note, at a temporary pitch t=18 (34 m), on quiet and even in the numeric attitude(relation) a field of stresses having values within the limits of 5,0 MPa, occur in support pillars of anomaly with the max values σ_{yy}=15,0 MPa. As a result of interference of two fronts of surges, when at incomplete damping of one surges in the same phase the blast waves of other slowing-down are imposed, there is a resonance. Practically, such can take place at applying a millisecond-delay blasting (КЗВ) with the incorrectly picked up spacings of slowing-downs. By results of mathematical simulation we shall esteem alternative, when the extraction of a support pillar with power between seams equal Δm=20 m is made. Here it is necessary to allow for an absorption coefficient, which one essentially slashes amplitude of dynamic stresses with spacing interval. If to esteem a wave pattern at a pitch t=5; 7, it not so differs from a wave pattern, when the breaking is made with the help between seams Δm=5 m. But already at heel tooth notches on time t=10; 12, 14 the appreciable difference as in qualitative, and in a quantitative sense is visible. At between seams t=5 m all field under выемочным wholly is cramping and tensile stress, which one with available statistical stresses can result in a

of the upper reservoir by extent 40 and 60 m lease. Specially it is necessary to stop on the pulled together reservoirs having power heightened stresses, the numerical value which one does not exceed 8 MPa. The nature of formation of these zones is interesting. They were formed as a result of meeting two

included into a zone characterized heightened fracture by formation. The dynamic stresses on an outline of a roof of cameras have magnitude more than 100 MPa. At between seams Δ *m=20* m of magnitude of dynamic stresses on top of oil horizon of cameras change in limits about 10 МПа.

I analyze the received wave pattern at t=19 (38) again we collide with the phenomen of adding up of dipping and reflected surges already on top of oil horizon of extraction chambers [3]. Here as a result of interference the magnification of stretching(dragging out) dynamic stresses has taken place up to 30 MPa, which one are capable to provoke отслоение or serial having broken away on the large floor space. The power отслоения or serial having broken away will be characterized first of all цикличностью and duration of dynamic affecting.

Analyzing a nature of originating of leases with the heightened dynamic stresses, which one are obliged by the originating first of all to interplay of two fronts of surges, and secondly цикличностью of explosive affecting, it is possible to forecast originating of such anomalous leases and if necessary to avoid their occurrence by variation of the passport БВГ. It is necessary to note, that such anomalous leases are for some reason formed only on the bottom horizon, and absolutely them are not present on that horizon, where the breaking of a support pillar is made.

ΔWhen the extraction of the second and third bearing is made at between seams Δm=5; 10; 20 m, the dynamic oilpainting of a stress distribution does not undergo radical variations. Here it is necessary to pay attention that the large leases of a roof effect seismic to save up know-how BVP, have no bearings.

Conclusions. The received accounts of dynamic stresses σ_{yy} and Δ_{yy} testify that withdrawal 1,2 and three boundary is whole of the upper reservoir results that inside fulfilled desks are developed large cramping and tensile stress, which one with available statistical stresses can result in a unstable state the most part of a fulfilled lease. Specially it is necessary to stop on the pulled together reservoirs having power between seams $\Delta m=5$ m. Here zone of dynamic stresses, which one can result in breaking down, most max, and at $\Delta m=20$ m this zone minimal. The held analysis of the received results of mathematical simulation gives the basis to speak that at repetitive improvement of the pulled together reservoirs it is necessary to using potential energy overlying strata of soils.

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Analysis of Interconnection and Interaction of Internal and External Factors and Parameters of the "Opencast" System

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Resume.
The intercouplings of the factors and arguments in system "Opencast" are established, and with objects of an exterior surrounding, the results of decomposition of system on subsystems and members are stated.

Key words. *Opencast, subsystem, member, exterior environment, factors and arguments, mining-transport operations, field.*

Introduction. Feature of design augmented by computer and budgeting of opened mining operations at the given stage is wide use of the automated systems, when the opencasts are esteemed from stands of system submissions (representations) as targeted unity of collection of set of objects - reductants of system, each of which executes the determined function, technological, organizational or service process, either operation of the basic or auxiliary assigning.

The decomposition of system demonstrates opencast on subsystems (fig. 1), that the basic subsystems supplying normal functioning of opencast are: the subsystem institutes an open-pit field, which one major arguments of opencast and their intercoupling; the subsystem institutes progressing of mining operations, which one a direction, intensity, mode and calendar mine maps, mining method and its(her) arguments; the subsystem institutes opening and opening-up of an open-pit field, dynamics of forming of openings from a beginning and up to the end of improvement of an open-pit field, and also separate opening schemes, reshaped during mining, and opening-ups of horizons; the subsystem links mining-transport complexes, together operation of all technological processes of opened mining on all technological zones of opencast, reshapes soil and ore-streams with demanded by the volumetric and qualitative performances both reception of an overburden and ore on dumps, warehouses and consumers;
By the basic exterior subsystems with which one immediate with know-how of mining, production the system opencast cooperates is geographic-climatic, geologic, ecological, technical-technological, financial and economic and normative-legislative. The interplay of system opencast with geographic-climatic environment, including a relief of a surface, influences bulks of building and operational operations, choice of know-how and all-up mechanization and mode of operations of opencast, that is in the final accounting mirrored in expenses. Geologic environment, including a field, is immediate object of mining. Type, pattern and constitution, form, sizes, pitch angles, power, position concerning a surface, quality requirements, reserves and quality of mineral resources, allocation of salinity in outlines of reservoirs, the technical-mechanical properties of ores and soils institute major arguments of opencast, system of opening and mining method, arguments of functioning of mining-transport complexes of opencast, technical and economic indexs, expediency of mining of a field and technical and economic indexs. financial the economical surrounding institutes a financial situation, supply and demand, dynamics of the prices on consumable materials and machinery, and also commodity, made by opencast. The ecological, technical-technological and normative-legislative surrounding is interdependent and cooperates is
budgeting of mining operations in opencast

of the basic and auxiliary processes and, naturally, influences forming of technical and economic indexs of functioning of opencast. One of most difficult and It is not enough learnt of problems of opened mining and as a whole in mining sciences is the problem of intercouplings and взаимовлияния of all variety of the factors on behavior of system "opencast". In a fig. 2 the results of ordering of the exterior and internal factors of system opencast are given. On the basis of above-stated structure in Institute of mining by D.A.Kunaeva information environment of system "opencast" for operative, current and perspective is constructed, which one consists of information resources and rules of formation, analysis and their use of the information. Thus the operations on infological and date logical to designing and creation of databases were executed.

Conclusions. the Executed operations on structuring of intercouplings and interplay of members of system opencast can to be basis for constructing information databases of systems and subsystems of opened digging of solid mineral resources.

Formulation of Computational Procedures with Consequent Definition of Expert Systems for Automated Design of Open Mining Operations

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Resume.

In the given work the approach to formalization of process of projection of open mining is considered with the purpose of detection of a possibility of simultaneous realization of accounts of separate sections with use of local computing networks.

Keywords: *Information's technology, computing procedure, automated design system.*

Introduction

In connection with development of information technologies the possibilities of automation of the process of designing of open mountain operations are increased. The rise of productivity during designing can be reached, for example, due to distributed information processing. Traditional the automated designing do not assume distributed data processing, since are constructed on the basis of the concept of sequential calculations.

The designing of open mountain operations represents the complex process requiring from the developer not only defined volume of special knowledge's, appropriate source and normative information, but also experience of operation, abilities to give an expert estimation on any question concerning the project.

The maintenance of competitiveness the automated designing of open mining operations can be supplied in case when this system will offer higher efficiency under a simultaneous condition of quality of the formed project. The rise of productivity during designing can be reached, for example, due to distributed information processing. Traditional the automated designing do not assume distributed data processing, since are constructed on the basis of the concept of sequential calculations.

Thus the creation of the automated designing of open mining operations with distributed data processing is the urgent task, it will allow essentially to reduce material input, periods of designing, and also will promote rise of quality of the project.

At first for achievement of such results it is necessary to make decomposition of the process of designing, by presenting it as a finite set of deciding rules of conversion of the entry information in output.

The formalizing of computing procedures on separate sections gives possibility of definition of levels (strats) of acceptance of concrete solutions.

