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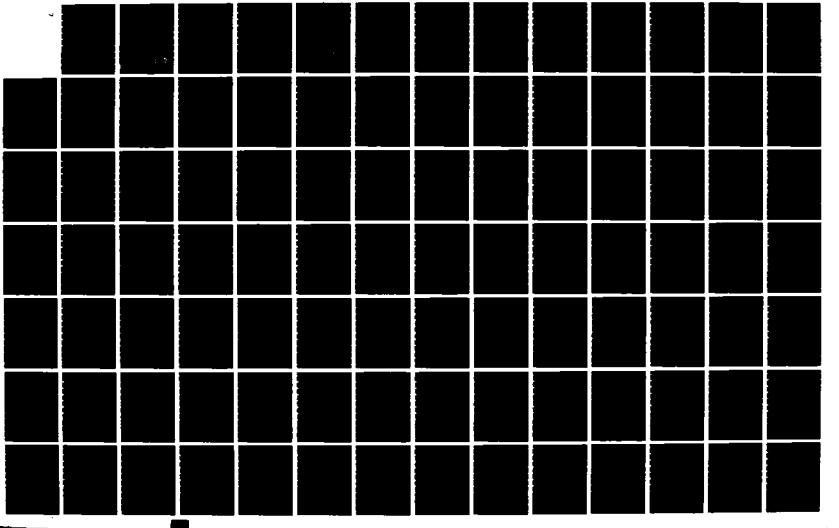

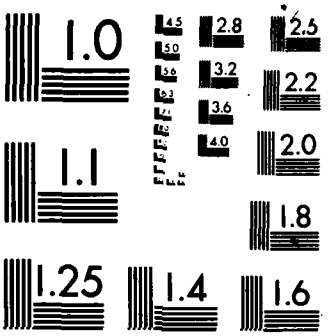

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ANNUAL REVIEW OF RESEARCH

under the

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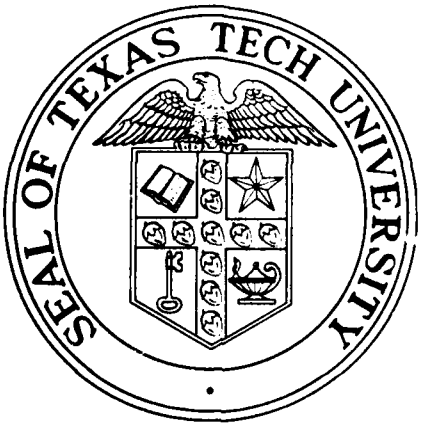

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report represents the seventh year of research under the auspices of the Joint Services Electronics Program at Texas Tech University. The program is in the area of information electronics and includes faculty from Computer Science, Electrical Engineering, and Mathematics. Specific work units deal with nonlinear control, parametric and nonparametric identification, pattern recognition for imaging systems, parallel computation and scheduling theory, analysis and design of large scale computing systems.

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The following items are provided for each work unit; a summary of the research performed in 1983, a list of publications and activities, and abstracts of published and pending papers. This annual report also contains lists of all grants and contracts administered by JSEP personnel and of all grants and contracts in the Departments of Electrical Engineering/Computer Science and Mathematics.

REVIEW OF RESEARCH

under the

JOINT SERVICES ELECTRONICS PROGRAM

at the

INSTITUTE FOR ELECTRONIC SCIENCE

TEXAS TECH UNIVERSITY

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December 1982 - December 1983

Lubbock, Texas 79409

ABSTRACT

This report represents the seventh year of research under the auspices of the Joint Services Electronics Program at Texas Tech University. The program is in the area of information electronics and includes faculty from Computer Science, Electrical Engineering, and Mathematics. Specific work units deal with nonlinear control, parametric and nonparametric identification, pattern recognition for imaging systems, parallel computation and scheduling theory, analysis and design of large scale computing systems.

The following items are provided for each work unit; a summary of the research performed in 1983, a list of publications and activities, and abstracts of published and pending papers. This annual report also contains lists of all grants and contracts administered by JSEP personnel and of all grants and contracts in the Departments of Electrical Engineering/Computer Science and Mathematics.

Contents

* Publications are available on request from Dr. L.R. Hunt, Director, Joint Services Electronics Program, Mathematics Department, Texas Tech University, Lubbock, Texas 79409.

Significant Accomplishments Report:

A. Nonlinear Control

George Meyer at NASA Ames Research Center is designing a totally automatic flight control system (TAFCOS) for aircraft with highly nonlinear mathematical models. Professors Hunt and Su were in Meyer's group at NASA Ames for 2 years (1980-1982). During that time and in more recent work, they have developed a mathematical theory to explain and support Meyer's technique. In fact they are presently extending the ideas and concepts of this revolutionary new design scheme. Hunt and Su's present interests lie not only in the appropriate mathematics, but in the engineering design as well.

The TAFCOS approach is currently being applied to have a UH-1H helicopter automatically fly a designated trajectory. A recent successful flight test marks a major step in the movement from classical control design to a modern control structure. Two reasons for this are:

1) Meyer's design technique does not ignore the hard nonlinearities of the mathematical model. This is distinct from the usual process of Taylor series linear approximations and gain scheduling.
2) A combination open/closed loop control action is used. The classical viewpoint that all control problems are "servo problems" should disappear as we demand more intelligence from our control schemes to handle difficult tasks.

The method developed at NASA was previously flight tested on fixed and augmentor wing aircraft, but the success with the helicopter is a significant development.

We appreciate JSEP's belief in and support of our research. During the last year, we have produced results that have led to a deeper understanding of nonlinear control systems. Our theory classifying those nonlinear systems that are "equivalent" to controllable linear systems has been greatly extended. In fact, canonical coordinate systems for general nonlinear mathematical models are currently being discovered.

B. Parametric and nonparametric identification

In ref. [1], we gave a novel solution to the nonparametric identification problem from noisy finite length I-O data. This solution has the following clear advantages over previous techniques:

i) We assume no a priori knowledge on the order of the unknown system,

ii) a realization of the identified model is obtained as a by-product,

iii) under clearly stated assumptions, our solution requires no further approximation,

iv) any finite set of finite length I-O sequences can be used to obtain the best estimate of the system from this data.

In Ref.s [2-3], we have given a new solution to the parametric identification problem for a class of multivariable systems which has the following advantages:

i) It is the first globally convergent recursive parameter identification technique where the parameters can enter the input-output map nonlinearly.

ii) It can be used to complement adaptive stabilization/pole-placement schemes which are the most general and realistic multivariable schemes that were ever developed (parametrizationwise) in Ref. [3].

iii) It provides a main framework in which to study recursive parameter identification problems where the parameters enter nonlinearly to the I-O map.

In Ref. [4] we have solved the problem of determining stabilizability and detectability of delay-differential systems with fixed point delays. In particular, we have proved a longstanding theorem (which is the natural extension of the delay free case) which was rather unexpected to be provable, although considered by many authors prior to [4]. Furthermore, our approach is exclusively based on theory of a single complex variable (as opposed to functions of several complex variables used in some other recent work) which extremely clarifies the subject. It is expected that our original result in [4], which is a cornerstone and which radically changes the direction of research in that area, will possibly lead to further results and/or alternative proofs by several other researchers. It is expected that it should also play a role in identification of delay-differential systems.

Texas Tech University | Institute for Electronic Science

Joint Services Electronics Program | Research Unit: 1

1. Title of Investigation: Nonlinear Control

2. Senior Investigators: L.R. Hunt (806) 742-1427
   Renjeng Su (806) 742-3716

3. JSEP Funds: $34,112

4. Other Funds:

5. Total Number of Professionals: PI 2 RA 2 (1/2 time)

6. Summary:

Our research into the theory of nonlinear control systems and applications to engineering design continues. The theory of transformations of nonlinear systems to controllable linear systems has been completed, and promising numerical procedures have been developed. Most importantly, George Meyer of NASA Ames Research Center has successfully flight tested the UH-IH helicopter using the transformation theory in a totally new design method. Thus this beautiful theory has passed a major real world test.

For more general nonlinear systems (i.e., systems which may not be transformable to linear systems) we have moved in two related directions:

i) Developing canonical coordinate systems which stress the intrinsic nonlinearities (those that cannot be "transformed away") and which depend upon the rich differential geometric flavor of nonlinear systems. These coordinates are defined by certain Lie bracket directions, and the system is expanded in these coordinates.

ii) Introducing a new linear approximation for a nonlinear system near an arbitrary point in state space. This approximation is

accomplished by matching the important Lie brackets instead of using the usual Taylor series approach. However, in the nice coordinate system mentioned in i), these two methods (Lie bracket matching and Taylor series) agree. By looking at the time response through Voltera series, we prove the validity of our linear approximations. We also consider approximating linearizations for control systems having outputs.

