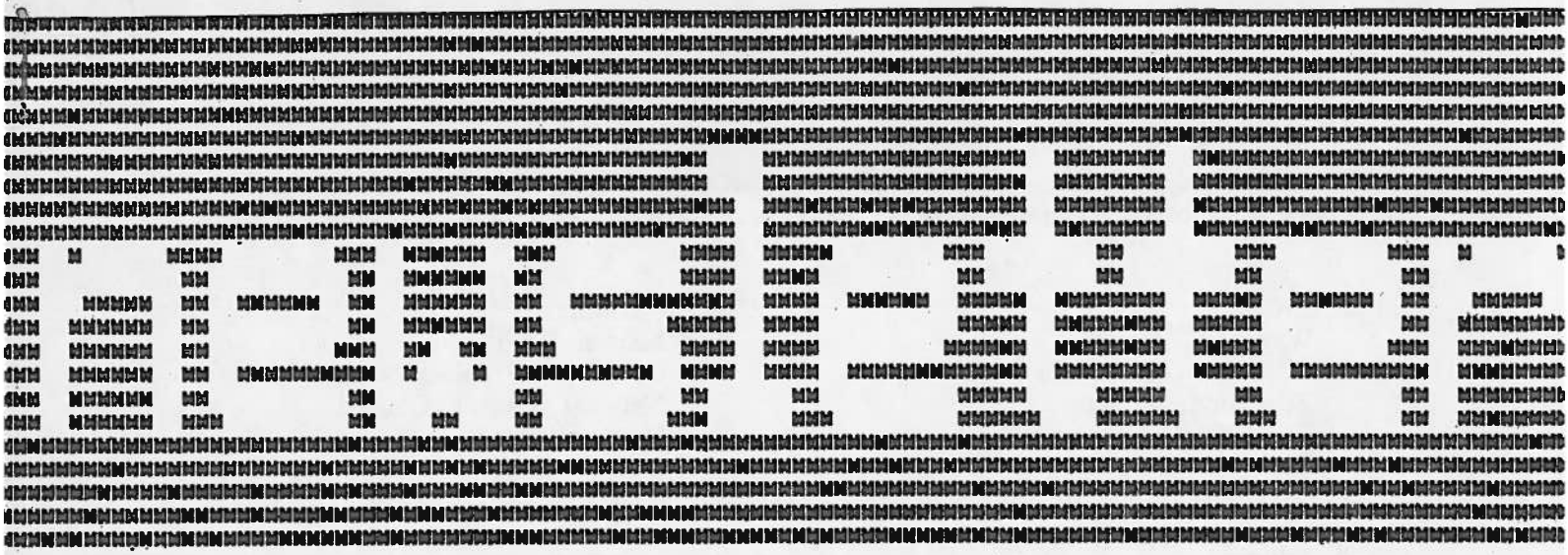

CSCSI/SCEIO **CMCCS/ACCHO** **CIPPRS**

Vol. 3, Number 2 June 1984

SEPARATION

Since this is the last issue of this newsletter that will be published jointly by the three societies, it is appropriate that a few comments (irrelevant or otherwise) are made. Producing such a newsletter was thought to be a good idea because it allowed the three groups a chance to interchange ideas and track the progress of the other group. It was also felt to be a considerable cost saving because of the overlapping nature of the three groups (please note the membership statistics that follow).

Unfortunately, due to many possible reasons, the newsletter hasn't had the content that it needed to make it a treasured publication. Possible reasons include: incompetence of the editor; editorials that were irrelevant, unnecessary, argumentative and just plain bad; a terrible format and publication schedule; a less than adequate source of material; poor quality photographs for the centrefold. While there are undoubtably many more possibilities, it cannot be said that the readers were somnolent. The written replies were printed, and the verbal ones noted. An interesting note is that the more outrageous the editorials got, the more concurring were the verbal responses. It would be interesting to hear a behaviorist's comment on the phenomena. Actually, almost no negative comments were heard, which can in itself be interpreted positively.

Enough of this navel gazing, thank you for your attention and *bon chance*.

MEMBERSHIP ANALYSIS (as of March 1984)

CIPPRS	183	CIPPRS, CSCSI or CMCCS	598
CSCSI	283	CIPPRS or CSCSI	357
CMCCS	449	CIPPRS or CMCCS	512
Total	*916*	CSCSI or CMCCS	579
		CIPPRS only	19
		CSCSI only	86
		CMCCS only	241

This newsletter is published by CSCSI/SCEIO, CMCCS/ACCHO, and CIPPRS at the University of Alberta, Department of Computing Science, Edmonton, Alberta, T6G 2H1.