The results of formalizing can be used for creation of consulting models in structure of system of computer-aided design of open mountain operations and estimation of complexity of the process of designing.

Besides there is a possibility of selection of parallel computing procedures for distributed information processing.

Let's consider the process of obtaining of solutions at designing open mountain operations as set of information converters.

Let's enter the following denotations:

X –a vector of entry variables. The components of the X vector represent data unitary entered during designing and is agreed with the customer of the project. For example: productivity of quarry, content of useful components in ore, height ledge etc.

Z- a vector of parameters entered by accepting solution person during designing. Components of the Z vector are, as a rule, the data of normative - informational character: coefficient of filling of a dredge ladle, cycle time etc.

Y – a vector of output intermediate parameters;

R – a vector of output resulting parameters.

The components of Y and R vectors are calculated with N of deciding rules applied to components of X and Z vectors. Thus, the components of the Y vector are intermediate variables used as data-ins in the consequent converters, and the components of the R vector represent set of finite results.

In view of the entered denotations the i-section of the project can be presented as the single converter (fig.1):

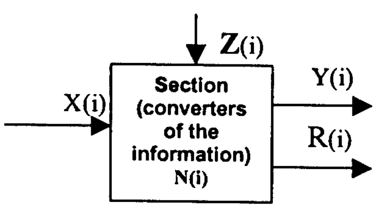

Fig.1

X(i) -vectors of entry (base) parameters of the i-converter;

Z(i) -vectors of data-ins entered face accepting solution in the i-converter;

Y(i) -vectors of output intermediate parameters of the i-converter;

R(i) -vectors of output resulting parameters of the i -converter;

N(i) -amounts of deciding rules in the i - converter

Conclusions. The approach, offered in the given clause, will allow to observe logical links during designing with the purpose of revealing possibility of simultaneous execution of accounts of separate sections of the project with use of several computers joined in the uniform local computer network. The application of the uniform local computer network at solving of problem for the system of computer-aided design of open mountain operations with a precise formalizing of computing procedures will allow not only to raise quality of the project, but also considerably to reduce material input and periods of designing.

Besides, the described approach will allow to receive rather full representation about structure and amount of works executed during designing, that can be used for an objective estimation of its complexity.

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System Analysis and Synthesis of the Ore Excavation Task Control Problems

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The application of mathematical methods and models in the tasks of control of mining is coupled to methodological difficulties. Firstly, in the literature practically there is no system description of the tasks of control of mining adequately identifying both technological processes, and their economic results; secondly, the possibilities of mathematical methods and computing algorithms, realizing them, as applied to all system of the tasks are poorly reflected. In the given operation the attempt of formalizing of the system of the tasks of control as the concept of control linking main material and information highways to the technology of a mining and processing of ore to the analysis of possible methods of their solution is done.

The methodology of solution of the task of control of the ore-streams assumes construction of models of the object of control and controlling system on the basis of the hierarchical description [1] and sequential decomposition of a management system of ore dressing firm [2], when on a top level this system represents by the controlling system (CS - 1) and two objects: " a management System of opencast " and " a management System of factory ". The management system of opencast in turn consists of the controlling system of the second level (CS – 2K) and own objects of control - management systems of technological processes.

Fastening main material and information highways of the "opencast" system with isolated by three levels of control of the ore dressing system (plant, opencast, technological processes), interacting among themselves through an information field, in which there are these processes of control, we received models of the coordination for each controlling system M1, M2, M3 (opencast - factory; a management system of opencast; the system of control of technological processes) [3].

From a position of the mathematical description the considered system of the tasks of control of mining is expedient for identifying with control ore-streams A collection all elementary, bench and quarries load streams of ore is considered as the continuous material object called in further "ore-streams", having mass defined during a work cycle of ore dressing cycle, average speed of progress, length and sectional area. It gives possibility to use the mathematical apparatus for the description of its structure and to control at a level a CS - 1 of the ore-streams of the system, the mathematical synthesis of structure can be presented as expression

$$W = \sum_{ii}\sum_{j}(\int_0^{L_{ij}} S_i dl) + \sum_{j}(\int_0^{L_j} S_j dl) + \sum_{k}(\int_0^{L_k} S_k dl) \quad (1)$$

Where L_{ij} - distance of transportation from i-working face up to a j-warehouse. For practical problem solving, matching of parameters ore of streams in his various sections it is necessary to research intercouplings of vectors entry (X) both output (Y) of parameters and technological (Z) of metrics, install mathematical sort of these intercouplings. As a mathematical method for installation of dependences the multifactor regression analysis of dynamic numbers is used.

The analysis and synthesizing of management systems of ore-streams with usage of the offered decomposition of the "opencast" system shows, that the application package, components together with PC the automized workstation of the mining geologist of the technologist is necessary for the experts of mining industry.

Distributed Information Processing Principle Applied to the Problem of Mining Firm Design

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The problem of creation of high-speed competitive domestic technologies of designing, can be solved not so much at the expense of hardware-software solutions, how many at the expense of the new methodological approaches. As one of such approaches can be the principle of distributed information processing with the help of a model of collective of calculators offered by the professor Evreinov E.V. For creation of the wide class of high-efficiency computers, information structures and environments.

The increase of speed of systems of computer-aided design demands a refusal of a principle of sequential execution of operations and transition to the more productive concept of parallel execution of operations by collective of calculators.

In a basis of a model of collective of calculators, the principle formulated in the axiom of a parallelism Evreinov E.V., according to which the given model can execute in a parallel way (simultaneously) as much as large (infinite) number of steps of calculations (operations).

To ensure a parallelism of execution of operations with the help of a model of collective of calculators, the process of designing is divided into more simples subtasks (minimum operational units), which solution is reduced to finding output parameters for each concrete subtask, and the information links inside the complex task are described as precise dependencies entry and output parameters of separate subtasks which are included in structure of complex.

Considering with the practical point of view the question of creation ADS with distributed data processing, is supposed, that the parallelism of calculations can be supplied at the expense of use of several computers constructed on a principle of sequential execution of operations, but connected among themselves in the uniform computer network. In this case there is a possibility without significant financial expenses to disperse the process of designing in space, involving an as much as necessary amount of calculators and providing high speed of the system of computer-aided design.

Application of Ore Loss and Dilution Normalization Method at Various Stages of Mining of Quality Requirements and Designing of Opencasts

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The problem of the feasibility report of the specifications of losses and dilution of ore arises at a substantiation of a choice of fields for industrial assimilation, establishment of quality requirements or technical conditions on extracted beneficial mineral, as the technical and economic indexes of operation of a mine depend on their size.

The quality of the extracted ore is valued by a content in it of metal, which one should not be less marginal ($C_{м.э.}$):

$$C_{мэ} = \frac{Z_{пр}}{0{,}01E \cdot Ц} \qquad (1)$$

Where $Z_{пр}$ - forthcoming expenditures on a mining and waste-handling, тенge/т; E - recovery ratio beneficial mineral at waste-handling ore, frac.un.; Ц - price of unit beneficial a component in final commodity, тen/т.

At mining all-up ores, ($C_{м.э.}$) can be expressed through a uniform conditional content of one of reductants accepted for basic, the contents of accompanying beneficial reductants are reduced in which one.

Thus, optimum boundary of an extraction of ore from a contact zone will be that boundary, after which one the content of metal in unit bulk of the extracted ore will be higher or equally marginal at passage from rock of the block in ore. Thus the dilution of ore mass in unit bulk will be marginal

$$P_{доп} = \frac{C - C_{мэ}}{C - b} \qquad (2)$$

Where C - a content in balance ore, %; b - a content in diluting rock, %.

Thus, the method of application of definition of losses of ore based on an establishment of positions of optimum boundary of an extraction and nature of a modification of dilution at improvement of contact zones, allows to erect their specifications in view of arguments of mining method, of morphometrical constitution of panels and value of accompanying beneficial reductants.