Another surprising result is finding sufficient observability criteria for nonlinear systems with output that does not depend on the inverse function theorem.

7. Publications and Activities

A. Refereed Journal Articles

1. L.R. Hunt, R. Su and G. Meyer, "Design for Multi-input Nonlinear Systems," Differential Geometric Control Theory, Birkhauser, Boston, R. W. Brockett, R. S. Millman, and H.J. Sussmann, Eds., 27 (1983), pp. 268-298.

2. R. Su, G. Meyer, and L.R. Hunt, "Robustness in Nonlinear Control," Differential Geometric Control Theory, Birkhauser, Boston, R.W. Brockett, R.S. Millman, and H.J. Sussmann, Eds., 27 (1983), pp. 316-337.

3. L.R. Hunt, R. Su, and G. Meyer, "Global Transformations of Nonlinear Systems," IEEE Trans. on Automat. Contr., Vol. AC-28, pp. 24-31, (1983).

B. Conference Papers and Abstracts

1. H. Ford, L.R. Hunt, and R. Su, "Nonlinear Transformations and Flight Control," Conference on Information Sciences and Systems, pp. 271-275, March 1983.

C. Preprints

1. G. Meyer, R. Su, and L.R. Hunt, "Applications of Nonlinear Transformations to Automatic Flight Control," Automatica, (to appear).

2. L.R. Hunt and R. Su, "Observability for Two Dimensional Systems," Math. Systems Theory, (to appear).

3. H. Ford, L.R. Hunt and R. Su, "A Simple Algorithm for Computing Canonical Forms," International Journal of Applications of Computers in Mathematics, (to appear).

4. L.R. Hunt, G. Meyer, and R. Su, "Nonlinear Control of Aircraft," International Symposium on Mathematical Theory of Networks and Systems, (to appear).

D. Dissertations and Theses

1. H. Ford, "Numerical and Symbolic Methods for Transforming Control Systems to Canonical Form," Ph.D. dissertation.

2. M. Luksic, "Systems Theory," Ph.D. dissertation (in progress).

3. David Nelson, "Command Generator Design for Autopilots," Ph.D. dissertation (in progress).

4. T.C. Hung, "Design of Inverse Systems," Ph.D. dissertation (in progress).

5. Javier Zablah, "Automatic Control of a Two-link Manipulator," M.S. thesis (in progress).

E. Conferences and Symposia

1. L.R. Hunt, IEEE Conference on Decision and Control, Orlando, Dec. 1982.

2. L.R. Hunt, American Math. Society Meeting, University of Oklahoma, March 1983.

3. L.R. Hunt, Conference on Information Sciences and Systems, Johns Hopkins University, March 1983.

4. L.R. Hunt and R. Su, SIAM Regional Meeting, Texas Tech University, May 1983.

5. L.R. Hunt, Berkeley-Ames Conference on Nonlinear Problems in Control and Fluid Dynamics, University of California, Berkeley, as conference coorganizer and codirector, June 1983.

6. L.R. Hunt, International Symposium on Mathematical Theory of Networks and Systems, BeerSheva, Israel, June 1983.

7. L.R. Hunt and R. Su, Regional Numerical Analysis Conference, Texas Tech University, Sept. 1983.

8. R. Su, Berkeley-Ames Conference on Nonlinear Problems in Control and Fluid Dynamics, University of California, Berkeley, as an invited speaker, June, 1983.

ABSTRACT

DESIGN FOR MULTI-INPUT NONLINEAR SYSTEMS

L. R. HUNT, RENJENG SU, AND G. MEYER

DESIGN FOR MULTI-INPUT NONLINEAR SYSTEMS

L. R. Hunt, Renjeng Su, and G. Meyer

Abstract

Consider the multi-input nonlinear system

$$\dot{x}(t) = f(x(t)) + \sum_{i=1}^{m} u_i(t) g_i(x(t)) ,$$

where $f, g_1, \ldots, g_m$ are C^∞ vector fields on some neighborhood of the origin in $\mathbb{R}^n$ and $f(0) = 0$. We present necessary and sufficient conditions for this system to be transformed to a controllable linear system. Our results are constructive and depend upon the solutions of overdetermined systems of partial differential equations. Moreover, we indicate how this theory is applied to build an automatic flight controller for vertical and short takeoff (VSTOL) aircraft. Flight-test simulation results are presented.

ABSTRACT

ROBUSTNESS IN NONLINEAR CONTROL

RENJENG SU, GEORGE MEYER AND L. R. HUNT

ROBUSTNESS IN NONLINEAR CONTROL

Renjeng Su, George Meyer and L. R. Hunt

Abstract

A new design methodology for nonlinear plants using transformations of nonlinear systems to linear systems is presently being developed. It is the purpose of this paper to show that this design theory is robust. If the linear system is asymptotically stabilized by applying appropriate feedback (a well-known technique), then a control to stabilize the nonlinear plant is easily computed through that part of the inverse transformation involving controls. Most importantly, all nearby plants (in the proper topology) are also asymptotically stabilized using this control. Lyapunov functions for nonlinear systems can be found using this method. A short discussion on the application of this design technique to the automatic flight control of aircraft is presented.

ABSTRACT

GLOBAL TRANSFORMATIONS OF NONLINEAR SYSTEMS

L. R. HUNT, RENJENG SU, AND GEORGE MEYER

GLOBAL TRANSFORMATIONS OF NONLINEAR SYSTEMS

L. R. Hunt, Renjeng Su, and George Meyer

Abstract

Recent results have established necessary and sufficient conditions for a nonlinear system of the form

$$\dot{x}(t) = f(x(t)) + u(t)g(x(t)).$$

with $f(0) = 0$, to be locally equivalent in a neighborhood of the origin in $\mathbb{R}^n$ to a controllable linear system. We combine these results with several versions of the global inverse function theorem to prove sufficient conditions for the transformation of a nonlinear system to a linear system. In doing so we introduce a technique for constructing a transformation under the assumptions that $\{g,[f,g],\ldots,(ad^{n-1}f,g)\}$ span an n-dimensional space and that $\{g,[f,g],\ldots,(ad^{n-2}f,g)\}$ is an involutive set.

ABSTRACT

NONLINEAR TRANSFORMATIONS AND FLIGHT CONTROL

H. Ford, L. R. Hunt and R. Su

NONLINEAR TRANSFORMATIONS AND FLIGHT CONTROL

H. Ford, L.R. Hunt and R. Su

Abstract

A technique for designing automatic flight controllers for aircraft which utilizes the transformation theory of nonlinear systems to linear systems is presently being developed at NASA Ames Research Center. We mention a method for taking controllable linear systems to Brunovsky canonical form, and introduce a linear approximation to the nonlinear system called the modified tangent model. Constructing the transformation for this model enables us to find an approximate transformation for the nonlinear system.

ABSTRACT

APPLICATION OF NONLINEAR TRANSFORMATIONS TO AUTOMATIC FLIGHT CONTROL

G. MEYER, R. SU AND L.R. HUNT

APPLICATION OF NONLINEAR TRANSFORMATIONS TO AUTOMATIC FLIGHT CONTROL

G. Meyer, R. Su and L.R. Hunt

Abstract

This paper presents the results of an application of transformations (from nonlinear to linear systems) to the design of a helicopter autopilot. Topics covered are 1) a review of the transformation theory and its use in the design approach, 2) a description of the helicopter mathematical model, 3) the construction of the transformation from the nonlinear system to the linear system, and 4) a discussion of the system performance.

ABSTRACT

OBSERVABILITY FOR TWO DIMENSIONAL SYSTEMS

L. R. HUNT AND RENJENG SU

OBSERVABILITY FOR TWO DIMENSIONAL SYSTEMS

L.R. Hunt and Renjeng Su

Abstract

Sufficient conditions that a 2 dimensional system with output is locally observable are presented. Known results depend on time derivatives of the output and the inverse function theorem. In some cases, no information is provided by these theories, and one must study observability by other methods. We dualize the observability problem to the controllability problem, and apply the deep results of Hermes on local controllability to prove a theorem concerning local observability.

ABSTRACT

A SIMPLE ALGORITHM FOR COMPUTING CANONICAL FORMS

H. Ford, L. R. Hunt, and Renjeng Su

A SIMPLE ALGORITHM FOR COMPUTING CANONICAL FORMS

H. Ford, L.R. Hunt, Renjeng Su

Abstract

It is well known that all linear time-invariant controllable systems can be transformed to Brunovsky canonical form by a transformation consisting only of coordinate changes and linear feedback. However, the actual procedures for doing this have tended to be overly complex. The technique introduced here is envisioned as an on-line procedure and is inspired by George Meyer's tangent model for nonlinear systems. The process utilizes Meyer's block triangular form as an intermediate step in going to Brunovsky form. The method also involves orthogonal matrices, thus eliminating the need for the computation of matrix inverses. In addition, the Kronecker indices can be computed as a by-product of this transformation so it is not necessary to know them in advance.