Editor-in-Chief:
Wayne A. Davis
University of Alberta
Edmonton, Alberta
T6G 2H1

CMCCS Editor:
Marceli Wein
Computer Graphics Section
National Reserch Council
Montreal Road
Ottawa, Ontario
K1A 0R8

CSCSI Editor:
Graeme Hirst
Dept. of Computer Science
University of Toronto
Toronto, Ontario
M5S 1A7

CIPPRS Editor:
Ching Suen
Department of Computer Science
Concordia University
1455 de Maisonneuve Blvd. West
Montreal, Quebec
H3G 1M8

LETTER TO THE EDITOR

March 19, 1984

Dear Dr. Davis:

I have just finished perusing the Vol. 3, Number 1 CSCSI/SCEIO newsletter. May I congratulate you on a document which contains a large amount of information and which serves to convince me that the field of A.I. is indeed alive in individuals like you.

I will save this issue as a source of contacts to approach when I can justify (financially) devoting my time to A.I. We are presently developing and selling application systems for business and universities (areas of bookkeeping and food costing and nutrient calculations). We work with mainframes to micros, in APL supplemented with assembly level routines.

Please do not assume that because we are silent we have no interest. We are just poor.

Sincerely,

Gaetan Godin
President, Iota Computer Services Ltd.
London, Ontario

CALL FOR PAPERS

Graphics Interface '85

Montréal, Québec

May 27 - May 31, 1985

Graphics Interface '85

Montréal, Québec

May 27 - May 31, 1985

Graphics Interface '85 is the eleventh Canadian Conference devoted to computer graphics and interaction techniques, and is the oldest regularly scheduled computer graphics conference in North America. Now an annual conference, exhibition and film festival, Graphics Interface has established a reputation for a high-quality technical program. The 1985 conference will be held in Montreal, May 27 to May 31, 1985.

Contributions are solicited describing research results and applications experience relating to the following areas of computer graphics :

- Graphics in Office Automation
- CAD/CAM
- Computer-Aided Building Design
- Computer Animation
- Videotex
- Cartography
- Graphics and the Arts
- Graphics in Education
- Image Processing
- Interaction Techniques
- Image Synthesis
- Geometric Modelling
- Graphics and Robotics
- Industrial Graphics
- Graphics and Operation Research
- Medical Computer Graphics

A 1500 word extended summary is due **October 31, 1984**. Authors will be notified by **January 1, 1985**. The full paper is due by **February 28, 1985. The best papers will be published, in full color, in the new International Journal on Computer Graphics, Springer-Verlag International.**

Send papers to

Dr. N. Magnenat-Thalmann
Graphics Interface '85
Hautes Etudes Commerciales
Université de Montréal
5255, av. Décelles
Montréal, P.Q.
Canada H3T-1V6
Tel. (514) 343-3867

Conference, Exhibit and Tutorial information

Dr. D. Thalmann
Graphics Interface '85
Département d'Informatique et
Recherche Opérationnelle
Université de Montréal
C.P. 6128 Succ. A.
Montréal, P.Q.
Canada H3C-3J7

This conference is being held in association with the Canadian Man-Computer Communications Society, the Computer Graphics Society, the Montreal chapter of IEEE Computer Society, the Montreal chapter of the Canadian Information Processing Society and other professional societies.

INTERNATIONAL JOURNAL ON
COMPUTER
GRAPHICS

Springer International

CALL FOR PAPERS

SPECIAL ISSUE ON COMPUTER ANIMATION

Theoretical, experimental and practical papers on Computer Animation are being solicited. This covers a very broad range of topics such as :

- computer-assisted animation
- paint systems and coloring techniques
- inbetweening techniques and key-frame systems
- object modelling
- motion specification and synchronization
- actor systems
- computer animation languages
- virtual camera motion and control
- light source motion and control
- image synthesis
- special effects

Authors should submit four copies of their paper (with original color pictures) by September 15, 1984 to one of the guest editors :

Dr. Nadia Magnenat-Thalmann
Centre Universitaire d'Informatique
Université de Genève
24, rue Général-Dufour
CH-1211 Genève 4
Suisse

Dr. Daniel Thalmann
Département d'Informatique
et de Recherche Opérationnelle
Université de Montréal
C.P. 6128 Succ. A.
Montréal, P.Q.
Canada H3C-3J7

Full-length articles published in the International Journal on Computer Graphics range from 3000-8000 words. All papers are refereed by Computer Graphics experts.

The AMERICAN JOURNAL OF COMPUTATIONAL LINGUISTICS -- Some New Developments

The AMERICAN JOURNAL OF COMPUTATIONAL LINGUISTICS is the major international journal devoted entirely to computational approaches to natural language research. With the 1984 volume, its name is being changed to COMPUTATIONAL LINGUISTICS to reflect its growing international coverage. There is now a European chapter of the ASSOCIATION FOR COMPUTATIONAL LINGUISTICS and a growing interest in forming one in Asia.

The journal also has many new people on its Editorial Staff. James Allen, of the University of Rochester, has taken over as Editor. The FINITE STRING Editor is now Ralph Weischedel of the University of Delaware. Lyn Bates of Bolt Beranek and Newman is the Book Review Editor. Michael McCord, now at IBM, remains as Associate Editor.

