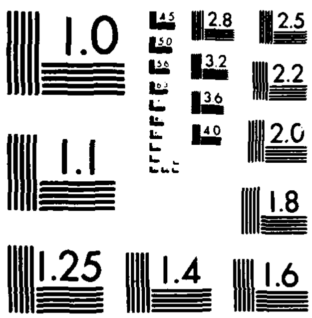
AD-A142 162 PARALLEL IMAGE PROCESSING AND IMAGE UNDERSTANDING(U) 1/1
MARYLAND UNIV COLLEGE PARK CENTER FOR AUTOMATION
RESEARCH A ROSENFELD APR 84 AFOSR-TR-84-0457
UNCLASSIFIED F49620-83-C-0082 F/G 14/5 NL

END
DATE
FILMED
7-84
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD-A142 162

(2)

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION: UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release; distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S): AFOSR-TR- 84-0457
6a. NAME OF PERFORMING ORGANIZATION: University of Maryland; 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION: Air Force Office of Scientific Research
6c. ADDRESS (City, State and ZIP Code): Center for Automation Research, College Park MD 20742	7b. ADDRESS (City, State and ZIP Code): Directorate of Mathematical & Information Sciences, Bolling AFB DC 20332
8a. NAME OF FUNDING/SPONSORING ORGANIZATION: AFOSR; 8b. OFFICE SYMBOL (If applicable): NM	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER: F49620-83-C-0082
8c. ADDRESS (City, State and ZIP Code): Bolling AFB DC 20332	10. SOURCE OF FUNDING NOS.: PROGRAM ELEMENT NO. 61102F; PROJECT NO. 2304; TASK NO. A7; WORK UNIT NO.

11. TITLE (Include Security Classification): PARALLEL IMAGE PROCESSING AND IMAGE UNDERSTANDING,

12. PERSONAL AUTHOR(S): Azriel Rosenfeld

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Yr., Mo., Day)	15. PAGE COUNT
Interim	FROM 1/4/83 TO 31/3/84	APR 84	6

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB. GR.	

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

During this period, the eight investigators produced 10 papers with titles including, "Reliability in cellular arrays through data sharing," "Interactive software systems for computer vision," "On mapping homogeneous graphs on a linear array processor model," "A parallel method for natural texture synthesis," and "Embedding of networks of processors into hypercubes."

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT: UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS ☐	21. ABSTRACT SECURITY CLASSIFICATION: UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL: Dr. Robert N. Buchal	22b. TELEPHONE NUMBER (Include Area Code): (202) 767- 4939; 22c. OFFICE SYMBOL: NM

DD FORM 1473, 83 APR   EDITION OF 1 JAN 73 IS OBSOLETE.   UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

84 06 18 149

AFOSR-TR- 84-0457

Annual Report on Contract F49620-83-C-0082

PARALLEL IMAGE PROCESSING AND IMAGE UNDERSTANDING

Submitted to: U.S. Air Force Office of Scientific Research
AFOSR/NM
Bolling Air Force Base
Washington, DC 20332

Submitted by: Center for Automation Research
University of Maryland
College Park, MD 20742

Report prepared by: Azriel Rosenfeld, Director

Period covered: 1 April 1983 - 31 March 1984

April 3, 1984

84 06 18 149

The research being conducted under this contract has two main themes:

a) Parallel algorithms for image processing

b) Expert systems for aerial image understanding

A supplemental theme is the mathematical modelling of images, with emphasis on texture modelling. Thirteen technical reports were issued on the contract; abstracts of these reports are appended to this Annual Report. Numbers in brackets in the following paragraphs refer to this list of abstracts.

It has been well known for over 25 years that mesh-connected cellular arrays are a very natural architecture for image processing at the pixel level. We have studied methods of increasing the reliability of cellular arrays by sharing data and computations between adjacent processors in the array [1].

More general classes of SIMD (single instruction stream, multiple data stream) architectures have also been studied on this project. We have studied methods of allocating data among processors in an SIMD system so as to perform parallel inferences using minimum computation and data transfer time [2]. A comparative survey of software systems for image processing is given in [3].