ABSTRACT

NONLINEAR CONTROL OF AIRCRAFT

L. R. HUNT, G. MEYER AND R. SU

NONLINEAR CONTROL OF AIRCRAFT

L.R. Hunt, G. Meyer and R. Su

Abstract

In recent work at the NASA Ames Research Center, transformations of nonlinear systems have been used to design automatic flight controllers for vertical and short take off aircraft. Under the assumption that a nonlinear system can be mapped to a controllable linear system, we motivate by partial differential equations a method to construct approximate transformations in cases where exact ones cannt be found. We also present an application of the design theory to a rotorcraft, the UH-1H helicopter.

Texas Tech University — Institute for Electronic Science

Joint Services Electronics Program — Research Unit: 2

1. Title of Investigation: Parametric and Nonparametric Identification
2. Senior Investigators: Erol Emre — Telephone: (806) 742-3581
3. JSEP Funds: $27,196
4. Other Funds:
5. Total Number of Professionals: PI 1 RA 1 (1/2 time)
6. Summary:

Our research on the JSEP project "Parametric and Nonparametric Identification" started on June 1, 1983, and it has been mainly in three different parts:

i) Nonparametric Identification

ii) Parametric Identification

iii) Stabilizability and Detectability of Delay-Differential Systems.

i) Nonparametric Identification: As we proposed in our research proposal, we had shown that the problem of nonparametric system identification from noisy input-output data could be formulated as a noisy exact model matching problem. Namely, we were interested in estimating the impulse response (= transfer matrix) of a discrete-time linear system

$$x(t+1) = Fx(t) + Gu(t)$$

$$y(t) = Hx(t)$$

from a finite set of finite length input-output sequences. However, it was assumed that the measurement of $y(t)$ was not exact, but corrupted by a white noise error random process (with a modification, noise in input can also be allowed).

We were able to reformulate this problem as a new type of input estimation problem, which, in turn is a noisy exact model matching problem.

iii) In addition to our research cited above, we have also obtained some fundamental results in delay-differential systems. As the concept of detectability (dual of stabilizability) plays a key role in some system identification schemes for delay-free systems, which utilize observers, for possible future identification schemes for systems with delays, it is first necessary to find the true detectability (stabilizability) criteria for delay-differential systems. However, the problem of determining usable detectability (stabilizability) criteria for such systems had been known to be a very difficult problem for many years as many attempts by many authors had failed previously. After very intensive research, we have been able to give a full solution to this problem (which had been though to be rather unsolvable) in Emre and Ashton [4]. It is natural to expect that the type of results as developed in [4] will eventually lead to some theoretically sound, practically implementable system identification techniques for systems containing delays.

References

[1] E. Emre, "A new approach to identification of linear systems and the optimal solution of a class of synthesis problems," to appear in Optimal Control: Appl. and Meth. 1984.

[2] E. Emre, "On adaptive control/observers and asymptotic parameter identification of linear systems," Proc. IEEE Conf. on Decision and Control, 1984.

[3] E. Emre, " Adaptive control/observers and asymptotic parameter identification of linear multivariable systems with continuous parametrizations," Preprint, Dept. of EE/CS Texas Tech Univ., Nov. 1983, Submitted for publication.

[4] E. Emre and G. Ashton, "Control of linear systems with fixed noncommensurate point delays," August 1983. To appear in IEEE Trans. Autom. Contr.

ii) Parametric Identification: In this part of our research, we have considered linear (unknown) systems with continuous parametrizations, $\sum(\alpha)$:

$$\dot{x}(t) = F(\alpha)x(t) + G(\alpha)\, u\,(t)$$

$$y(t) = H(\alpha)x(t)$$

where the entries of F,G,H are twice continuously differentiable (nonlinear) functions of the (unknown) parameter vector α which takes values in a subset of $\mathbb{R}^N$. Thus α represents the uncertainty in the unknown system $\sum(\alpha)$. Such a system $\sum(\alpha)$ can be obtained either from physical laws or may arise due to linearizing a nonlinear system in which case α represents the unknown operating point. After considerable research, in Emre [2,3], we have given the first globally convergent asymptotic parameter identification techniques for a large class of multivariable (possibly unstable) linear systems. Our techniques are such that, we are able to construct a differential equation

$$\dot{\beta}(t) = f(t,\beta(t))$$

from $u(t)$, $y(t)$ and $\sum(\alpha)$ such that for any $\beta(o) \in \mathbb{R}^M$, this differential equation has a unique solution on $[o,\infty)$, and

$$\beta(t) \longrightarrow \beta^*$$

where the true value of α, α^*, is a subvector of β^*.

In Emre [2,3], we have also established some fundamentals of parameterized systems, oriented to the study of above type of asymptotic parameter identification techniques for possibly more general parameterized systems. Our results in this area, in particular, are a part of also first globally stable generally applicable multivariable adaptive control (stabilization/pole-placement) techniques (see [2,3]).

Our research in both areas is continuing in further extending the results we have obtained in Emre [1-3].

For more details on these, we refer to our JSEP proposal.

During the period June 1983 - December 1983, we have done a much deeper study of this problem and considerably extended our solution. Previously, we were able to obtain a solution to this problem under a condition on the input-output data. Our research during this period has resulted in a solution which can be applied to any finite set of finite length sequences. In this, we have made essential use of some of the results on the geometric theory of linear systems (i.e., (F,G)-invariant subspaces). In fact, we have also obtained some new results in this area.

Our results in this area in their present form can be found in Emre [1]. In fact, in [1], we not only solve the identification problem, but we also obtain the first optimal solutions of the problems of a) Optimal Model Matching, b) Optimal Deadbeat Control, and c) Optimal Disturbance Decoupling problems. We have shown in [1] that all of these problems give rise to the same (new) type of optimization problem which we can now solve using some geometric theory and quadratic control results in a much more general setting.

In particular, as applications of our methods developed in [1], one can obtain "optimal inverse systems" which can be used in optimal deconvolution as for example in seismic data processing or image processing. Obviously, our identification techniques can also be used in modeling "wavelets" as linear systems, which again arise in seismic data processing, and many other areas.

Our general solution to the identification problem has some clear advantages over previous techniques among which are the following: a) our technique does not assume any a priori bound on the order of the systems, b) a realization of the identified system is obtained as a by-product of our solution, c) any input-output sequence can be used.

7. Publications and Activities:

A. Refereed Journal Articles

1. E. Emre "A new approach to identification of linear systems and the optimal solution of a class of synthesis problems," to appear in Optimal Control: Methods and Applications, 1984.

2. E. Emre and G. Knowles "Control of linear systems with fixed noncommensurate point delays," to appear in IEEE Trans. Automatic Control.

B. Conference Papers and Abstracts

1. E. Emre "On adaptive control/observers/parameter estimation of multivariable systems," Proc. IEEE Conference on Decision and Control, San Antonio, TX, 1983.

C. Preprints

1. E. Emre "Adaptive control/observers and asymptotic parameter identification of multivariable systems with continuous parametrizations," submitted for publication.

D. Dissertation and Thesis

1. Andrzej Gapinski (in part), "Systems Theory." Ph.D. Dissertation (in progress).

2. Heng-Meng Tai (in part), "Systems Theory," Ph.D. Dissertation (in progress).

E. Conferences and Symposia

1. E. Emre, IEEE Conference on Decision and Control, San Antonio, Dec. 1983.

ABSTRACT

A NEW APPROACH TO IDENTIFICATION OF LINEAR SYSTEMS AND THE OPTIMAL SOLUTION OF A CLASS OF SYNTHESIS PROBLEMS

EROL EMRE

A NEW APPROACH TO IDENTIFICATION OF LINEAR SYSTEMS AND THE OPTIMAL SOLUTION OF A CLASS OF SYNTHESIS PROBLEMS

Erol Emre

ABSTRACT

A unifying solution is given to the problems of optimal deadbeat control, disturbance decoupling, exact model matching, and system identification. It is shown that the optimal solutions of these problems can be obtained by solving a new type optimization problem. Our solution makes use of certain recent results on system structure and on geometric and polynomial theories of linear systems.