With these major changes in editorial staffing, the journal has fallen behind schedule. In order to catch up this year, we will be publishing close to double the regular number of issues. The first issue for 1983, which was just mailed out, contains papers on "Paraphrasing Questions Using Given and New Information" by Kathleen McKeown and "Denotational Semantics for 'Natural' Language Question-Answering Programs" by Michael Main and David Benson. There is a lengthy review of Winograd's new book by Sergei Nirenburg and a comprehensive description of the new Center for the Study of Language and Information at Stanford University.

Highlights of the forthcoming 1983 AJCL issues:

- Volume 9, No. 2 (expected March '84) will contain, in addition to papers on "Natural Language Access to Databases: Interpreting Update Requests" by Jim Davidson and Jerry Kaplan and "Treating Coordination in Logic Grammars" by Veronica Dahl and Michael McCord, will be accompanied by a supplement: a Directory of Graduate Programs in Computational Linguistics. The directory is the result of two years of surveys, and provides a fairly complete listing of programs available internationally.

- Volume 9, Nos. 3 and 4 (expected June '84) will be a special double issue on Ill-Formed Input. The issue will cover many aspects of processing ill-formed sentences from syntactic ungrammaticality to dealing with inaccurate reference. It will contain papers from many of the research groups that are working on such problems.

We will begin publishing Volume 10 later in the summer. In addition to the regular contributions, we are planning a special issue on the mathematical properties of grammatical formalisms. Ray Perrault (now at SRI) will be guest editor for the issue, which will contain papers addressing most of the recent developments in grammatical formalisms (e.g., GPSG, Lexical-Function Grammars, etc). Also in the planning stage is a special issue on Machine Translation that Jonathan Slocum is guest editing.

With its increased publication activity in 1984, COMPUTATIONAL LINGUISTICS can provide authors with an unusual opportunity to have their results published in the international community with very little delay. A paper submitted now (early spring '84) could actually be in print by the end of the year, provided that major revisions need not be made. Five copies of submissions should be sent to:

James Allen, CL Editor

Dept. of Computer Science
The University of Rochester
Rochester, NY 14627, USA

Subscriptions to COMPUTATIONAL LINGUISTICS come with membership in the ASSOCIATION FOR COMPUTATIONAL LINGUISTICS, which still is only $15 per year. As a special bonus to new members, those who join the ACL for 1984 before August will receive the special issue on Ill-Formed Input, even though it is formally part of the volume for 1983.

To become a member, simply send your name, address and a check made out to the Association for Computational Linguistics to:

Don Walker, ACL membership
SRI International
333 Ravenswood Avenue
Menlo Park, CA 94025, USA

People in Europe or with Swiss accounts can pay an equivalent value in Swiss francs, by personal check in their own currency, or by a banker's draft that credits account number 141.880.LAV at the Union Bank of Switzerland, 8 rue de Rhone, CH-1211 Geneva 11, SWITZERLAND; send the statement with payment or with a copy of the bank draft to:

Mike Rosner, ACL
ISSCO
54, route des Acacias
CH-1227 Geneva, SWITZERLAND

SEVENTH INTERNATIONAL CONFERENCE ON PATTERN RECOGNITION

Queen Elizabeth Hotel, Montreal — 28 and 29 July 1984

TUTORIAL SCHEDULE

SATURDAY, 28 JULY 1984

8:30 - 12:00

Image Communications	B. Prasada, E. Dubois & S. Sabri, BNR
Robotic Manipulators	Mathew Mason, Carnegie-Mellon
Introduction to Image Processing	Robert Haralick, VPI and State
Expert Systems	Edward Shortliffe & Bruce Buchanan, Stanford

1:30 - 5:00 p.m.

Image Communications, continued	B. Prasada, E. Dubois & S. Sabri, BNR
Robotic Vision	Takeo Kanade & Jim Crowley, Carnegie-Mellon
Introduction to Image Processing, continued	Robert Haralick, VPI and State
Expert Systems, continued	Edward Shortliffe & Bruce Buchanan, Stanford

SUNDAY, 29 JULY 1984

8:30 - 12:00

Computer Speech	Renato DeMori, Concordia
CAD/CAM	Dave Bonham, University of New Brunswick
Special Purpose Architectures	Mike Duff, University College, London
Visual Inspection	L. F. Pau, Battelle-Geneva

1:30 - 5:00 p.m.

Computer Speech, continued	Renato DeMori, Concordia
CAD/CAM, continued	Dave Bonham, University of New Brunswick
Dynamic Image Analysis	H.H. Nagel, Fraunhofer Institut
Image Data Bases	George Nagy, University of Nebraska & Steve Tanimoto, University of Washington

TUTORIAL DESCRIPTIONS

Image Communications — 08:30 - 17:00 Saturday 28 July 1984

Speaker: B. Prasada, E. Dubois & S. Sabri, Bell Northern Research

Content: An overview of the field of image communication with special emphasic on image coding will be presented. Imagery is a fundamental component of many new and existing communication services such as video and audiovisual conferencing, television distribution, document communication, image database acccess, telemedicine and surveillance systems. Since

image transmission in general requires high channel capacity, image coding is the key discipline underlying these applications. The first part of the tutorial will address image coding techniques. Topics to be presented include sampling, quantization predictive coding, transform coding and motion compensation techniques. This will be followed by document communication systems, including segmentation, resolution requirements and encoding of text, graphics and images. Finally, video teleconferencing and interactive visual teleconferencing systems will be discussed.