Statistical Optimization of Networks in Quarry Load Flows

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The important stage of creation quarries load sreams is the installation of necessary capacity for all units карьерной of the railway network, including face sites. The distinction of capacity of units on the network is stipulated by non-uniform allocation of intensity load streams and their service on opencast and on a surface. Circuit quarries load sreams with maximum transport network in the beginning are optimized on the graphs under the average characteristics of the network and integrated economic metrics The further optimization of the obtained "minimum" network is carried out on the simulation model quarries load sreams. The railway network with transport streams and items of their service is represented as the network of the multiphase system of queuing. As criterion of efficiency cost of system operation for the installed time unit is accepted. For an estimation of this system the estimated functional is used, where the non-uses in time of units of the network, expense for their contents, allocation on карьерной of the network of idle times of excavators, carriage rolling stock and units of the network, probability of stay them in this or that of indicated a state enter of cost of stay in queue of excavators and trains.

The given model is realized as a program complex on Turbo Pascal. By optimization of the transport circuits described in a similar way, there are specific difficulties consisting that the algorithms of simulation modeling, allowing to receive numerical values of the characteristics of the system and selected criteria of an optimality only in separate points, do not give possibilities to estimate character of the function as a whole. Therefore it is more expedient to decide the task of creation quarries load srreams with the optimally distributed spares of capacity on sites of the transport network by a method of sequential statistical search with adapting.

The task of optimization is considered as follows. A metric of efficiency, except for unguided parameters (schedule - the profile of a excavator-railway complex, cost of units of operations and includes others), still variants of capacity of sites of paths connected to quantity of parallel paths on each site. For finding the optimal system by results of experiments on model it is required to find such vector from allocation of parallel paths on all sites, at which the indicated metric of efficiency accepts minimum values. In load streamsit corresponds to optimal allocation of spares of capacity on all parts quarries of the railway network. In the given model of search the limitations imposed by processes and the technology of mining operations on concrete opencast (for example are taken into account width of platforms, on which is possible to build a transport site, limiting intensity of transport streams and others).

During search of optimal allocation of capacity of paths on opencast each new retrieval step means new allocation of quantity of parallel paths on all sites of the transport network of opencast. Each subsequent step depends on result previous as increase or minimal of common expenses of a simulated complex and random implementation of some random vector. It is clear, that each step is preceded by simulation of a selected stage of operation of a complex. The trial steps proceed before reaching a bending point on a minimum of a selected functional.

The Urgency of Creation of the Republican Network of Monitoring and Ergonomics for Labor Protection in Mining Industry

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Per the last years the state of safety of work on industrial objects continues to remain difficult. The peaking of a situation is observed in connection with transition of economy to the market forms of managing. Especially unfavorable concerning safety traditionally there are firms coal and mining-ore industry. There is a question, as, taking into account having place changes in a national economy to achieve a fracture in the circumstances and to increase efficiency of operations on a support of safe working conditions. For the answer to it we shall analyze a rule of a mining industry with a safety of work.

1. The forced unwillingness of firms is observed to arrange safety (though their necessity) is understood, as it is reflected in the cost price of production and productivity of work.
2. There are no effective economic stimulus in improvement of a state of safety on firms.
3. The uniform requirements and measures ordered for solution of separate questions of safety, can not be equally effective in completely various mining-geological.

From stated above it is visible, that the handle of safety on objects of a coal industry experiences system crisis, i.e. there are all necessary possibilities of handle, but it is carried out is ineffective, as on firms only rests of a former branch control system. Taking into account complexity of mountain production and diversity of available potential dangers, effectively to decide questions of safety it is possible only at a matching network of monitoring and ergonomics of protection of work.

The monitoring of protection of work represents the information system ensuring observation behind all sorts of effects of objects of a mountain industry on safety of work. You see only through monitoring the questions of a reliability of operation of the equipment, strict observance of technological norms at all stages of main and auxiliary productions, estimation of effect of firm on an environment are decided. The ergonomics on mining firms is directed on preventive maintenance of occupational diseases of the people by change of the equipment, workplaces, products and methods of work. There are many examples showing about link of ergonomics of workplaces with industrial diseases. Results are absence at work, degradation and high costs both for the worker, and for the employers.

From stated above it is possible to judge a urgency of creation of the republican network of monitoring and ergonomics of protection of work of a mining industry. Main functions of this information network:

1) Collection, analysis, processing and generalization of data of working conditions;
2) Support of an estimation and control of a state of safety of mountain operations;
3) Information support of services of the safety precautions;
4) Duly acceptance of effectual measures on lowering risk on the basis of it of an estimation;
5) Control behind accepted measures on a safety and lowering of risk.

SECTION
“IMAGE RECOGNITION AND GEO-INFORMATION TECHNOLOGIES”

On Stability of Group Fuzzy Classifications

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Resume.

Given work is devoted to an investigation of some questions of stability of group fuzzy classification allgorithms. An estimation of stability of algorithms of group fuzzy classifications over reduction of length of initial set of objects is obtained.

Keywords: *fuzzy classification, group classification, stability.*

Introduction. The stability of algorithms of classification to admissible modifications of a classified set of objects is important and necessary requirement for the justification the choice of algorithm of a classification. In last time for the decision of problems of classification the group methods consisting in synthesis of outcomes obtained at application of various algorithms to the given initial information or choice optimum, somewhat, algorithms from the given gang, widly, are used.

We make some attempts to investigate an approximate stability of algorithms of group fuzzy classification concerning reduction of length initial set of object. One approach to the definition of fuzzy group classification is considered and an estimation of the stability of algorithms of a group fuzzy classification is obtained.

Let's remind necessary definitions.

Let $M = \{S_1,...,S_n\}$ - is a finite set of objects.

Definition 1. [4] A fuzzy subset F of the set M is a map $\mu_F : M \mapsto [0,1]$.

We put

$$V_n^l = \{A \mid A = \|a_{i,j}\|_{nxl}, \sum_{j=1}^{l} a_{i,j} = 1\}.$$

Definition 2.[2] A fuzzy classification of the set M on l classes is a map $M \to A, A \in V_n^l$. The element $a_{i,j}$ of the matrix A will be interpreted as a degree of a membership of object S_i to the class with number j

Let $\mathrm{K}(M)$ denotes the set of all classifications of M. Let d be the metric on the set $\mathrm{K}(M)$.

Definition 3.[3] Let $K_1,...,K_m \in \mathrm{K}(M)$. Then K^* is a group classification if

$$\Phi(K^*) = \min_{K \in \mathrm{K}(M)} \Phi(K),$$

where

$$\Phi(K) = \sum_{i=1}^{m} d^2(K, K_i).$$

Let ρ be a Euclidean metric on the V_n^l

$$\rho(A,B) = \sqrt{\sum_{i=1}^{n}\sum_{j=1}^{l}(a_{i,j} - b_{i,j})^2},$$

it is the metric on the set of all classifications of the set M on l classes.

Let $K_1,...,K_m$ be fuzzy classifications of the set M on l classes, which are defined by matrixes $A_1 ,..., A_m$.

.Now we define the fuzzy classification corresponding to the matrix

$G = \|g_{i,j}\|_{nxl}$, where $g_{i,j} = (\sum_{p=1}^{m} a_{i,j}^{(p)})/m$.

Obviously, that matrix will be define a fuzzy classification of the set M on l classes, that is

$$0 \le g_{i,j} \le 1, \ \sum_{j=1}^{l} g_{i,j} = 1 .$$

One can prove the following proposition

Proposition. Let $K_1,...,K_m$ are the classification of the set M on l classes, which are defined by matrixes $A_1 ,..., A_m$. Then the classification defined by matrix G is a group fuzzy classification for $K_1,...,K_m$.

Let A be an algorithm of fuzzy classification then $K = A(M)$ denotes the classification which is the result of work of algorithm A on M. Let $I \subset M$. Denote $M \setminus I$ by M_I.

Definition 4. A restriction of K on $M \setminus I$ is the classification $K|M_I$ which is defined as follows: let the matrix A corresponds to classification K, then lines i and columns j will be eliminated from A for all $S_i, S_j \in I$, the obtained matrix will correspond to $K|M_I$.

Let's introduce the following definition of stability of algorithm of classification.

Definition 5. Let $K = A(M)$ be the classification obtained in an outcome of work of the algorithm A on M, $K(M_I)$ is the classification obtained in an outcome of work of the same algorithm A on $M \setminus I$. We say that the algorithm of a classification A is (ε,δ)-stable on M, if $d(K|M_I, K(M_I)) \le \varepsilon$ when $|I| \le \delta$.