ABSTRACT

CONTROL OF LINEAR SYSTEMS WITH FIXED NONCOMMENSURATE POINT DELAYS

E. EMRE AND G. KNOWLES

CONTROL OF LINEAR SYSTEMS WITH FIXED NONCOMMENSURATE POINT DELAYS

E. Emre and G. Knowles

ABSTRACT

The first solution is given to the fundamental open problem of stabilizability and detectability (necessary sufficient conditions for internal stabilization by feedback) of retarded and a large class of neutral delay-differential systems with several fixed, noncommensurate point delays, using causal compensators (observers and state-feedback or dynamic output feedback) which are also the same type of neutral or retarded delay differential systems with fixed, point delays only. Our results are rank conditions on the system matrices $[zI-F:G]$ and $[zI-F^T:H^T]$ evaluated at points in the complex plane and are the weakest possible generally applicable sufficient such rank conditions for stabilization of neutral systems in the light of what is known on the stability of such systems. These conditions are necessary for most practical purposes. The class of systems we consider includes all retarded delay-differential systems with noncommensurate, fixed, point delays. In the case of retarded systems, these rank conditions are necessary and sufficient conditions for stabilization via compensators which are causal retarded delay-differential systems with fixed, point delays only. These constitute the first full solution of these previously unsolved problems of stabilizability and detectability (which, together, are necessary and sufficient conditions for internal stabilization by feedback) for delay-differential systems even in the retarded single fixed point delay case. An application of our results to a problem of practical importance in control of linear systems with no delays provides a stabilization criterion interesting in itself.

ABSTRACT

ON ADAPTIVE CONTROL/OBSERVERS/PARAMETER ESTIMATION OF MULTIVARIABLE SYSTEM

E. Emre

ON ADAPTIVE CONTROL/OBSERVERS/PARAMETER ESTIMATION OF MULTIVARIABLE SYSTEM

E. Emre

ABSTRACT

Adaptive Control and Adaptive Parameter identification problems are given solutions for a general class of linear multivariable systems for the first time.

ABSTRACT

ADAPTIVE CONTROL/OBSERVERS AND ASYMPTOTIC PARAMETER IDENTIFICATION OF MULTIVARIABLE SYSTEMS WITH CONTINUOUS PARAMETRIZATIONS

EROL EMRE

ADAPTIVE CONTROL/OBSERVERS AND ASYMPTOTIC PARAMETER IDENTIFICATION OF MULTIVARIABLE SYSTEMS WITH CONTINUOUS PARAMETRIZATIONS

Erol Emre

ABSTRACT

The adaptive stabilization/pole-placement, adaptive observers, and parameter identification of multivariable systems with continuous parametrizations is considered. First, the problems of determining suitable structures for adaptive stabilization/pole-placement and adaptive observers are given solutions for several classes of continuously parameterized multivariable systems. These are the first solutions of these problems for multivariable systems without the assumptions of the knowledge and constancy over the parameter space of quantities such as observability/reachability indices, or the interactor of the transfer matrix. Our assumptions here are necessary and sufficient conditions for such structures to exist. Also, the parametrizations considered here are much more general types of parametrizations (continuous functions of the parameters) even for implicitly parameterized single input-single output systems than the parametrizations previously considered. Second, it is shown that under some uniformity and extendability conditions on the given parametrization, globally convergent asymptotic parameter identification is possible for parameterized systems with twice continuously differentiable parametrizations. A general approach is given for this. In particular, two identification techniques are shown to be possible under assumptions on the system parametrization which are already present in all previous asymptotic system identification techniques. These

parameter identification techniques are shown to complement the adaptive stabilization/pole-placement structures developed in this paper, thus leading to globally stable adaptive control/observer techniques for several classes of continuously parameterized multivariable systems, with minimal assumptions. General types of implicitly parameterized multivariable systems are also considered. In this case, the techniques developed here lead to new globally stable adaptive control/observer schemes for multivariable systems, which are natural generalizations of the results previously given for the single input-single output case. The multivariable schemes developed here work under the same assumption as the single input-single output case solved in the literature. All the results developed in this paper are new, and they constitute the first globally stable solutions of the adaptive control/observer and globally convergent parameter identification problems for a rather large class of multivariable systems with minimal assumptions (in the sense that these assumptions are either necessary, or the weakest sufficient assumptions that exist thus far).

Texas Tech University — Institute for Electronic Science

Joint Services Electronics Program — Research Unit: 4

1. Title of Investigation: Pattern Recognition in Imaging Systems
2. Senior Investigators: Thomas G. Newman Telephone: (806) 742-2571
3. JSEP Funds: $30,946.
4. Other Funds: $69,500 requested from Conoco, Inc.
5. Total Number of Professionals: PI 1 (1 1/2 mo. RA's 3 (3 mo. ea.)
6. Summary:

In this project we are attempting to develop algorithms suitable for the automatic detection and recognition of objects in the context of a dynamic imaging system, i.e., which may be in motion relative to the three dimensional scene. We are primarily interested in methods which are invariant with respect to the aspect, position, and relative motion of the target. From our earlier published work on this problem, a necessary condition for this type of invariant recognition is that the object to be classified be segmented from its surroundings, which in turn necessitates pre-detection of possible targets.

We are currently considering a detection/matching algorithm which involves calculation of a class of local features, by means of a suitable class of weighting functions. The resulting class of features have the property that they are infinitesimal relative invariants to the Lie algebra of differential operators corresponding to the action of the group of projective transformations on the image plane. This simply means that for any X in this Lie algebra, and any feature F, we may express X(F) as a linear combination of a finite number of other features in the class. Due to this fact, we are able to get around the problems arising from the lack of suitable finite dimensional representations of the projective group.

One of the questions which we have been considering concerns the sensitivity of our features to random disturbances (noise) in the image data. Progress has been made in this regard, with a completed Masters Degree expected to be awarded in the Spring Semester of 1984 for work on this problem. Basically, the results to date indicate that the features are considerably more sensitive to motion than to noise, and should therefore be suitable for target detection and the determination of aspect and position.

7. Publications and Activities:

A. Conference Papers and Abstracts:

1. Newman, T.G., "Geometric Methods in Dynamic Image Processing," Berkeley-Ames Conference on Nonlinear Problems in Control and Fluid Dynamics, June 1983.

B. Theses:

1. Cloyd, R., "Correlation as a Measure of Quality for Calculation of Derivatives in Digital Images," Texas Tech University, Spring 1983.

2. White, G.B., "Use of Perspective Distortions for Image Analysis," Texas Tech University, Fall 1983.

C. Conferences and Symposia:

1. Berkeley-Ames Conference on Nonlinear Problems in Control and Fluid Dynamics, June 1983.

2. Regional Chapter Sigma Xi, "Dynamic Image Processing," Invited Address, October 1983.

ABSTRACT

GEOMETRIC METHODS IN DYNAMIC IMAGE PROCESSING

THOMAS G. NEWMAN

GEOMETRIC METHODS IN DYNAMIC IMAGE PROCESSING

Thomas G. Newman

ABSTRACT

The requirements for real-time image processing call for the use of mathematical techniques not commonly used in static image processing. In this paper we show how concepts from Lie theory and elementary differential geometry may be applied to certain problems in the analysis of dynamic images, particularly with respect to problem areas dealing with motion.

We begin by presenting a model for the motion induced in an image plane due to rigid motion in space, showing that the former can be approximated by the action of the projective group on the image plane. The main results presented are concerned with tracking such motion. We show that tracking can be implemented by means of numerical solution of a first order linear 3x3 matrix differential equation, in which the velocity coefficients may be measured from data sampled from the image plane.

Brief mention is made of other applications, such as shape determination and recovery of rigid motion rates (e.g., roll, pitch, and yaw) from the rates of projective motion.

Texas Tech University — Institute for Electronic Science

Joint Services Electronics Program — Research Unit: 5A

1. Title of Investigation: Parallel Computation and Scheduling Theory
2. Senior Investigators: Kazuo Nakajima Telephone: (806) 742-1977
3. JSEP Funds: $18,031
4. Other Funds: None
5. Total Number of Professionals: PI 1 RA 0
6. Summary:

Although it is still possible to improve the existing sparse matrix techniques, it is generally agreed that we have done as much as we can with the use of these techniques to reduce the computation time of solving a system of sparse linear equations. Therefore, considerable research efforts have recently been directed at the development of parallel solution techniques for sparse linear equations. However, research activities in this area are still at an early stage. In fact, only two heuristic algorithms have been proposed for reordering a sparse matrix so as to minimize the completion time of its triangulation process in a parallel computing system.

During the past year the principal investigator introduced a graph theoretic approach to the reordering problem for a sparse asymmetric matrix. Using a directed graph model, we have developed exact algorithms for optimal parallel triangulation of the asymmetric matrix for its two special cases. For the case of a symmetric matrix, we have also obtained efficient optimal reordering algorithms for several special cases using an undirected graph model; and our heuristic algorithm for the general case has been shown to be superior to the existing algorithms. Some progress has also been made in an investigation of the scheduling problems arising in the parallel

solution of sparse linear equations and in the area of traditional sparse matrix techniques.