Biography: Eric Dubois received the B. Eng. and M. Eng. degrees from McGill University, and the Ph.D. degree from the University of Toronto, all in electrical engineering. In 1977, he joined INRS-Telecommunications, University of Quebec, where he is now an Associate Professor. His research has centered on the sampling, source coding, and processing of television imagery. He has collaborated extensively with the Visual Communications Systems department of BNR.

Birendra Prasada is Manager of Visual Communications System Research at Bell-Northern Research and Visiting Professor at INRS-Telecommunications, Montreal. In 1963, he joined the Technical Staff at Bell Laboratories, Murray Hill, New Jersey and in 1965 he was appointed to the faculty of Massachusetts Institute of Technology. He served as Head of the Electrical Engineering Department from 1968 to 1972, then Head of the Advanced Center for Electronic Systems from 1972 to 1973 at the Indian Institute of Technology, Kanpur, India. From 1973 to 1976 he was a member of the Technical Staff of the Electronics and Computers Systems Research Laboratory of Bell Laboratories, Holdel, New Jersey. He has also acted as a consultant for industries in both India and the United States.

Shaker Sabri received the B.Sc. and the M.Sc. degrees in electrical engineering from Alexandria University, Egypt. In 1968 and 1972 respectively and the Ph.D. from the University of Ottawa in 1977. From 1968 to 1971 he worked with the Army Signaling Corps. In 1971 he joined the Department of Electrical Engineering, Alexandria University as a lecturer where he was involved in teaching and carrying out research in the digital signal processing area. From 1973 to 1976 he was with the Department of Electrical Engineering, University of Ottawa. During this period he also worked as a consultant. In 1976, he joined BNR where he has been working in the areas of image processing, digital processing of video signals, video conferencing and advanced television systems. He is Manager of the Video Systems Department at BNR.

Introduction to Image Processing 08:30 - 17:00 Saturday 28 July 1984

Speaker: R. M. Haralick, Virginia Polytechnic Institute and State University

Content: This tutorial will introduce the participants to the concepts and techniques of digital image processing. The following topics will be included: digitization and quantization, smoothing, filtering, enhancement, restoration, edge detection and following, segmentation, transformations, registration, feature extraction, image analysis, data formats and storage, manipulation software, output techniques, and applications. In addition, a short survey of future directions and developments in image processing will also be presented.

Biography: Bob Haralick received undergraduate and graduate degrees from the University of Kansas, Lawrence in 1964, 1966, 1967 and 1969 respectively. He has worked at Autonetics and IBM. In 1965 he worked for the Center for Research, University of Kansas, as a Research Engineer and in 1969 he joined the faculty of the Department of Electrical Engineering, where he served as a professor from 1975 to 1978. In 1979 he joined the

faculty of the Departments of Electrical Engineering and Computer Science, Virginia Polytechnic Institute and State University, Blacksburg, where he is now a Professor and Director of the Spatial Data Analysis Laboratory. He has done research in pattern recognition, multiimage processing, remote sensing, texture analysis, data compression, clustering, artificial intelligence, and general systems theory. He is responsible for the development of GIPSY (general image processing system), a multiimage processing package which runs on a minicomputer system.

Expert Systems - Theory and Practice 08:30 - 17:00 Saturday 28 July 1984

Speakers: Edward H. Shortliffe & Bruce G. Buchanan, Stanford University

Content: This tutorial will provide a broad introduction to the subject of expert systems. The emphasis will not only be on practical issues involved in structuring the knowledge of a domain and building an acceptable consultation tool, but will also include theoretical issues to help identify the key areas for ongoing research and the limitation of accomplishments to date. Topics covered will include: the conceptual roots of the field; techniques for the representation of expert knowledge; methods for controlling the inference mechanisms; the process of building an expert system; interviewing experts; selection of an optimal representation strategy; high level tools for building expert systems; inexact inference and system validation. Examples will be drawn from many representative systems, including DENDRAL, MYCIN, PROSPECTOR, INTERNIST/CADUCEUS, XON, MOLGEN, CASNET, ONCOCIN EMYCIN, AGE, EXPERT, and MRS. At the conclusion of the tutorial, attendees will have a broad familiarity with expert systems, the key research issues and programs, and will have the foundation necessary for further independent reading and study.