Let's consider a (ε,δ)-stability of the algorithms of the group classifications. Assuming that the stability of initial algorithms of the classifications over reductions of length of the classified set of objects on δ is known we'll try to obtain an estimation of a stability of algorithms of a group classification over reduction of length of initial set on δ.

Theorem . Let $M = \{S_1,...,S_n\}$, $I \subset M$, $|I| \le \delta$, $A_1,...,A_m$ are (ε_i,δ)-stable algorithms of the classifications, G is the matrix of the group fuzzy classification for classifications $A_1(M),...,A_m(M)$, Γ is the corresponding algorithm of the computation of a group fuzzy classification. Then $\rho(G|M \setminus I, \Gamma(M \setminus I)) \le \varepsilon^*$, where $\varepsilon^* = \max\{\varepsilon_1,...,\varepsilon_m\}$, ρ is Euclidean metric.

Conclusion. Thus, the stability of the algorithm of a fuzzy group classification is stronger then the least stability of initial algorithms of classifications.

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Modern Situation and Prospects of Digital Cartography Development in the Republic of Kazakhstan

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Resume.

In given item the problems and prospects of development of Cartography and Geodesy branch of Kazakstan are covered. For the decision of cartography and geodesy tasks and satisfaction of growing needs of Republic in cartographic production it is necessary to use digital and geoinformation technologies.

Keywords: *digital cartography, digital cartographic data.*

In the former USSR the Kazakstan Geodesy and Cartography was a part of the USSR Chief Administration on Geodesy and Cartography.

In 1992, due to the USSR disintegration, the united branch of Geodesy and Cartography was divided. That such division took place on the basis of the territorial principle, therefore not all national Geodesy and Cartography services of the CIS countries received equal potentials for the preparation and production of the modern cartographic products. As the result of such division all Scientific-Technical and Polygraphic enterprises of the united branch were left outside of Kazakstan.

At present, the existing cartographic data for the Kazakstan territory is out-of-date and demands practically complete updating. The last updating of the existing cartographic information was carried out in the middle of nineteen eighties. Of course, an updating of cartographic data for the whole territory of Kazakstan, with the use of traditional technology, is a rather difficult task, demanding considerable funds, which, in connection with a difficult economic situation of our country, is very problematic.

Due to the change of geo-political situation, the Kazakstan Cartography and Geodesy service was to settle new tasks, not solved before, such as:

Mapping of delimitation, demarcation and

- check of the passage of the state border-line with China as well as with the new independent countries;
- Mapping of the changes of Kazakstan administrative division;
- Mapping of the division of the Caspian Sea bottom between countries of the Caspian basin.

To solve the specified tasks and to satisfy the growing needs of the Republic in urgent cartographic products in general, it is necessary to use the modern digital and geo-information technologies.

Due to the development of oil and gas deposits in the west of Kazakstan, environmental studies of Aral Sea area, Semipalatinsk nuclear polygon and also global geopolitical changes the interest to the cartographic data of the mentioned areas has been increased. It is necessary to note that the digital cartographic data is of higher demand. At present all the territory of Kazakstan is covered by digital cartographic data with 1:1000000 scale. And only some regions of Kazakstan have digital data with 1:200 000 scale.

At present one specialized enterprise of Geodesic and Cartographic branch and about ten research and private enterprises are operating in the field of digital mapping in Kazakstan.

"CartInform" is a leading branch Enterprise in the field of digital cartography and geoinformation technologies and has advanced hardware and software such as geoinformation system MapInfo (USA) and vectorizer EasyTrace (Russia). The enterprise has wide work experience of creation of digital cartographic data of various scales and on behalf of Kazakstan is included in the organization-executor's list in the international project of global cartography Global Mapping.

Methods of Creation of the List of Contour Points of Simply Connected Regions of Various Forms

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In many tasks of automated projecting, a pattern recognition on images, the machine graph there is a necessity of functional exposition of an outline of areas of any form. Input data at shaping contour points are the references of binary images of simply connected two-dimensional object. The images of majority of lines have a fuzzy aspect. For selection of sceletons of curves an image usually is subjected to a shrinking.

The task of compression of an information - minimization of volume of a videoinformation, for example, cartographical information, task of selection of linear formations on images of a terrestrial surface, task of selection of the boundaries of areas with indistinctly expressed outlines is reduced to operation of a shrinking. At significant stretch of linear structures the condition of tracing is applied. Actually shrinking means deleting of an excessive information without loss of an essence and connectivity of pixels. Thus, shrinking can be refered to the first stage of generalization of an information in an automatic pattern recognition.

For result of the list of coordinates of contour points two methods are offered: a method of rays and method of circular histograms. The method of rays is the most simple, its application is expedient for objects with the convex form. The advantages of a method of contour histograms are exhibited at its application for the objects of plants having the nonconvex form.

The method shape from contour we offered, shape from contour is based on development of idea of algorithm of an automatic classification. Here only the boundaries of a modification of a browser of an image are set. It does not use concept of contour points and considers average points for each time period.

The advantages of each of methods on complex criteria describing quality sould be estimated of a solution of the concrete task.

GIS and Remote Sensing Methods for Mapping and Protection of Forests of Kazakhstan

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The territory of Kazakhstan is about 272490.2 thou square kilometres. There are mainly steppe and desert areas. Those are covered by the forest – 11427.1 thou square kilometres or 4.2 %. The coniferous forests constitute 15 % of the total number of forests, deciduous forests constitute 14 %, saksaul – 48 %, and bushes – 23 %.

Periodic mapping (not less than once in 5 years) account, control and recovery of forests is one of the main problems of our country. This problem is complicated by the fact, that the forests in the north of the country are mainly having small-divisional structure, but nonetheless take huge territories, mountain forests are mainly situated in unreachable places. Thus mapping is usually done by the methods of satellite and aero- remote sensing and ground observation.

Mapping and taxing of forests with the usage of aerophotographies are well known and used during long time but they are based on hand labour, not automatized and require a lot of work and means. So photography "sewing together" has been carried out by the methods of photo-scaling (in the case of images made on different heights), cutting of central part, pasting and hand classification.

Proposed here technology is based on the usage of ERMapper 4.1. and ERDAS-8.3 software for aero- and space images processing. Aerophotographies are scanned, radial distortions are corrected and sewed to general orthonormed space image already having precise geographic tie. "Sewing together" is made on 5-6 control points (roads, rivers, ponds etc.). Aerophotographies have different spectral characteristics i.e. the same objects may be of different colors, so photoplan needs spectral correction. After "sewing together" and spectral correction we begin to classify forest. Forest has very heterogeneous and small structure, for this reason direct classification doesn't give required results. Structure of small dots is received in this case. To obtain wide enough classes (sizes are limited by corresponding standards) preliminary texture filtration should be carried out. As result small structure diminishes and we obtain searching solution. If this technique doesn't lead to desired result there is used another algorithm, namely direct classification is conducted and after that every class is processed by the method of focal analyses (small structure is destroyed, and large one absorbs neighbouring small lots), we receive searching solution. Obtained classes are vectorized. And finally vector classes, under ArcInfo 7.1 software, are transformed to corresponding type, added with attribute data and composited with topographic data. So, digital map and "Forest of Kazakhstan" geoinformation system are being built.

Learning System in Image Recognition in Composition of GIS Technology

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Remote study of the Earth's surface on the territory of Kazakstan has great practical application in geological prospecting, agriculture, construction etc. Due to constant change of anthropogen landscape necessity to frequently renew geographical maps arises. Need in detailed fresh geographical maps is not satisfied in full due to expensive process of topography. Automotization of the process of visual analysis of images of air photography, recognition of objects of natural and anthropogen origin on them is a difficult task..

In order to recognize the graphic symbols in an image a complex of program means is elaborated. Algorithm of recognition is based on the knowledge on eyesight functioning and on research of brain's physiology.

Visual path is divided into levels, in each of which transformation of visual information takes place, forming the concepts each level summarizes and differentiates the concepts of the previous level. With each level concepts become more complicated, approaching the real image of the graphic symbol. The created self-educating system can correct its knowledge. Each concept has the rate of correspondence, which is the sum of activity of ordinary cells with consideration of the rate of their relation to this concept. The user gets informed of the concept with the maximum meaning of the rate of correspondence.

At the first level concept about the dots of image is formed, at the second level – concepts about lines and edges, at the third level – general concept of the graphic symbol demanded on the system. General concept is based on the results of the second level.