When we implement the parallel solution process of a system of sparse linear equations in a multiprocessor computing system, it becomes important to detect and locate any faulty processors in this computing system. It is also important to design a VLSI system for this. We have investigated the system fault diagnosis problem and obtained some significant results. We have made some progress in the VLSI circuit layout problem area.

7. Publications and Activities:

A. Refereed Journal Articles

1. Hakimi, S.L., and K. Nakajima, "On Adaptive System Diagnosis," IEEE Trans. on Computers, Vol. C-33, pp. 234-240 (1984).

2. Hakimi, S.L., and K. Nakajima, "On a Theory of t-Fault Diagnosable Analog Systems," IEEE Trans. on Circuits and Systems, (to appear).

B. Conference Papers and Abstracts

1. Nakajima, K., and M. Sun, "On Graph Theoretic Models for the Circuit Layout Problem," Proc. of the 1983 IEEE Int. Symp. on Circuits and Systems, Newport Beach, CA, May 1983, pp. 1022-1025.

2. Nakajima, K., and V.P. Krothapalli, "On Adaptive Fault Identification in Optimal Diagnosable Systems," Proc. of the 21st Allerton Conf. on Communication, Control, and Computing, Urbana, IL, Oct 1983, pp. 373-382.

3. Nakajima, K., "A Graph Theoretic Approach to Parallel Triangulation of a Sparse Asymmetric Matrix," Proc. of the 18th Conf. on Information Sciences and Systems, Princeton, NJ, March 1984, (to appear).

4. Nakajima, K., "The Fixed Job Scheduling Problem and its Generalizations," Bulletin of the 17th TIMS/ORSA Joint National Meeting, San Francisco, CA, May 1984, paper MB9.4.

5. Hakimi, S.L., and K. Nakajima, "On t-Fault Diagnosable Analog Systems," Proc. of the 1984 IEEE Int. Symp. on Circuits and Systems, Montreal, Canada, May 1984, (to appear).

6. Hakimi, S.L., and K. Nakajima, "Recent Development in Adaptive System-Level Diagnosis," Proc. of the 1984 IEEE Int. Symp. on Circuits and Systems, Montreal, Canada, May 1984, (to appear).

C. Preprints

1. Krothapalli, V.P., F. Lombardi, and K. Nakajima, "Fault Diagnosis for a Multistage SW Banyan Interconnection Network," (submitted for publication).

2. Nakajima, K., "On the Reduction of Fill-ins in a Sparse Matrix," (submitted for publication).

3. Nakajima, K., and I. Suzuki, "Efficient Algorithms for Optimal Parallel Triangulation of a Sparse Matrix," (submitted for publication).

D. Conferences and Symposia

1. Nakajima, K., 1983 IEEE Int. Symp. on Circuits and Systems, Newport Beach, CA, May 1983.

2. Nakajima, K., 21st Allerton Conf. on Communication, Control, and Computing, Urbana, IL, Oct. 1983.

3. Nakajima, K., 18th Conf. on Information Sciences and Systems, Princeton, NJ, March 1984.

ABSTRACT

ON ADAPTIVE SYSTEM DIAGNOSIS

S. Louis Hakimi and Kazuo Nakajima

ON ADAPTIVE SYSTEMS DIAGNOSIS

S. Louis Hakimi and Kazuo Nakajima

ABSTRACT

In the theory of t-fault-diagnosable systems, one first chooses a set of diagnostic tests, then seeks the results of these tests, and finally proceeds to use the test results to identify the faulty units assuming that the number of faulty units does not exceed t. Nakajima was the first to suggest a departure from this practice. He proposed to adaptively choose the tests and to seek their results until one can identify a fault-free unit. This fault-free unit may then be used as a tester to identify all faulty units. In this paper we exploit this idea fully and show that one needs the results of at most (n + 2t - 2) adaptive tests to identify all faulty units in a t-fault-diagnosable system with n units. The impact of the applications of this idea to the various models and diagnosis algorithms is examined.

ABSTRACT

ON A THEORY OF τ-FAULT DIAGNOSABLE ANALOG SYSTEMS

S. Louis Hakimi and Kazuo Nakajima

ON A THEORY OF t-FAULT DIAGNOSABLE ANALOG SYSTEMS

S. Louis Hakimi and Kazuo Nakajima

ABSTRACT

The theory of t-fault diagnosable systems initiated by Preparata et al. has been studied for applications to automatic self-testing of large scale digital systems. Recently, Amin introduced another variation of their model. In this paper, we show that this model has an application to analog fault diagnosis. We further specialize Amin's model to obtain characterization theorems which are much more transparent and also are more suitable for this particular application.

ABSTRACT

ON GRAPH THEORETIC MODELS FOR THE CIRCUIT LAYOUT PROBLEM

KAZUO NAKAJIMA AND MOSES SUN

ON GRAPH THEORETIC MODELS FOR THE CIRCUIT LAYOUT PROBLEM

Kazuo Nakajima and Moses Sun

ABSTRACT

We consider the circuit layout problem on integrated circuits and single layer printed circuit boards. In the past a cycle has been proven to be a powerful model for use in a topological approach to solving the problem. In this paper we show that a star is as powerful as a cycle for that purpose. The use of this graph model is further supported by a recently developed efficient algorithm for testing the planarity of a partially oriented graph representing the circuit.

ABSTRACT

ON ADAPTIVE FAULT IDENTIFICATION IN OPTIMAL DIAGNOSABLE SYSTEMS

KAZUO NAKAJIMA AND VIRABRAHMA P. KROTHAPALLI

ON ADAPTIVE FAULT IDENTIFICATION IN OPTIMAL DIAGNOSABLE SYSTEMS

Kazuo Nakajima and Virabrahma P. Krothapalli

ABSTRACT

In the earlier work on the adaptive system diagnosis problem, it was assumed that every unit is capable of testing every other unit in the system. Several adaptive diagnosis algorithms were developed for such systems. Recently, two of the algorithms were shown to be applicable to a certain class of "optimal" t-fault diagnosable systems in which every unit is tested by exactly t other units. We show that a variation of the Hakimi-Schmeichel algorithm identifies a fault-free unit for another class of optimal systems. We then present a necessary and sufficient condition for identification of all faulty units after locating a fault-free unit. Finally, we briefly discuss the adaptive fault identification problem for undirected graph models.

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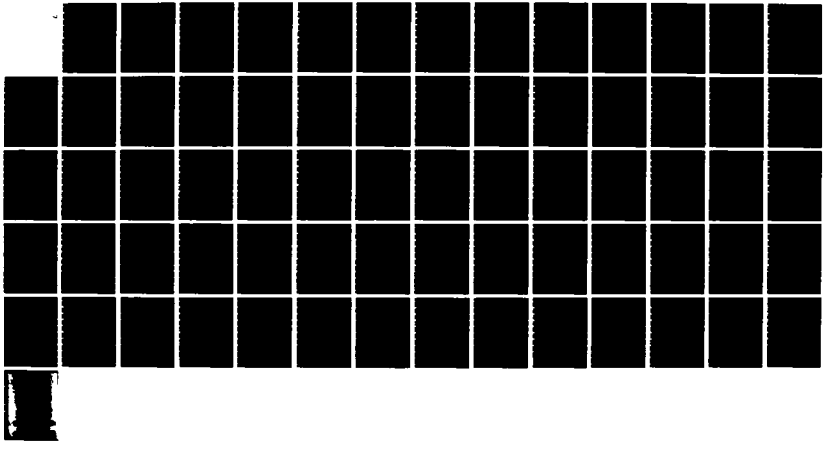
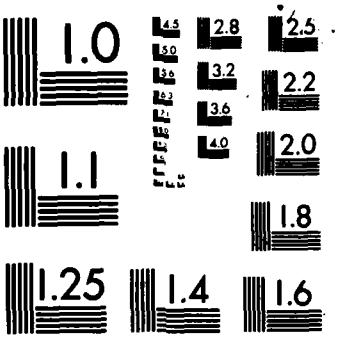




ABSTRACT

A GRAPH THEORETIC APPROACH TO PARALLEL TRIANGULATION OF A SPARSE ASYMMETRIC MATRIX

KAZUO NAKAJIMA

A GRAPH THEORETIC APPROACH TO PARALLEL TRIANGULATION OF A SPARSE ASYMMETRIC MATRIX

Kazuo Nakajima

ABSTRACT

We consider the problem of reordering a sparse asymmetric matrix so as to minimize the completion time of its triangulation process in a parallel computing system. A weighted directed graph is used to model such a parallel triangulation process. We present optimal reordering algorithms for two special classes of the matrix. The formula for the minimum completion time of the parallel triangulation process is also derived for these classes.