Biographies: Edward Shortliffe is an Assistant Professor of Medicine and Computer Science at Stanford University. He was principal developer of the expert system known as MYCIN. His interests include the broad range of issues related to expert systems and their effective implementation. Of particular concern are models for evidential reasoning and representation techniques to support advanced explanation capabilities. Currently he divides his time between clinical medicine and computer science research. Dr. Shortliffe serves on several editorial boards and review committees. In addition, he received the Grace Murray Hopper Award of the Association for Computing Machinery in 1976 and is a Henry J. Kaiser Family Foundation Faculty Scholar in General Internal Medicine. He has written many books and articles in the field of medical artificial intelligence.

Bruce Buchanan, professor of Computer Science Research at Stanford University, has a B.A. in Mathematics and an M.A. and Ph.D. in Philosophy. He has been an instructor of Philosophy and a Research Associate in Computer Science. In addition he was a Research Computer Scientist, while holding a National Institutes of Health Career Development Award. Professor Buchanan's main line of research is in the class of artificial intelligence programs known as expert systems. He is co-principal investigator of the Heuristic Programming Project at Stanford, founding board member and membership chairman of the American Asosociation for Artificial Intelligence, and member of several editorial boards. He is co-author of two books, and has published numerous papers and review articles in a wide variety of books and journals.

Robotic Manipulators 08:30 - 12:00 Saturday 28 July 1984

Speaker: Mathew Mason, Carnegie-Mellon University

Content: This tutorial will review basic concepts and principles of robotics as well as major trends in advanced robotics research. It will discuss the structure and capabilities of typical robot systems, using examples drawn both from commercial installations and from research laboratories. Also examined will be fundamental methods of manipulation, including programmed motion, compliant motion, grasping, and the use of sensory feedback. The tutorial will conclude with an introduction to work on model-based programming and automatic planning of robot programs.

Biography: Matt Mason is an Assistant Professor at Carnegie-Mellon University, holding a joint appointment with the Computer Science Department and the Robotics Institute. He received his Ph.D. in 1982 from the MIT Artificial Intelligence Laboratory. In 1983, at the International Symposium of Robotics Research, Dr. Mason received the System Development Foundation Prize for the best recent doctoral thesis in robotics.

Robotic Vision 13:30 - 17:00 Saturday 28 July 1984

Speaker: T. Kanade and J. Crowley, Carnegie-Mellon University

Content: This tutorial starts with introduction to the computational theory of vision in order to acquire three-dimensional scene information from images. Then, examples of 2D and 3D vision systems applications will be analyzed so that participants can understand where the basic difficulties exist in vision and how successful systems use natural and artificial constraints. Topics include early processing of images; representation and analysis of 2D and 3D shapes, state-of-the-art in commercial vision systems; and engineering principles for vision applications. While we deal with practical techniques, emphasis is also placed on new trends of computer vision; that is, Image Understanding approaches for understanding images as three-dimensional scenes.

Biographies: Dr. Kanade is as Associate Professor of Computer Science and a Senior Research Scientist at the Robotics Institute, Carnegie-Mellon University. He is currently the Principal Investigator of the DARPA Image Understanding project at CMU. Prior to joining the CMU faculty, he was an Associate Professor of Information Science and Research Associate at Kyoto University, Japan. Since 1969, he has developed and co-developed a human-face recognition system, a theory of the origami world and skewed symmetry, an interactive picture processing system, the 3-D Mosaic System, and the CMU DD Arm I. His current research interests include 3-D shape understanding from images, aerial photo interpretation, special 3-D range-sensors, and the CMU Direct-Drive Arm project.

Dr. Crowley is a Research Associate at the Robotics Institute where he is Principal Investigator of the project, "Guidance Control for a Mobile Household Robot". His current research interests include techniques for measuring, representing, and matching 2-D and 3-D shapes and developing hardware to support the fast interpretation of grey-scale images. Dr. Crowley holds a B.S. in Electrical Engineering from Southern Methodist University and a M.S. and Ph.D. in Electrical Engineering from Carnegie-Mellon University.

Computer Speech 8:30 - 17:00 Sunday 29 July 1984

Speaker: Renato DeMori, Concordia University

Content: Dr. DeMori will speak on the following topics: the speech communication chain; problems and difficulties in Automatic Speech Recognition (ASR); a brief history of achievements; passive and active model for ASR; an overview of signal analysis methods for ASR; dynamic programming (DP) algorithms as a tool for time warping and matching between an input pattern and a prototype pattern; methods for automatically learning prototypes; two-level DP-matching for connected and recognition; VLSI for DP-matching; continuous speech recognition using stochastic language models; automatic learning of stochastic models; rule-based generation of hypotheses about phonetic features; the use of phonetic and phonological knowledge in accessing a large lexicon; the use of syntax and semantics; and search strategies and system architectures.

Biography: Renato DeMori has a Doctoral degree in Electronic Engineering from the Polytechnics of Turin where he was a Professor of Electrical Enginering. He also has been a Professor and Chairman of the Department of Computer Science, University of Turin. Recently he joined the Department of Computer Science at Concordia University. Dr. DeMori is a member of the ACM and IEEE, and he is also on the Advertising Committee of EURASIP. He is an Associate Editor of three international journals, and the author of more than 70 papers, the author of a book on computer speech, and the co-editor of another. Dr. DeMori is the chairman of the Speech Recognition Committee of IAPR.