The elaborated system can be successfully used for development and understanding of the images, especially for creation of electronic maps of area and for remote study of the Earth's surface. Besides, this system can be used in the block of mathematics models in composition of GIS.

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Recursive Grammar Development for the One Class of Contextual Languages

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The language L^P is language with polynomial recursive structure if $L^k_{P(1)} = \{a^{P(n)}\}$, and P(n) – integer-valued polynomial.

In the report we show that if L^P belongs to class L^P, then we can build the Recurrent Grammar G', so that $L(G') = L^P$.

Definition . Recurrent Grammar is quintuple $G' = \{V_T, V_N^t, S, P', t\}$, where

V_T - Terminal alphabet; V_N^t - set of functional nonterminals of forms:

$$A_i(1),\ A_i(2),\ A_i(3),\cdots,\ A_i(t),\ A_i(t+1),\cdots$$

t - Recurrent parameter, so that $t = \{0,1,2,3,\cdots\}$

S - Starting symbol of the grammar;

P' - Set of recurrent grammar rules of following forms:

$$A_i(0) \to \alpha_i,\quad A_i(1) \to \alpha_i\,,\quad \cdots\quad ,\quad \alpha_i \in V_N^*$$

$$A_i(t+1) \to A_i(t)\omega,\quad \omega \in V_T^{t*} \cup V_N^*\quad ,$$

Recurrent Grammar constructing method.

Applying the method of finite differences for integer-valued polynomials to the strings of L^P we can build following subsets of the language L^P:

$$s_1 = \{\alpha_{11}, \alpha_{12}, \cdots, \alpha_{1k-1}, \alpha_{1k}\},$$

$$s_2 = \{\alpha_{21}, \alpha_{22}, \cdots, \alpha_{2k-2}, \alpha_{2k-1}\},$$

$$\vdots$$

$$s_q = \{\alpha_{q1}, \alpha_{q2}, \cdots, \alpha_{qk-n-1}, \alpha_{qk-n}\},$$

$$\alpha_{i+1j} = \alpha_{ij+1} - \alpha_{ij}\ ,\ (strings \quad differences)$$

$$\alpha_{1j} = a^{P(j)},\ j = 1,2,..,n\,;$$

$$\alpha_{q1} = \alpha_{q2} = \alpha_{q3} = \ldots = a^{n!} = const.$$

For each subset of the set of strings s_i we input respectively nonterminals

$A_i(t)\,,\, A_i(t) \in V_N\,.$

Grammara G' now can be built in such way:

$$A_1(1) \to \alpha_{11}\,;$$

$$A_1(t+1) \to A_1(t)A_2(t), which\ corresponds\ to: \alpha_1$$

$$A_2(t+1) \to A_2(t)A_3(t),$$

$$A_2(1) \to \alpha_{21}\,,$$

$$\vdots$$

$$A_{q-1}(t+1) \to A_{q-1}(t)A_q(t),$$

$$A_q(1) \to \alpha_{qi},$$

where $\alpha_{qi} = a^{n!}, a \in V_T,\ A_1(t\ )$ *– starting symbol of the Gra*

Recursive Grammar for Description and Recognition of Some Class of Objects

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In articles on syntactic pattern recognition as well as in articles on applied linguistics there are a number of different modifications and families of formal grammar formalism with the purpose of maximal adequacy in description of classes of objects being investigated. Such objects can be strings of symbols or complex visual images.

Here we propose new approach to extension of standard grammar formalism by introducing the new type of grammar rules and nonterminals. Such rules very similar to recurrent formulas and recurrent rules, so the new grammar was called recurrent grammar..

This type of grammars very suitable for recognition and description of some classes of context-sensitive languages, like $\left\{a^{n^2}\right\}$.

We input variable parameter t in some nonterminal symbols, so we input time and order categories to ordinal grammar rules. Moreover, we can talk about parallel processing during derivation of the strings. New grammar rules are still simple and context-free, but the languages are not context free and can be very complex.

For example, lets consider context sensitive language $\{a^n b^n c^n\}$. To build grammar for such languages in standard (Chomsky style) forms is not simple problem, since intuitively each group of strings we can easily represent by regular rule $A \to Aa$. The problem is to implement such rules for every symbolic group simultaneously. We can see how it easy and highly understandable in case of recurrent grammar:

$$A(1) \to a,$$
$$B(1) \to b,$$
$$C(1) \to c,$$
$$A(t+1) \to A(t)a,$$
$$B(t+1) \to B(t)b,$$
$$C(t+1) \to C(t)c,$$
$$S \to A(t)B(t)C(t),$$
$$t = 1,\ 2,\ 3,\ \dots;$$

$S-$ starting symbol ;

$A(t),\ B(t),\ C(t)-$ functional nonterminals,

$a,b,c-$ terminals.

In the report we show the derivation trees for recurrent grammar and consider a big classes of context – sensitive languages, including languages with polynomial recursive structures (LPRS).

LPRS languages are the languages like follows: $\{a^{n^2}\},\dots,\{a^{f(n)}\}$, where *f(n)- integer valued polynomial.*

Since in case of the languages like $\{a^n b^n c^n\}$,i.e. number of terminals more then two, we have context- sensitive language and can use recurrent grammar. Such languages can be used for scalable image description. In this case n can be scaling parameter. So we could see some possibilities of practical implementation of recurrent grammars.

SECTION
“COMPUTER LOGIC AND NEURO-INFORMATION TECHNOLOGIES”

Generic Queries of Databases Embedded in a Weakly o-Minimal Universe

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Resume.

One of the problems in Database is to prove that under certain conditions on universe U any locally generic extended query is equivalent over finite state over U to a restricted query. We prove here that for weakly o-minimal universe any locally generic extended query is equivalent over finite Database states to an ordered restricted query.

Keywords: *Database. Infinite Universe. First Order Theory. Extended and Restricted, Generic and Locally Generic Query. The Isolation Property. Weak o-minimality.*

Introduction. Most of the terminology below comes from the database literature: see [1] for a general discussion of the notion of generality, and [2] for a discussion of collapse results.

A structure of relation language L (L-structure) is a non-empty set with a mapping that assigns to every relational symbols in L relations of the same arity over the set. We will consider two language L and SC; L is language of infinite (totally ordered) universe U and SC (database scheme) is finite relational language disjointed with L. For any SC-structure A with finite domain contained in U, $U(A)$ denotes the unique ($L \cup SC$)-structure which expands U and agrees with A on the interpretation of relation symbols of SC. Such $(A;SC)$ is what w mean by an embedded finite model [3], [4] and $(A;SC)$ is called *Database state* of $U(A)$. Database query is the family of pairs $((A;SC), Q(A))$ where $(A;SC)$ is finite Database state and $Q(A)$ is new relation of fixed arity over U.

We say that a query Q is extended if there is first order formula φ of language $L \cup SC$ such that for any $(A;SC)$ the relation $Q(A)$ is definable by φ in $U(A)$. We say that a query Q is (order) restricted if such φ is a formula of language $(\{<\} \cup SC)$ SC.

Query is a formula of first order language of signature $L \cup SC$. Query is called ordered *generic*, if any ($\{<\} \cup$SC)-isomorphism of the universe preserves it, k-ary query Q is called *locally (ordered) generic* over finite states, if $\bar{a} \in Q(s)$ iff $\varphi(\bar{a}) \in Q(\varphi(s))$, for any partial $<$-isomorphism $\varphi: X \to U$, such that $X \in U$, for all finite states over X, and for all k-tuples $\bar{a}$ from X. Query over totally ordered universe U is called (e,<)-*generic*, if it is <-generic over any elementarily extension of U.

An ordered structure is called *o-minimal* if any parametrically definable subset is a finite union of intervals and points [8]. An ordered structure is called *weakly o-minimal* if any parametrically definable subset is a finite union of convex sets [13], [14]. An ordered structure is called *quasi o-minimal* if any parametrically definable subset is equivalent to a Boolean combination of intervals and ∅-definable subsets [5], [9].

The general problem on Database queries is then under which conditions on the universe are extended queries reducible to (order) restricted queries? This problem is called the Problem of Generic Collapse of extended queries. Belegradek, Stolboushkin, Taitslin [5] had collapsed the consideration of this problem to the consideration of collapse of Boolean (locally generic) queries.