ABSTRACT

FIXED JOB SCHEDULING PROBLEM AND ITS GENERALIZATIONS

KAZUO NAKAJIMA

THE FIXED JOB SCHEDULING PROBLEM AND ITS GENERALIZATIONS

Kazuo Nakajima

ABSTRACT

The fixed job scheduling problem is the problem of assigning independent jobs with each having a prescribed starting time to the minimum number of identical parallel machines. Recently two generalizations of this problsm have been studied. After reviewing their complexity results, we consider yet another generalization of the problem.

ABSTRACT

ON τ-FAULT DIAGNOSABLE ANALOG SYSTEMS

S. Louis Hakimi and Kazuo Nakajima

ON t-FAULT DIAGNOSABLE ANALOG SYSTEMS

S. Louis Hakimi and Kazuo Nakajima

ABSTRACT

The theory of t-fault diagnosable systems has been most widely studied in the area of fault analysis of digital systems. Recently, Wu, Nakajima, Wey and Saeks borrowed an idea from this theory and proposed a new approach to fault diagnosis of analog systems. Then, Hakimi and Nakajima formalized their approach in the framework of the theory of t-fault diagnosable systems. In this paper, their new theory of t-fault diagnosable analog systems is reviewed and the implications of their results are discussed.

ABSTRACT

RECENT DEVELOPMENT IN ADAPTIVE SYSTEM-LEVEL DIAGNOSIS

S. Louis Hakimi and Kazuo Nakajima

RECENT DEVELOPMENT IN ADAPTIVE SYSTEM-LEVEL DIAGNISIS

S. Louis Hakimi and Kazuo Nakajima

ABSTRACT

This paper begins by briefly reviewing the traditional approach to system-level diagnosis initiated by Preparata, Metze, and Chien. We then describe a new approach, called adaptive system diagnosis, studied by Hakimi and Nakajima and others. Finally, more recent results on the new approach are presented.

ABSTRACT

FAULT DIAGNOSIS FOR A MULTISTAGE SW BANYAN INTERCONNECTION NETWORK

V. P. KROTHAPALLI, F. LOMBARDI AND K. NAKAJIMA

FAULT DIAGNOSIS FOR A MULTISTAGE SW BANYAN INTERCONNECTION NETWORK

V.P. Krothapalli, F. Lombardi and K. Nakajima

ABSTRACT

Multistage networks play an important role in parallel processing architectures and particularly in reconfigurable structures as they provide the ability to switch paths between modules according to the requirements of both throughput and fault tolerance. In this respect, effective fault diagnosis techniques of these devices are highly desirable to cover all the switching modes. In this paper diagnostic tests applicable to SW Banyan Networks (SWBNs) with a spread of two and a fan-out of two are presented. The results represent net improvements over the previous diagnostic procedures for the minimization in the required number of tests and for the full diagnostic coverage of all the possible states of the network.

ABSTRACT

ON THE REDUCTION OF FILL-INS IN A SPARSE MATRIX

KAZUO NAKAJIMA

ON THE REDUCTION OF FILL-INS IN A SPARSE MATRIX

Kazuo Nakajima

ABSTRACT

We consider the problem of reducing a set of the fill-ins produced by a given pivot ordering for a sparse symmetric matrix. Using a graph-theoretic approach, we present an efficient algorithm for reducing such a set to a minimal set and simultaneously finding the pivot ordering which produces this minimal set of fill-ins.

ABSTRACT

EFFICIENT ALGORITHMS FOR OPTIMAL PARALLEL TRIANGULATION OF A SPARSE MATRIX

KAZUO NAKAJIMA AND ICHIRO SUZUKI

EFFICIENT ALGORITHMS FOR OPTIMAL PARALLEL TRIANGULATION OF A SPARSE MATRIX

Kazuo Nakajima and Ichiro Suzuki

ABSTRACT

The triangulation process of a sparse symmetric matrix in a parallel computing system has been modelled by the vertix elimination process of the undirected graph associated with the matrix. Based on this graph model, we develop efficient algorithms for reordering the matrix so as to minimize the completion time of its triangulation process.

Texas Tech University — Institute for Electronic Science

Joint Services Electronics Program — Research Unit: 5 B

1. Title of Investigation: Availability Analysis and Modelling of Parallel Processing Architectures

2. Senior Investigators: Fabrizio Lombardi Telephone: (806) 742-3611

3. JSEP Funds: $18,031

4. Other Funds: None

5. Total Number of Professionals: PI 1 RA 1 (1/2 time)

6. Summary:

Our program during the past year under this project has been directly in two directions:

A. Theory:

i) Formulation of equivalent conditions for large scale Markov's Chains by complexity reduction for availability evaluation;

ii) Diagnostic analysis (using queueing theory and system-level diagnosis) of highly structured computer networks (arrays, systolic systems); and

iii) Reconfiguration strategies using triplet testing for distributed systems using memory as coupling devices.

B. Experimentation:

i) Evaluation of modular computer architectures for distributed/parallel processing using simulation and a testbed environment for synchronous processing in a strictly fair bus allocation;

ii) Design of control for large scale duplex-orientated computer systems for VLSI implementation using basic cell arrangements; and

iii) Decentralized techniques for parallel system diagnosis with direct applicability to real time processing for fast roving in highly concurrent modes of operation.

7. Publications and Activities:

A. Refereed Journal Articles

1. F. Lombardi " Control of Locally Testable Duplex System for Large Scale Implementation" Electronic Letters, Vol. 19, No. 10, pp. 392-393, IEE Press, 1983.

B. Conferences

1. F. Lombardi and S. Ratheal "Generalized Modelling of Testing and Reconfigurability: System Activities for Improved Performance" 5th Annual Int. Conf. on Computer Capacity Management, pp. 169-178, New Orleans, April 1983.

2. V. Obac Roda, O.J. Davies and F. Lombardi "Analysis and Implementation of Static and Dynamic Fault Tolerant Ring Systems" Proc. 21st Annual Allerton Conf. on Comm., Control and Computing, pp. 822-831, Urbana, October 1983.

3. S. Ratheal and F. Lombardi "Analysis and Simulation of Triplet Configuration for Network Testability, Proc. 17th Annual Conf. on Inf. Sciences and Systems, pp. 649-653, Baltimore, March 1983.

4. F. Lombardi: "Performance/Efficiency Evaluation of Parallel Multiprocessor Restructurable Systems using Analytical Modelling Techniques" IEEE 3rd Annual Int. Phoenix Conf. on Comm. and Computers, pp. 72-79, Phoenix, March 1984.

5. F. Lombardi and S. Ratheal "Testable Large Scale Computer Networks: Analysis and Simulation of Reconfiguration Algorithms" IEEE 3rd Annual Int. Phoenix Conf. on Comm. and Computers, pp. 80-86, Phoenix, March 1984.

C. Preprints

1. A. Kovaleski, S. Ratheal and F. Lombardi "An Architecture for Distributed Processing: A Bus Network Approach" to IEEE Int. Conf. in Parallel Processing, also submitted to IEEE Trans. and Computers.

D. Dissertation and Thesis

1. S. Ratheal "Reconfiguration Strategies in Multiprocessor Computer Systems: M.Sc. Thesis, Texas Tech University (expected May 1984).

ABSTRACT

CONTROL OF LOCALLY TESTABLE DUPLEX SYSTEM FOR LARGE-SCALE IMPLEMENTATION

F. LOMBARDI

CONTROL OF LOCALLY TESTABLE DUPLEX SYSTEM FOR LARGE-SCALE IMPLEMENTATION

F. Lombardi

ABSTRACT

The control of a duplex system is presented. This is characterized by the locality of the testing devices and by easy expandability to a larger system with large-scale attributes. The control suggests the viability of a VLSI chip implementation by a modular design.

ABSTRACT

GENERALIZED MODELLING OF TESTING AND RECONFIGURABILITY: SYSTEM ACTIVITIES FOR IMPROVED PERFORMANCES

FABRIZIO LOMBARDI AND STEVE RATHEAL

GENERALIZED MODELLING OF TESTING AND RECONFIGURABILITY: SYSTEM ACTIVITIES FOR IMPROVED PERFORMANCES

Fabrizio Lombardi and Steve Ratheal

ABSTRACT

In this paper different models for reconfigurable and testable systems are presented. The results are analyzed using the frequency balancing approach. The hardware and software implementations for those purpose-built systems are presented. The availability is used as the primary figure of merit for improved performance.

ABSTRACT

ANALYSIS AND IMPLEMENTATION OF STATIC AND DYNAMIC FAULT TOLERANT RING SYSTEMS

V. Obac Roda, O.J. Davies and F. Lombardi

ANALYSIS AND IMPLEMENTATION OF STATIC AND DYNAMIC FAULT TOLERANT RING SYSTEMS

V. Obac Roda, O.J. Davies and F. Lombardi*

ABSTRACT

In this paper the analysis and design of a particular class of fault tolerant systems is presented. These systems referred to as ring systems, are characterized by the complementary use of software and hardware for the attainment of fault tolerance. Various aspects (theory and practice for a complete implementation) are presented. These include control characterization, reliability and performability analysis, software overhead, hard core minimization and sparing.