Visual Inspection 08:30 - 12:00 Sunday 29 July 1984

Speaker: L. F. Pau, Battelle, Geneva

Content: Whereas the technical feasibility of using image processing is now established in a variety of tasks related to automatic inspection, assembly, quality control, instrumentation, etc., the actual implementations are still somewhat limited. This tutorial will survey basic approaches in automatic imaging inspection, sensor and illumination requirements, scanning and quantization procedures, control of the environment, selected feature extraction and image understanding algorithms, and custom hardware. A listing of past or potential applications will be presented, as well as of current basic research efforts in visual inspection, stressing advantages and limitations.

Biography: Dr. L.F. Pau has been on the faculty of the Technical University of Denmark, ENS Telecommunications, Massachusetts Institute of Technology and University of Maryland. He is currently a senior scientist at the Battelle Memorial Institute. He has published over 100 articles and five books. His main interests have recently been: automatic inspection in microelectronics, failure detection, infrared imagery, image based expert systems, sensor fusion, and custom hardware.

Dynamic Image Analysis 13:30 - 17:00 Sunday 29 July 1984

Speaker: H.-H. Nagel, Fraunhofer Institut fur Informations und Datenverarbeitung

Content: Image sequences capture information about the temporal as well as spatial variations of recorded scenes. Technological developments which facilitate image sequence analysis will be outlined, followed by a survey of various application areas. The main part

will treat recent approaches to cope with the following problems: review of approaches to the estimation of displacement vector fields as a mapping between consecutive image frames; dissimilarity grading between different images frames (change detection); formal relations between approaches for displacement vector estimation and dissimilarity grading; hierarchy of abstractions for the description and interpretation of interframe dissimilarities and displacement vector fields (moving rigid 3-D point configurations, surfaces and 3-D objects; non-rigid objects, 3-D object configurations and object trajectories in 3-D space); higher level abstractions related to the description of temporal variations in scenes (motion verbs, episodes); other hypotheses to be considered are changes in the location, direction, color and other attributes of illumination sources and their effects on the recorded scene. Common tasks such as object or target tracking as well as scene surveillance will be treated in this context.

Biography: Hans-Hellmut Nagel obtained his Diploma in Physics from the University of Heidelberg in 1960 and his doctorate in Physics from the University of Bonn in 1964. He spent time at MIT, and subsequently at Bonn and Hamburg on the automatic evaluation of bubble chamber film. He obtained his venia legendi (Habilitation) at the University of Bonn in 1970. In 1971 he became full professor of Informatik (Computer Science) at the University of Hamburg and in January of 1983 at the University of Karlsruhe in a joint appointment as director of the Franhofer-Institut fur Informations und Datenverarbeitung at Karlsruhe. Since 1971, his activities center on the evaluation of image sequences, especially TV-frame sequences. In addition, his interests include the implementation and use of higher level programming languages for the realisation of image analysis systems on networks. He is an associate editor of Computer Vision, Graphics and Image Processing, a member of the editorial board of AI Journal as well as Pattern Recognition Letters, and is on the advisory board of IEEE Trans. Pattern Analysis and Machine Intelligence. He is a member of Gesellschaft fur Informatik, AISB, ACM, IEEE Computer Society and the Pattern Recognition Society.

Special Purpose Architectures 08:30 - 17:00 Sunday 29 July 1984

Speaker: M.J.B. Duff, University College, London

Content: This tutorial will review the broad classes of newly-developed computer architectures specialized for processing image data. A distinction will be drawn between high-level language structures and computer hardware implementing them and will discuss the significance of attempts to 'hide' the computer structure from the user by raising the levels of the languages used. The ways in which knowledge of the architecture can influence the design of algorithms and also ways that algorithms can influence architecture will be considered. As well as describing the architecture now available, the tutorial will examine the problem of trying to benchmark performance of new architectures and show how misleading conclusions can be drawn unless great care is taken to design and describe the benchmarks. Finally, the increasing use of VLSI technology to implement image processing algorithms will be evaluated and an attempt made to compare the relative merits of general purpose programmability and hardware dedication.

Image Data Bases 13:30 - 17:00 Sunday 29 July 1984

Speaker: George Nagy, University of Nebraska-Lincoln, & Steve Tanimoto, University of Washington

Content: Databases of images and of other forms of pictorial information are increasingly

important in medicine, remote sensing, computer-aided design, computer graphics, digital cartography, geography, document processing, and industrial pattern recognition. This tutorial surveys techniques of database management and picture processing that are relevant to the design of pictorial database systems. Emphasis is placed on the adaptation, integration and application of the techniques to provide more effective systems. Specifically covered are: logical and physical database organization including views, hierarchical, network, relational and hybrid approaches; image data structures including multiresolution and contour-based methods; image data compression; algorithms for pictorial and spatial information retrieval including methods from computational geometry; query methods; pictorial indexing; progressive transmission; and interactive techniques. Current and future pictorial database systems will be discussed, including design implications of laser disk technology.