Several of our studies have concerned the mapping of networks of processors onto other networks. In particular, we have shown how to embed trees and arrays into hypercubes efficiently (i.e., without great increase in number of nodes or in distance between neighboring nodes) [10]. We have also partially supported the research of Prof. I. V. Ramakrishnan [5,6,11], who is studying the mapping of various types of algorithms onto linear arrays of processing elements which are well suited for VLSI implementation.

In the area of expert image understanding systems, we have developed a control structure that deals with objects satisfying given spatial relations. By accumulating predictions originated from existing instances, our system can dynamically reason about what to do in order to construct interpretations of the image. The system is being applied to a relatively simple domain consisting of images of houses and roads on aerial photographs [4,13].

In connection with *image modelling*, some excellent work on the computer synthesis of natural textures was done by Drs. Andre Gagalowicz and Songde Ma on a six-month visit to our laboratory from INRIA (France). They developed both parallel [7] and sequential [8] algorithms for synthesizing textures having given second-order spatial statistics. An important new result [9] was the development of methods for directly synthesizing textures on curved surfaces, rather than first synthesizing them on a plane region and then mapping that region onto the surface. This work has important applications to the fast synthesis of textures for the dynamic simulation of natural scenes. On a more abstract level of image modelling, we have investigated methods of defining fuzzy relationships among image parts, with emphasis on relationships of adjacency and surroundedness [12].

Appendix: Abstracts of Technical Reports

1. Roger Eastman, "Reliability in Cellular Arrays Through Data Sharing." CAR-TR-7, CS-TR-1285, May 1983.

ABSTRACT: This paper describes several methods for increasing cellular array reliability for image processing through redundancy, with emphasis on error masking methods tnat preserve continuous operation of the array. We define n-module data sharing (NMDS) for a cellular array, which achieves redundancy by sharing data and computations between adjacent processors in the array. The time, space and reliability performance of NMDS is compared to standard n-module redundancy (NMR).

2. Simon Kasif and Reinhard Klette, "A Data Allocation Problem for SIMD Systems." CAR-TR-11, CS-TR-1292, June 1983.

ABSTRACT: Let $S=\{S_1,S_2,...,S_N\}$ be a set of data objects, and f be function from $S\times S$ into S. For $T\subseteq\{1,2,...,N\}^2$ the operation T_f applies f to every element of $\{(S_i,S_j)\mid(i,j)\in T\}\subseteq S\times S$. For the optimal computation of T_f on a SIMD system with p processors, the data allocation problem consists in distributing objects to the p processors such that the computation and data transfer time is minimized. In the paper, the cases $T=\{1,2,...,N\}^2$ and $T=\{(i,j)\mid 1\le j<i\le N\}$ are dealt with.

3. Klaus Voss, Peter Hufnagl, and Reinhard Klette, "Interactive Software Systems for Computer Vision." CAR-TR-12, CS-TR-1293, June 1983.

ABSTRACT: This paper gives an overview of the main directions of program system development in computer vision, where special emphasis is paid to interactivity. A systematic representation of interactive computer vision systems is given. Brief information about 39 different software systems is listed in an Appendix.

4. Vincent Shang-Shouq Hwang, Takashi Matsuyama, Larry S. Davis, and Azriel Rosenfeld, "Evidence Accumulation for Spatial Reasoning in Aerial Image Understanding." CAR-TR-28, CS-TR-1336, October 1983.

ABSTRACT: We describe a control structure for building an Image Understanding System. This system can deal with objects with diverse appearances when consistent spatial relations exist between objects. By accumulating consistent predictions originated from existing instances, our system can dynamically reason about what to do in order to construct interpretations of the image. In this paper, we have discussed parts of the proposed system - the representation of spatial knowledge, the accumulation of evidence, the focus of attention mechanism, and the integration of constraints for top-down control.

5. I. V. Ramakrishnan, D. S. Fussell, and A. Silberschatz, "On Mapping Homogeneous Graphs on a Linear Array-Processor Model." CAR-TR-30, CS-TR-1339, October 1983.