* This paper appeared in 1983, but was supported by the Joint Services Electronic Program in 1982.

ABSTRACT

ANALYSIS AND SIMULATION OF TRIPLET CONFIGURATION FOR NETWORK TESTABILITY

STEVE RATHEAL AND FABRIZIO LOMBARDI

ANALYSIS AND SIMULATION OF TRIPLET CONFIGURATION FOR NETWORK TESTABILITY

Steve Ratheal and Fabrizio Lombardi

ABSTRACT

In this paper two algorithms for network reconfigurability are presented. The algorithms are used to provide the capability of triplet testing within a given system. The reconfigurability strategies are based on module-to-module and module-to-memory-to-module transmissions. Distributed tables are used to establish conditions of the network. The algorithms have been simulated using two programs. The preliminary results are presented.

ABSTRACT

PERFORMANCE/EFFICIENCY EVALUATION OF PARALLEL MULTIPROCESSOR RESTRUCTURABLE SYSTEMS USING ANALYTICAL MODELLING TECHNIQUES

FABRIZIO LOMBARDI

PERFORMANCE/EFFICIENCY EVALUATION OF PARALLEL MULTIPROCESSOR RESTRUCTURABLE SYSTEMS USING ANALYTICAL MODELLING TECHNIQUES

Fabrizio Lombardi

ABSTRACT

In this paper an approach to the quantification of the performance/efficiency of generalized (N module) restructurable parallel architectures is presented. This is based on the frequency balancing approach for the steady state solution to the availability. The normal parallel flow of the state transition diagram is perturbed by single or multiple deviances which represent the restructuring capability of the system. Restructuring is the process which consists of the set of procedures to return the system to a fault free state by minimization of lost performance due to multiple fault occurrences. Two restructuring policies (periodic and self degrading) are analyzed with respect to different architectures. Theoretical results are analytically derived and they are applicable to general queueing processes.

ABSTRACT

TESTABLE LARGE SCALE COMPUTER NETWORKS: ANALYSIS AND SIMULATION OF RECONFIGURATION ALGORITHMS

F. LOMBARDI AND S. RATHEAL

TESTABLE LARGE SCALE COMPUTER NETWORKS:
ANALYSIS AND SIMULATION OF RECONFIGURATION ALGORITHMS

F. Lombardi and S. Ratheal

ABSTRACT

In this paper two algorithms for large scale network reconfiguration are presented. The algorithms use triplet testing to assess the status (faulty or fault free) of the modules and to provide a reliable reconfiguration. The reconfiguration strategies are based on module-to-module and module-to-memory transmissions. Distributed tables are used to establish the conditions of the modules in the network according to the fault occurrences. The algorithms have been simulated using two programs. Numerical results are presented.

ABSTRACT

AN ARCHITECTURE FOR DISTRIBUTED PROCESSING: A BUS NETWORK APPROACH

A. KOVALESKI, S. RATHEAL, F. LOMBARDI

AN ARCHITECTURE FOR DISTRIBUTED PROCESSING:

A BUS NETWORK APPROACH

A. Kovaleski, S. Ratheal, F. Lombardi

ABSTRACT

This paper describes an interconnection scheme based on a bus network consisting of high speed time-sliced buses and inter-bus links of matching bandwidth. Simulation results and two contrasting approaches to simulating such a machine are discussed. The network is best applied to problems demanding the coexistence of complementary models of computation and which exhibit locality in their communication patterns (e.g. image processing).

ABSTRACT

IMAGE RESTORATION BY TRANSFORMATION OF SIGNAL-DEPENDENT NOISE TO SIGNAL-INDEPENDENT NOISE

RANGACHAR KASTURI, JOHN F. WALKUP AND THOMAS F. KRILE

IMAGE RESTORATION BY TRANSFORMATION OF SIGNAL-DEPENDENT NOISE TO SIGNAL-INDEPENDENT NOISE

Rangachar Kasturi, John F. Walkup,
and Thomas F. Krile

Abstract

A transformation to convert signal-dependent noise corrupting an image to additive Gaussian signal-independent noise is derived in this paper. Wiener filtering techniques using a Markovian covariance model for the image signal are applied to the transformed data followed by an inverse transformation to restore the degraded image. An ad hoc technique using contrast manipulation to adaptively convert signal-dependent noise to signal-independent noise is also described. The results of the computer simulations designed to evaluate the performance of these techniques are also presented.

GRANTS AND CONTRACTS ADMINISTERED BY JSEP PERSONNEL

A. Funded

Emre, E., ONR, Joint Services Electronics Program, $27,196, ends May 31, 1984.

Emre, E., NSF, Research Initiation: An Approach to Adaptive Control and Adaptive Observers for Multivariable Systems $43,290, ends October 31, 1984.

Emre, E., AFOSR, On a Theory of Control for Linear Multivariable Systems Over Rings, $34,831, ends June 30, 1984.

Hunt, L.R., NASA, Nonlinear Systems, $31,325 10/1/82-9/30/83

Hunt, L.R., NASA Supplement, Nonlinear Systems, 10/1/83-9/30/84, $34,493.

Hunt, L.R., ONR, Joint Services Electronics Program, $59,795, 6/1/80-5/31/83.

Hunt, L.R., and Saeks, R., ONR, Joint Services Electronics Program, $38,488, ends May 31, 1984.

Hunt, L.R., and Su, R., ONR, Joint Services Electronics Program, $34,112, 6/1/83-5/31/84.

Lombardi, F., ONR, Joint Services Electronics Program, $18,031, ends May 31, 1984.

Lombardi, F., State Matching Funds, Modeling and VLSI Control of Fault Tolerant Computer Systems, $1,000, 9/1/82-8/31/83.

Nakajima, K., ONR, Joint Services Electronics Program, $18,031, ends May 31, 1984.

Newman, T.G., ONR, Joint Services Electronics Program, $58,795, 6/1/80-5/31/83.

Newman, T.G., ONR, Joint Services Electronics Program, $30,946, ends May 31, 1984.

Su, R., NASA, System Theory and Algorithms of Totally Automatic Flight Control Systems, $33,170, ends September 30, 1984.

GRANTS AND CONTRACTS IN MATHEMATICS

Anderson, R.M., and Ford, W.T., DOE, CSPP - Design and Performance Analytical Models, $181,748.

Ashton, G.J., NSF-CBMS Conference, Quasitriangularity and Analyticity in Operator Algebras, $23,000, 5/1/83-10/31/83.

Ford, W.T., Gulf Universities Research, State-of-the-Arts Seminar in Complex Fluid Flow in Porous Media, 12/76-indefinitely.

Ford, W.T., and Anderson, R.M., DOE, Mathematical Methodology for Evaluating Simulations of Flow in Porous Media, $141,367, 2/1/80-8/31/83.

Ford, W.T., and Anderson, R.M., Conoco, Inc., Center for Petroleum Mathematics 5/4/83-indefinitely.

Ford, W.T., Anderson, R.M., and Heichelheim, H.R., $9,900, Center for Energy Research, TTU, Cubic Equations of State, FY 82/83.

Hunt, L.R., NASA, Nonlinear Systems, $31,325, 10/1/82-9/30/83.

Hunt, L.R., ONR, Joint Services Electronics Program, $58,795, 6/1/80-5/31/83.

Hunt, L.R., NASA Supplement, Nonlinear Systems, $34,493, 10/1/83-9/30/84.

Hunt, L.R., and Su, R., ONR, Joint Services Electronics Program, $34,112, 6/1/83-5/31/84.

Lewis, I.W., NSF, Mathematical Sciences: Homogeneity and the Structure of Continua, $21,600, 7/1/83-12/31/84.

Lutzer, David, NSF, Abstract Spaces, Function Space and Ordered Spaces, $24,388, 12/1/80-11/30/83.

Nelson, Paul, NSF, Computational and Mathematical Aspects of Radiation Transport, $102,488, 11/1/80-4/30/83.

Nelson, Paul, State matching Funds, Computational and Mathematical Aspects of Radiation, $10,000, 11/1/80-4/30/83.

Nelson, Paul, AF Subcontract form Georgia Institute of Technology, Electron Transport Mathematics Application of the Methods of Streaming Rays and Order-of-Scattering to Electronic Transport in Irradiated Solids, $33,640, 3/25/83-9/30/83.

Nelson, Paul, Arts and Sciences Research Award, Numerical Solution of Stiff Initial-Value Problems by Invariant Imbedding, $5,000, 9/1/82-8/31/83.

Newman, T.G., ONR, Joint Services Electronics Program, $58,795, 6/1/80-5/31/83.