Biographies: George Nagy has a Ph.D. in Electrical Engineering from Cornell. He spent ten years at the IBM T. J. Watson Research Center, developing pattern classification techniques for optical character recognition, speech processing, data compression, and remote sensing. He has been chairman of the Computer Science Department at the University of Nebraska. He has spent time at Cornell University, Universite de Montreal, IBM, Bell Laboratories, the Italian Research Council's laboratories at Genoa and Naples, and INRS/Bell-Northern Research in Montreal. He has served as a research consultant also for Tektronix, Compression Laboratories, Caere Corporation, and NASA. He has given lectures at many universities and technical conferences, and is the author of numerous research and survey articles. Currently a Professor at the University of Nebraska-Lincoln, his research interests are in geographic data processing, digital image registration, and quantitative evaluation of the computer interface.

Steven Tanimoto is currently an Associate Professor in the Department of Computer Science at the University of Washington in Seattle, where he conducts research and teaches image processing, computer graphics and artificial intelligence. His research in image processing has concentrated on pyramidal data structures and the languages and parallel algorithms that work with them. Another research project is concerned with the use of pictures and diagrams to program and use computers. During the 1982-83 academic year he was a visiting professor at the Institut de Programmation, University of Paris, and a visiting scientist at the Department of Electrical Engineering, Linkoping University, Sweden. Tanimoto received the bachelor's degree from Harvard University in 1971 and the Ph.D. in Electrical Engineering from Princeton University in 1975.

CAD/CAM 8:30 - 17:00 Sunday 29 July 1984

Speaker: Dave Bonham, University of New Brunswick

Content: The approach taken by Dr. Bonham is to consider CAD/CAM from the bottom or the manufacturing level up through to the system requirements to the CAD. The general philosophy is to remove the human from the system where he is inappropriate and to include him where it is appropriate. The tutorial deals with the current state-of-the-art in each of the associated technologies that collectively comprise an integrated CAD/CAM facility.

Biography: Currently, Dr. Bonham is Chairman of the Department of Mechanical Engineering at the University of New Brunswick, Fredericton. His educational background includes the Bachelor's at Queen's University, Master's and Ph.D. from McMaster University. Dr. Bonham started doing research in CAD/CAM in 1967. He joined the University of New Brunswick in Fredericton in 1974. He has originated the New Brunswick Manufacturing Technology Center and is a member and past chairman of the CAD/CAM Advancement Council.

SEVENTH INTERNATIONAL CONFERENCE ON PATTERN RECOGNITION

Queen Elizabeth Hotel, Montreal — July 30 - August 2, 1984

CONFERENCE PROGRAM

Monday, July 30 9:00 - 9:30 a.m. OPENING SESSION

9:30 - 11:00 a.m.

MOTION I (Chairmen: H. Nagel and J. R. Aggarwal)

TIME-VARYING CORNER DETECTION
M. A. Shah and R. Jain, University of Michigan

DISPLACEMENT VECTOR FIELDS BY "ORIENTED SMOOTHNESS" CONSTRAINTS
H-H. Nagel and W. Enkelmann, FIID, FRG

ESTIMATING TARGET POSITION FOR IMAGE TRACKING OF MOVING TARGETS
S. Ishikawa, M. Yamada and S. Ozawa, Keio University, Japan

MEASURING OBJECT DISPLACEMENTS WITH SUBPIXEL ACCURACY
Q. Tian and M. N. Huhns, University of South Carolina

VELOCITY ESTIMATION FROM IMAGE SEQUENCES
O. Tretiak and L. Pastor, Drexel University

THE MOTION CONSTRAINT EQUATION FOR OTICAL FLOW
B. G. Schunck, MIT

BIOMEDICAL APPLICATIONS I (Chairmen: E. Tanaka and S. Dwyer)

EVALUATION OF THERMOGRAPHIC IMAGES FOR BREAST CANCER DETECTION
Y. S. Fong, W. G. Wee and M. Moshowitz, Clarkson College of Technology

3-D RECONSTRUCTION OF ECHOCARDIOGRAMS BASED ON SECTIONS
S. Tamura et al., Osaka University, Japan

REGION SEGMENTATION OF BIOMEDICAL TISSUE IMAGE USING COLOR TEXTURE
N. Funakubo, Electrotechnical Laboratory, Japan

APPLICATION OF MEDIAN FILTERING ON NUCLEAR SCINTIGRAM IMAGES
A. A. Ionnides, D. Kazakos and D. D. Watson, University of Virginia

A DECISION SYSTEM FOR INTERPRETATION OF ELECTROMYOGRAMS
J. Quignon and C. Faure, Universite de Technologie de Compeigne, France