A Boolean query Q on U is a collection of SC-structures with domain a finite subset of U [4].

We say that Boolean query is locally generic if it is closed under SC-isomorphism.

An abstract query Q is a collection of isomorphism types of finite LS-structures. Finite Model Theory investigates the collection of abstract queries and (equivalently) locally generic queries that are definable in predicatelogic. Well known results include that the abstract query of all even cardinality sets (the parity query) and the set of connected graphs are not first order definable.

Given a first order sentence φ in $L \cup SC$, the Boolean query defined by φ is the set of SC-structures A with domain a finite subset U such that $U(A) \models \varphi$. We say that φ is locally generic if the Boolean query defined by it is generic. The results in [6] imply that any pure first order abstract query is first order definable in the sense of Finite Model Theory. M. Benedikt, G. Dong, L. Libkin, L. Wong [7] showed that the ordered locally generic extended and restricted queries have the same expressive power over every o-minimal domain [8]. O. Belegradek, A. Stolboushkin, M. Taitslin [9] extended this result for ordered model with quasi o-minimal theory (in fact, they solved the problem of locally generic collapse of extended queries for the theories with the Isolation Property). J. Baldwin and M. Benedikt [10] proved that any locally generic extended query over a stable structure is equivalent over finite states to a restricted query.

We consider the ordered universe with weakly o-minimal theory. From analyze [11], [12] of property of definability of one-types over a set and types over a model in weakly o-minimal theories we can understand that any weakly o-minimal theory has the Isolation Property, and, consequently, by [9], [5] the following holds:

Theorem. Let U be an arbitrary L-model of a weakly o-minimal theory. Then any locally generic over finite Database states over universe U extended query is equivalent over finite Database states over universe U to an ordered restricted query.

Conclusion. A decision of the problem of collapse of a generic extended query to restricted one permits o pass to the problems of query safety, i.e. whether non-Boolean queries are infinite, and on the case of existence of infinite answers it can find states for which these answers are finite. Theorem 1 permits to solve the safety problem for a dense weakly o-minimal universe.

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On the Equivalence of Programming Language

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Resume.

One of the problems in Database is to characterize indexations of a database class. Also it is proved that equivalence of two arbitrary chosen programming languages is not effectively recognizable.

Keywords: *Database. Programming languages. Effective recognizability. Indexations.*

Introduction. An abstract programming language L under given signature σ is treated as the class of all programs in σ which compute functions required for every input a finite but not bounded number of stages of computation.

Programming languages L_1 and L_2 are called equivalent if the class of functions computed upon the programs in L_1 coincides with the class of functions computed upon the programs in L_2.

THEOREM 1. Equivalence of arbitrary chosen programming languages L_1 and L_2 is not effectively recognizable.

If we can effectively translate very program in language L_1 into a program of the same function in language L_2 and vise versa then languages L_1 and L_2 are called effectively equivalent.

THEOREM 2. Effective equivalence of arbitrary chosen programming languages L_1 and L_2 is not effectively recognizable.

Note that, for a given class of functions, if there exist two equivalent but not effectively equivalent programming languages then the number of such languages if infinite.

If bank of data is described by a system of axioms then that system represents in the abstract the class of all possible states (data bases) of the bank, and, therefore, that class has a computable indexation.

Let γ^A and γ^B be any computable indexations of the axiomatic descriptions **A** and **B** of some banks of data. We say that indexation γ^A is reducible to indexation γ^B (symbolically, $\gamma^A \leq \gamma^B$) if for each γ^A -index of data base **D** we can effectively find some γ^B -index of **D**. Reducibility of indexations generates their equivalence defined as follows: $\gamma^A \equiv \gamma^B \Leftrightarrow \gamma^A \leq \gamma^B \land \gamma^B \leq \gamma^A$.

THEOREM 3. If given class of data bases has two non-equivalent computable indexations then it has countably many non-equivalent computable indexations.

All mentioned above results follow from analogous results for computable classes of recursive functions and recursively enumerable sets and for computable indexations of classes of constructive models.

Conclusion. It has been proved that equivalence of arbitrary chosen programming languages L_1 and L_2 is not effectively recognizable, and if given class of data bases has two non-equivalent computable indexations then it has countably many non-equivalent computable indexations.

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User-Oriented Task Specification Languages

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Resume.
We formalize (give an exact description of) two characteristics of a user: his intellectual resources and intellectual claims. We suggest and study an appropriate language for task specifications.
Keywords: *task specification languages, intellectual resources, intellectual claims.*

Introduction. One of the most important problems of computer science is to teach a user to solve his problems without intervention of programmers, since the tandem "user-programmer" often gives disappointing results in quality as well as in speed, apart from financial expenses. It would seem that personal computers were created to enable a user to solve his problems by himself, but developing computers and software and teaching a user to solve his own problems with it appeared to be two very different things. Here the problem of user-oriented task specification languages, as that of effective tool for problem definition and solving, becomes of especial importance. It is our opinion that, a personal computer will be a real assistant of a man only if a user could effectively solve his tasks with it.

What should we take into account when developing software for a given class of tasks? Here the following question is worthy to answer: "How can a software designer reasonably capture intellectual resources and intellectual claims of a given category of users, for which it is meant? Can he do so at all?"

A reasonable answer to this question is a basis for managing the costs and quality of software developing, and – which is the most important – a user obtains a facility to solve his problems immediately, without programmers' help. Undoubtedly, such investigations should result in growth of demand on computer service market.

Of course, the ideas above are not new. Nevertheless, nowadays we still have no software that solves this problem and we are in doubt about practical value of the existing approaches.

We tried to find a solution on the way of investigation of the interplay between intellectual resources of users and their intellectual claims. Below are some informal considerations which help us to understand the essence of the problem we consider.

Intellectual resources. At the moment a user turns to a computer, he either knows what does he want or he does not know this. At first case, he *understands* his task at least. At second case he should not deal with computer at all. By this we can assume, without any loss for presumptive use of software, that only tasks that are *understood* by a user will be processed by a computer.

Intellectual resource of a user. Developing arguments by M. Dummett, one can outline an experimental procedure to investigate the dependence between persuasiveness of a proof and its length, according to some system of marks, when working within a fixed axiomatic system. Similar procedures can be pointed out for the investigations of the dependence between the rate of error-free distinction (by a control man) of terms or formulas and their lengths. Thus, we can estimate an intellectual resource by a given man relative to a given axiomatic system S by a triple of nattural numebrs res(p,S)= (m_1(p,S), m_2(p,S), m_3(p,S)) m_1(p,S), m_2(p,S), m_3(p,S) such that:

- m_1(p,S) is the maximal length of proofs in a given system S that still has rather high (a priory fixed) mark of persuasiveness for a given man p;
- m_2(p,S) is the maximal length of sequences in the alphabet of the language of S that still have rather high (a priory fixed) mark of error-free distinction as formulas (either non-formulas of the language of the system) by a given man p;
- m_3(p,S) similar to m_2(p,S) for terms.

Intellectual claims of an ideal user. We start with the assumption that each ideal user can be comprehensively presented (as a result of a special quiz procedure) by the collection of data about his subject area he possesses or he thinks he possesses. Without stretching, our assumption means that an ideal user is a first order theory T, one of whose models is the very implicit subject area. In this case, "a task for a user" is "a task for an arbitrary model of T", or briefly "T-task".

Each such a task is identified with an algorithm that partitions the set of all proofs in T into two subsets: the first one is the set of all proofs that are declared to be a solution to a given T-task, the second one consists of the rest proofs. If the first subset is nonempty then the task has a solution, otherwise it has no solutions. Each description of such a partition will be a definition of the T-task.

In particular, each formula φ can be considered as a definition of a T-task, because it effectively defines a partition of the set of all proofs in T into two subsets: the subset of all proofs with final formula φ and the set of all other proofs. Each proof in the first subset is said to solve the given formula T-task $\hat{\varphi}$. Each proof in the second subset is said not to solve $\hat{\varphi}$.