Newman, T.G., ONR, Joint Services Electronics Program, $31,000, 6/1/83-5/31/84.

Schovanec, L., Arts and Sciences Research Award, Boundary Value Problems for Nonhomogeneous Elastic Bodies, $1,500, 9/1/82-8/31/83.

Strauss, M.J., and Lutzer, D.J., NSF, Computer Literacy for Middle School Mathematics Teachers, $30,000, 7/31/81-2/29/84.

Victory, H.D., Arts and Sciences Research Award, The Study of Wave Propagation through Inhomogeneous Media, $6,000, 9/1/82-8/31/83.

Victory, H.D., Alexander von Humboldt Foundation, Humboldt Fellowship in Germany, 28000 Deutsch Marks, 9/1/82-9/1/83.

GRANTS AND CONTRACTS IN ELECTRICAL ENGINEERING/COMPUTER SCIENCE

Chao, K.S., NSF, Continuation Methods in Nonlinear Network Analysis $44,751, ends December 31, 1983.

Emre, E., ONR, Joint Services Electronics Program, $27,196, ends May 31, 1984.

Emre, E., NSF, Research Initiation: An Approach to Adaptive Control and Adaptive Observers for Multivariable Systems, $43,290, ends October 31, 1984.

Emre, E., AFOSR, On a Theory of Control for Linear Multivariable Systems Over Rings, $34,831, ends June 30, 1984.

Gustafson, D., E-Systems, Digital and Optical Signal Processing and Detection, $1,115, Open.

Gustafson, D., and Krile, T., E-Systems, Digital and Optical Signal Processing and Detection, $19,899, ends December 31, 1983.

Hagler, M., and Kristiansen, M., State Matching Funds, Current Drive by Fast Alfven Waves in a Small Tokamak, $16,668, ends August 31, 1984.

Hagler, M., and Kristiansen, M., NSF, Current Drive by Fast Alfven Waves in a Small Tokamak, $85,838, ends November 30, 1984.

Hardwick, M., College of Engineering, Data Base Techniques for Simulation Oriented Computer-Aided Instruction, $6,000, ends August 31, 1984.

Hardwick, M., Software Development, $15,000, ends August 31, 1984.

Hennessey, K., College of Engineering, Proposal for a Laboratory Information System Based on Linkage and Enhancement of Existing Software, $6,000, ends August 31, 1984.

Hennessey, K., Software Development, $23,081, ends August 31, 1984.

Hunt, L., and Saeks, R., ONR, Joint Services Electronics Program, $38,488, ends May 31, 1984.

Hunt, L., and Su, R., ONR, Joint Services Electronics Program, $34,112, ends May 31, 1984.

Kristiansen, M., AFOSR, Coordinated Research Program in Pulsed Power Physics, $431,394, ends September 30, 1984.

Kristiansen, M., Exploratory Concepts, $49,375, ends September 30, 1984.

Kristiansen, M., and Krompholz, H., AFOSR, Spark Gap Electrode Erosion, $101,922, ends September 30, 1984.

Kunhardt, E., ONR, Non-Stationary Ionization Phenomena in Gases, $97,248, ends June 30, 1984.

Lombardi, F., ONR, Joint Services Electronics Program, $18,031, ends May 31, 1984

Nakajima, K., ONR, Joint Services Electronics Program, $18,031, ends May 31, 1984.

O'Hair, E., and Simpson, T., DOE, Crosbyton Solar Power Project, $3,871,091, ends February 2, 1986.

Portnoy, W., Masterite, Inc., Semi-Conductor Device Physics and Reliability, $1,401, Open.

Portnoy, W., AFOSR, Investigation of the Physics of Failure in Semiconductors Resulting from Electrical Transients, $109,959, ends March 27, 1984.

Portnoy, W., Research and Avalanched Transistors, $16,500, August 8, 1984.

Saeks, R., AFOSR, Feedback Systems and Simultaneous Design Problems, $37,764, ends February 29, 1984.

Schoenbach, K., NSF, Externally Controlled Diffuse Discharges, $19,329, ends May 31, 1984.

Schoenbach, K., Schaefer, G., and Kristiansen, M., AFOSR, Opening Switches, $202,837, ends September 30, 1984.

Su, R., NASA, System Theory and Algorithms of Totally Automatic Flight Control Systems, $33,170, ends September 30, 1984.

Trost, T., NASA, Lightning Sensors and Data Intrepretation, $75,000, ends April 14, 1984.

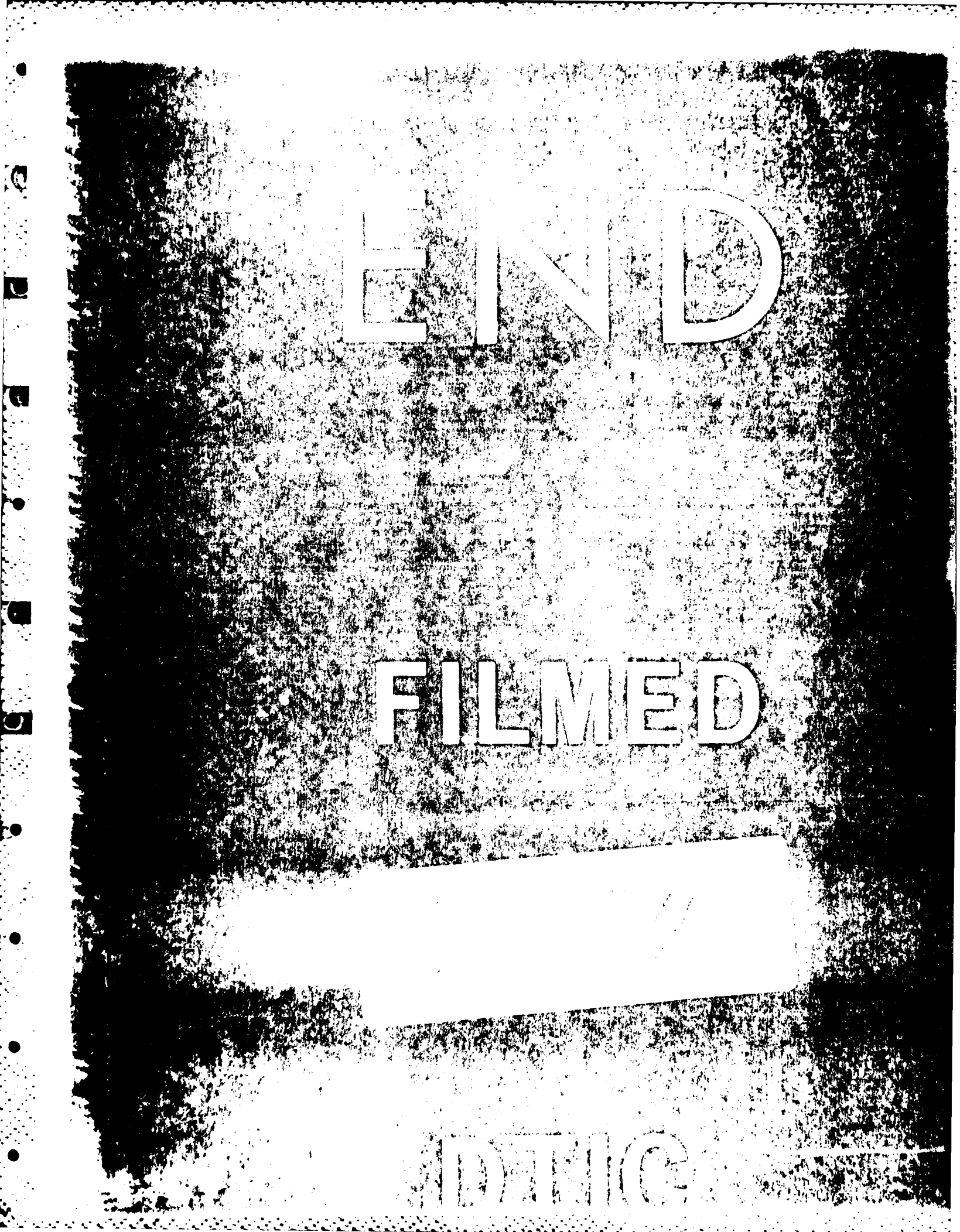
Walkup, J., and Krile, T., State Matching Funds, Space-Variant Optical Systems, $2,500, ends September 30, 1984.

Walkup, J., and Krile, T., AFOSR, Space-Variant Optical Systems, $130,351, ends September 30, 1984.

Walkup, J., and Krile, T., SPIE, Optical Engineering Education, $2,500, Open.

Williams, F., Research Corp., Driven Raman Processes as Sources of Coherent Excitation, $2,662, Open.

Williams, F., Schaefer, G., and Kristiansen, M., AFOSR, Transient Processes in Triggered Electrical Breakdown, $87,405, ends September 30, 1984.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