ABSTRACT: This paper presents a formal model of linear array processors suitable for VLSI implementation as well as graph representation of programs suitable for execution on such a model. A distinction is made between correct mapping and correct execution of such graphs on this model and the structure of correctly mappable graphs is examined. The formalism developed is used to synthesize algorithms for this model.

6. I. V. Ramakrishnan, "Modular Matrix Multiplication on a Linear Array." CAR-TR-31, CS-TR-1340, November 1983.

ABSTRACT: A matrix-multiplication algorithm on a linear array using an optimal number of processing elements is proposed. The local storage required by the processing elements and the I/O bandwidth required to drive the array are both constants that are independent of the sizes of the matrices being multiplied. The algorithm is therefore modular, that is, arbitrarily large matrices can be multiplied on a large array built by cascading small arrays. The array is well-suited for VLSI implementation.

7. Songde Ma and André Gagalowicz, "A Parallel Method for Natural Texture Synthesis." CAR-TR-32, CS-TR-1343, F49620-83-C-0082, November 1983.

ABSTRACT: This paper deals with an optimization technique applied to natural texture synthesis. We propose a definition of a global criterion which is the mean square error between the statistical features of a natural original texture and those of an artificially generated one. A gradient algorithm is used to minimize this criterion. The statistical feature vector used was the autocorrelation function although this is by no means the only choice. The textures generated are very similar to the original ones. This method can be implemented in a highly parallel manner.

8. André Gagalowicz and Song De Ma, "Synthesis of Natural Textures on 3-D Surfaces." CAR-TR-33, CS-TR-1344, F49620-83-C-0082, November 1983.

ABSTRACT: This paper presents a new method for the synthesis of textures on 3-D surfaces. To our knowledge, one basic technique has been presented up to now in the literature (see [7-18]). In this standard method, textures are synthesized by mapping a rectangular template onto the curved surface. This method is complex, requires substantial computing time, and presents some drawbacks such as the possibility of obtaining aliasing effects and continuity problems along the edges of the curved templates. Procedures to eliminate these problems are available [11,12] but make this synthesis even more unattractive. The method proposed in this paper does not present te former drawbacks. We do not use a template mapping, which is a drawback in itself. The synthesis is achieved continuously on the surface, so that there are no edge effects and also no aliasing effects. This method is a simple extension of a procedure that we have proposed before in the literature [2,3] for planar textures. Any kind of texture can be reproduced with a good similarity to the reference texture used. It also has the important advantage that only one set of second order statistics (a small amount of data) needs to be computed on a planar version of the reference texture to synthesize this texture on any surface and at any distance. Some results on simple surfaces are displayed (cylinder, sphere), but the method holds for any surface and is relatively quick and easy.

9. André Gagalowicz and Song De Ma, "Sequential Synthesis of Natural Textures." CAR-TR-34, CS-TR-1345, November 1983.

ABSTRACT: A new method for the generation of natural textures is presented. Using a priori-given second order statistics (second order spatial averages or autocorrelation parameters) of a natural texture as input, we give a procedure to synthesize an artificial texture field in such a way that its second order statistics are equal to the desired ones. The synthesis is achieved directly without inventing higher order statistics, as was the case in earlier publications [3-7,15]. This method allows us to synthesize gray tone texture fields while "controlling" their second order statistics in rather large neighborhoods. The synthesized textures are very similar visually to the original natural textures used to compute the second order statistics, but second order spatial averages give better results than autocorrelation parameters. This seems to strongly support the conjecture [6,8,10] that the visual system is only sensitive to the second order spatial averages of a given texture field, so that these statistics should be used to model textures.

10. Angela Y. Wu, "Embedding of Networks of Processors into Hypercubes." CAR-TR-36, CS-TR-1354, December 1983.

ABSTRACT: The hypercube is a good host graph for the embedding of networks of processors because of its low degree and low diameter. Graphs such as trees and arrays can be embedded into a hypercube with small dilation and expansion costs, but there are classes of graphs which can be embedded into a hypercube only with large expansion cost or large dilation cost.