Intellectuals claims of a real user. Thus, intellectual claims of an ideal user p – is the set of all formula T_p-tasks, where T_p is the theory of the subject area p deals with. We would like to stress that this presentation of claims is based upon the assumption that p is completely represented by T_p. Nevertheless, we should keep in mind that this is a *simplifying* assumption. It would be more realistic to consider the representation of a user to be more than merely a theory T_p; it is rather a pair (T_p,res(p,T_p)), where res (p,T_p) is the intellectual resource of p. This more realistic assumption corresponds to the term a task for a real user p being considered as an abbreviation for "formula T_p-task that could be understood by p" and the term intellectual claims of a real user p as an abbreviation for "the set of all such tasks ".

Languages and logics for specifications of tasks for ideal users

Languages. Let L be a first order language of the signature σ. Logic symbols of L are: $\&, \vee, \rightarrow, \forall, \exists, \perp$, and maybe the "equality" $=$, $\perp$ is the atomic false proposition.

Let T be a calculus in L[1]. T is called

- formal provided the set Thm(T) of theorems of T is effectively enumerable;
- inconsistent, if Thm(T) = F(L), where F(L) is the set of all formulas of L;
- consistent, if Thm(T) $\neq$ F(L);
- strongly consistent, if $\perp \notin$ Thm(T).

For each formal T in L we define a special set C(T) of formulas in L so that to provide an opportunity to say that $\varphi \in$ C(T) if and only if φ is a symbolic record of some valid proposition on formula tasks in T.

DEFINITION. Let L be a first order language and T be a formal calculus in L. The pair (L,C(T)) is called a constructive semantic of language L with respect to T, or, shortly, T-constructive semantic (of language L). If, in addition, T is a representation of an idealized user then T-constructive semantic (L,C(T)) is called a semantics of formula tasks for an ideal user T, or, briefly, T-task semantics. If (L,C(T)) is a T-task semantics then L is called a specification language for formula tasks for user T, or, briefly, a specification language for T-tasks.

[1] We understand the term "calculus" as defined by Yu.L.Ershov and E.A.Palyutin in : Yu.L.Ershov and E.A.Palyutin, Mathematical Logic, Moscow, 1979, 320 p (Russian).

Clearly, if σ is a finite signature then any T in L is a res-formal calculus; moreover, in this case the sets F(L,res), Thm(T,res), and the set Term(L,res) of all res-terms in L are always finite.

For each res-formal T in L, we define the set C(T,res) of res-formulas in L so that to provide an opportunity to say that $\varphi \in$ C(T,res) if and only if φ is a symbolic record of a valid sentence on some formal tasks in T which *could be understand* by the user presented by the pair (T,res).

Now we formulate some theorems concerning the essence of the considered problem.

T H E O R E M 1. The calculus CPC(L) (classical predicate calculus in L) is not a contructive system.

T H E O R E M 2. The calculus P (first order Peano arithmetic) is not a constructive system.

By Theorem 1, not all logical systems can be understood as facts about logical tasks.

Theorem 2 implies that not all classical arithmetical truths can be understood as facts on arithmetical tasks.

T H E O R E M 3. The calculus HPC(L) (Heyting predicate calculus in L) is a constructive system, and if G(σ) is a nontrivial group then HPC(L) is not exact.

T H E O R E M 4. (i) HA (Heyting arithmetic) is a constructive (task) system; (ii) HA is not exact.

T H E O R E M 5. If T (in L) is an exact constructive system then all axioms and inference rules of the minimal Iogansson's proposition calculus are admissible in T. If, moreover, T is a strongly consistent calculus then all axioms and inference rules of Heyting intuitionistic proposition calculus are admissible in T.

T H E O R E M 6. If the signature σ of a language L is finite then for any res-formal calculus T in L, the (T,res)-constructive semantics (L,(T,res)) is finite.

This theorem is obvious. Moreover, one can easily construct a universal exhaustive search algorithm that, given any res-formal calculus T in the language L of a finite signature σ, outputs the corresponding set C(T,res). Thus, there exists a theoretical opportunity to take into account the intellectutal claims of a real user in all practically significant cases.

These problems are considered in detail in [1]. An algorithm of estimation of intellectual resources and comparison of these with intellectual claims are studied in the paper [2].

Conclusions

Yet in this stage of the study, it is unclear, whether there are res-analogues for Theorem 3-5, and if yes, how should they be formulated. To what extend his tristful circumstance lowers the practical importance is a question that cannot be answered a priory without conducting experiments to determine intellectual resources of real people. These resources could appear to be so small that in many practically important cases one can immediately use Theorem 6 and a restricted version of universal algorithm for constructing (T,res)–task semantics corresponding to small m_1, m_2, m_3 (res = (m_1 ,m_2 ,m_3)) mentioned in connection with Theorem 6.

This question shows the direction for the next study.

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Elementary Ordered Generic Queries of a Database

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In [1] the notions of <-genericity, local <-genericity of queries of a database over totally ordered universe had been introduced. Note, that local <-genericity depends more on properties of elementarily first order theory of universe, than on properties of universe, i.e. if a query is locally <-generic in a universe, then it locally <-generic in any elementarily extension of the universe. For <-genericity this property does not hold. Hence, we introduce new notion (e,<)-genericity and adduce some properties of (e,<)-genericity over a states of a database for a fixed universe. Let *U* be an infinite

structure of a language *L* (universe), where *L* contains symbol <, which interpretation in *U* satisfies total ordering axioms. Databases operating over *U* use non-signature relation symbols as well. A *database scheme SC* is a finite collection of relation symbols of fixed arities. A *database state* (over *U*) for the database scheme is an assignment to these relation symbols of concrete relations of corresponding arities over *U*. These relations are called *database relations*. A database state is called a *finite database state* if all the relations are finite, and — *finitely representable*, if every predicate of *SC* can be defined by quantifier-free formula in language {=,<}.

Query is a formula of first order language of signature $L \cup SC$. Query is called *<-generic*, if any ({<}∪SC)-isomorphism of the universe preserves it, *k*-ary query *Q* is called *locally <-generic* over finite state, if $\bar{a} \in Q(s)$ iff $\varphi(\bar{a}) \in Q(\varphi(s))$, for any partial <-isomorphism $\varphi: X \to U$, such that $X \in U$, for all finite states over *X*, and for all *k*-tuples $\bar{a}$ from *X*.

Query over totally ordered universe *U* is called (e,<)-*generic*, if it is <-generic over any elementarily extension of *U*.

Proposition 1. Let *U* be a totally ordered dense structure without end points. Then local <-genericity of a query of database over finite states over *U* coincides with (e,<)-genericity of a query over finite states over *U*.

Proposition 2. Let *U* be a totally ordered structure, and *Q* be a query over *U*, then the following holds:

1. *Q* is locally <-generic over all finite states iff *Q* is locally <-generic over all finitely representable states.
2. *Q* is (e,<)-generic over all finite states iff *Q* is (e,<)-generic over all finite states.

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Information Systems of Data Base

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Here we present a theorem on existence of an informative system of which elements are relational models of data bases.

Definition 1. An informative system is a structure $A = (D, \Delta, Con, \perp)$ where D - data objects set, Δ - a distinguished element of the set (the least informative element), Con - some set of finite subsets (consistent sets of objects), $\perp$ - a binary relation between elements of Con and elements of D (sequence relation for objects). Concerning Con for all finite subsets $u, v \subseteq D$ the following axioms to be held:

1) if $u \subseteq v \in Con$ then $u \in Con$;
2) if $X \in D$ then $\{X\} \in Con$;
3) if $u \perp X$ then $u \cup \{X\} \in Con$.

Concerning $\perp$ for all $u, v \in Con$ and for all $X \in D$ the following axioms to be held:

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4) $u \perp \Delta$;
5) if $X \in u$ then $u \perp X$;
6) if $u \perp X$ and for all $Y \in u$ $v \perp Y$ holds then $v \perp X$.

Definition 2. Elements of an informative system $A = (D_A, \Delta_A, Con_A, \perp_A)$ are such subsets $\mathbf{x}$ of D_A that

1) all the finite subsets $\mathbf{x}$ belong to Con_A;
2) if $u \subseteq \mathbf{x}$ and $u \perp_A X$ then $X \in \mathbf{x}$.

Theorem. Let Δ be a formula which expresses an natural restriction on relational models of data bases D; K_Δ - a class of all relational models in which Δ holds. Then there is an informative system $A = (D_A, \Delta_A, Con_A, \perp_A)$ of which elements are relational models from the class K_Δ and $\Delta_A = \Delta$.

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Queries of Databases Over a Countable Categorical Ordered Domain

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In the relational model of databases a database state is thought of as a finite collection of relations between elements. Names of the relations and their arities (numbers of argument places) are fixed and called a database scheme. Particular information stored in the relations of a given scheme is called a database state.

Although relational databases were invented for finite collections of data, it is often convenient to assume that there is an infinite *domain* - for example, the integer or rational numbers - such that the data elements are chosen from this domain. Functions and relations defined over the entire domain, like $<$ and $+$, may also be used in querying, for example, if the language of first-order logic FO is used as the query language, its formulas may use database relations as well as the domain relations, while variables range over the entire domain.

These domain functions/relations are fixed (do not depend on a state, have the same meaning for any state) and are infinite by their nature. When we refer to a domain, we mean the domain together with the set of domain functions and relations that we consider.

Here we study the problem of collapse of extended queries to restricted ones over a countable categorical ordered domain of databases. All the necessary definitions can be found in [1]. This consideration uses results from [2], [3]. In particular, here is used a description of weakly o-minimal linear orderings from [2] and also a description of some properties of countably categorical structures from [3].

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On Quasi o-Minimal Group Domain of Databases

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All definitions and notation which are found without references are taken from [1]. One of the problems in Database is to tell formulas with finite answer from those with infinite? This has become known as the *state-safety* problem [2]. Although the set of safe formulas is unsolvable, it may be possible to impose certain syntactical restrictions on the class of formulas that we are going to use such that the safe queries are exactly those ones which can be formulated with this restriction. So, the following problem is implied: find condition on first order theory of infinite domain of a database so that some extended query can be equivalent to a restricted query. Under quasi o-minimal ordered groups an extended locally generic query is equivalent to a restricted query [1]. Here we have described completely up to elementarily equivalence these groups.

Let U be an infinite ordered structure over the signature L (*universe*). A *database scheme SC* is a finite collection of relation symbols of fixed arities, $SC \cap L = \varnothing$. A *database state* (over U) for SC is an assignment to these relation symbols of concrete relations of corresponding arities over U and called a *finite database state* if all the relations are finite. We consider two languages for querying. Queries of the first and second one are FO formulas of the signature $\{<\} \cup SC$ and $L \cup SC$ — we call them *restricted* and *extended,* correspondingly. Query Q is called *locally generic over finite states* if $a \in Q(s)$ iff $\varphi(a) \in Q(\varphi(s))$, for any partial $<$-isomorphism $\varphi: X \to U$ with $X \in U$ for any finite state s over X, and for any k-tuple a in X.

Definition 1. [3] A structure $(M, <, \ldots)$ (and then its theory) is called quasi o-minimal if in any structure elementarily equivalent to it the definable subsets are exactly the Boolean combination of $\varnothing$-definable subsets and intervals. We call an ordered structure (and its theory) *essential quasi o-minimal,* if it becomes quasi o-minimal after naming some ($\equiv$ all) its elements.

Theorem 2. [4] Let $(G, <, +)$ be an ordered group. Then $(G, <, +)$ is essential quasi o-minimal iff $(G, <, +)$ is elementarily equivalent to either $(\mathbf{Z}^n, <, +)$ or $(\mathbf{Z}^n \times \mathbf{Q}, <, +)$, for some $n \in \mathbf{N}$, where order $<$ is lexicographical.

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Interpretation of Temporal Logic of Actions in a Language of the First Order Logic

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Following L. Lamport [1], a concurrent algorithm is usually specified by a program. Correctness of the algorithm means that the program satisfies the desired property. *Program*, *property* and *satisfaction* are three things which define: a programming language, a language for expression properties and satisfaction relation. L. Lamport proposed [1] a simple approach in which both the algorithm and property are specified by formulas in a single logic. The logic that L. Lamport proposed for reasoning about concurrent algorithm is Temporal Logic f Actions, TLA for short. TLA is a combination of two logic: Logic of Action (LA) and for Simple Temporal Logic of Actions (STLA). In particular, if a program is expressed by a TLA formula φ and some property is expressed by a TLA formula F, then the assertion "program φ has the property F" is expressed in TLA by validity of the formula $\varphi \rightarrow F$, which assert that every behavior satisfying φ satisfies F. L. Lamport in [1] had considered some popular classes of properties, invariance and eventuality.

In the works [2], [3] interpretations of TLA in Predicate Calculus were proposed, that permitted to make more simple proving completeness of STLA [2] and consistence of TLA [3] and to include developed methods of Model Theory and classic Mathematical Logic for investigating TLA.

In our report we give some modification of the interpretation [3] of TLA for a fixed weakly o-minimal or quasi o-minimal universe in some first order model. Under behavior, as L. Lamport, we mean ω-sequence of finite database states, and what is more time is interpreted in the o-minimal model $(\mathbf{N}, =, <, s^1)$, the set of behaviors stand out by the unary predicate, and everything is connected as in [3] by the functions. Unlike [3] the set of variables *Var* we index accordingly database scheme (*SC*), where *SC* is finite predicate language. All of this permits in one side to prove completeness of TLA and in other side to investigate database queries in TLA, as in [4].

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Fractals and Neural Networks for Prediction of the Caspian Sea Dynamics

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The Caspian Sea is the largest intercontinental reservoir without water flow which demonstrates the unique global evolution on an extent of a huge interval of time. The economies of communities around the Caspian are highly dependent on sea levels. Therefore, development of correct models of the sea level prediction is very important. Existing linear model of outflowless reservoirs and non-linear stochastic models are based on hydrologic balance equation and have a number of limitations [1].

We applied non-linear topological dynamics methods to study the dynamics of the Caspian Sea. According to the general assumption about properties of an unknown dynamical model of the sea level we reconstructed a diffeomorphic copy of its attractor in N-dimensional space from scalar time series [2]. We estimated a correlation dimension of the reconstructed attractor and built input patterns for an artificial neural network.

We used the fully-connected artificial neural network (ANN) "MultiNeuron" developed by Russian scientists [3] as a predictor to make a non-linear prediction of the dynamics [4] of the Caspian Sea. The net was trained on Takens' m -dimensional vectors (m>2ν+1) constructed from the instrumental data until 1980 AD and successfully tested on the data from 1980 AD until 1992 AD. The obtained result agreed with original data very well, and promised good prospects for the use of topological dynamics and neural network methods to predict the Caspian Sea levels.

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Using Topological Dynamics and Neural Network Methods for Seismic Event Discrimination

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In the framework of the Comprehensive Test Ban Treaty(CTBT), development of reliable methods to discriminate between underground nuclear explosions and earthquakes at regional distances (less than 2500 km) is very important. Existing methods of seismic event discrimination are based on the analysis of spectral characteristics of a variety of waves: Pn, Pg, S, Sn, Lg. However, these linear parameters are very sensitive to non-uniformity of the lithosphere and the astenosphere and they depend on the location of the event and the path of a signal propagation. Moreover, modern technologies of nuclear testing complicate distinguishing between nuclear explosions and earthquakes. Necessarity of nuclear explosion identification at the unknown regions creates preconditions to use absolutly new approach to the discrimination problem, based on non-linear nature of seismic events.

Many authors showed the practicability of using Artificial Neural Networks (ANN) for the problem solution. ANN is a modern powerful mathematical tool for solving different tasks in both linear and non-linear statements. Result of ANN running completely depends on a training process, which starts from forming an attribute (feature) space. The problem of the attribute space creation is more art than science. Known examples of Artificial Neural Network (ANN) using for the discrimination problem based on the feature space containing linear parameter. This made ANNs dependent on the station location and/or event localization.

With the aim of creation of seismic signal image as an input pattern for a neural net, the authors have attempted to form the attribute space using Topological Dynamics and Wavelet-Transformation methods. We proposed to build a universal geometrical model of a seismic signal using the canon algorithm of F. Takens to take into account structural features of the lithosphere. In addition, we suggested to use the Discrete Wavelet Transformation (DWT) method to estimate distribution of the seismic signal energy at various frequency ranges, which differ for different types of seismic events. Seismograms of underground nuclear explosions and earthquakes recorded at regional distances were pre-processed for training the fully-connected Artificial Neural Network ' MultiNeuron' developed by Russian scientists.

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