EDGE DETECTION (Chairmen: S. Peleg and B. Neumann)

A GENERAL SCHEME FOR DISCONTINUITY DETECTION
I. K. Sethi, Wayne State University

A NEW ALGORITHM FOR IMAGE EDGE EXTRACTION AND ITS APPLICATIONS
A. Kundu and S. K. Mitra, University of California

THE LOCAL STRUCTURE OF IMAGE DISCONTINUITIES IN ONE DIMENSION
Y. G. Leclerc and S. W. Zucker, McGill University

ESTIMATION OF EDGE ORIENTATION BY TEMPLATE MATCHING
E. R. Davies, Royal Holloway College, UK

A STOCHASTIC APPROACH TO EDGE DETECTION
R. F. Hauser, IBM Zurich Research Laboratory, Switzerland

EDGE DETECTION FOR IMAGES VIA DYNAMIC PROGRAMMING
M. A. Furst and P. E. Caines, McGill University

SIMILARITY AND DISTANCE (Chairmen: T. Kohonen and C. H. Chen)

A NEW APPROACH TO THE RECOGNITION OF NEAR GEOMETRIC SHAPES
K. R. Tampi and S. S. Chetlur, F.A.C.T. Ltd., India

AUTOMATIC FIGURE DECOMPOSITION INTO ELEMENTARY FEATURES
M. Nagao and M. Katayama, Kyoto University, Japan

A CONTEXT-DEPENDENT METRIC FOR PICTURES
E. Tanaka, Utsonomiya University, Japan

COMPLETE EUCLIDEAN DISTANCE TRANSFORMATION BY PARALLEL OPERATION
H. Yamada, Electrotechnical Laboratory, Japan

HOW TO QUANTIFY SHAPE DISTANCE FOR 2-DIMENSIONAL REGIONS
S. K. Paroi and D. Dutta Majumder, Indian Statistical Institute

SIMILARITY BETWEEN RELATIONAL GRAPHS FOR IMAGE ANALYSIS
M. A. Eshera and K-S. Fu, Purdue University

Monday, July 30, 11:30 a.m. - 1:30 p.m.

TEXTURE I (Chairmen: Y. Shirai and A.K.C. Wong)

MEASURING THE DEGREE OF TEXTURE REGULARITY
D. Chetverikov, Hungarian Academy of Sciences

TEXTURE DISCRIMINATION BASED ON DETAILED MEASURES OF THE POWER SPECTRUM
F. D'Astous and M.E. Jernigan, University of Waterloo

A DIRECTIONAL FILTERING APPROACH TO TEXTURE DISCRIMINATION
A. Ikonomopoulos and M. Unser, Swiss Federal Institute of Technology

A PARALLEL METHOD FOR NATURAL TEXTURE SYNTHESIS
S. Ma and A. Gagalowicz, University of Maryland

TEXTURE CLASSIFICATION BASED ON HYPOTHESIS TESTING APPROACH
M. J. Carlotto, The Analytic Sciences Corporation

MULTIPLE RESOLUTION TEXTURE ANALYSIS AND CLASSIFICATION
S. Peleg, J. Naor, R. Hartley and D. Avnir, The Hebrew University of Jerusalem

CURVES (Chairmen: H. Marko and R.J.P. de Figueiredo)

A NEW METHOD FOR 2-D SHAPE DILATION
S. N. Biswas and D. Dutta Majumder, Indian Statistical Institute

PIECEWISE LINEAR L_1 APPROXIMATION OF PLANE CURVES
N. N. Abdelmalak, National Research Council

A DISCUSSION ON SHAPE DESCRIPTION BASED ON CURVE FITTING
J-O. Eklundh AND J. Howasko, Royal Institute of Technology, Sweden

DETERMINATION OF CRITICAL POINTS ON PLANAR SHAPES
R. A. Jones and V. J. Tejwani, University of Arkansas

ON THE CHORD PROPERTY AND ITS APPLICATIONS
S.H.Y. Hung and T. Kasvand, National Research Council

2-D INTERPOLATION BY GENERALIZED SPLINES BASED ON PDE IMAGE MODELS
T. C. Chen and R.J.P. de Figueiredo, Rice University

FEATURE SELECTION (Chairmen: D. Rosenfeld and J. T. Tou)

FEATURE SELECTION FOR LINEAR CLASSIFIERS
M. Ichino and J. Sklansky, University of California at Irvine

ON FEATURE SELECTION
C. E. Quiros and E. S. Gelsema, Free University, Netherlands

A NEW FEATURE SELECTION METHOD BASED ON THE MAHALANOBIS DISTANCE
G. Xuan, Xi'an Jiaotong University, People's Republic of China

OPTIMAL FEATURE SELECTION: PART I - THEORY
S. D. Morgera and L. Datta, Concordia University

OPTIMAL FEATURE SELECTION: PART II - IMPLEMENTATION
L. Datta and S. D. Morgera, Concordia University

IMAGE PROCESSING (Chairmen: P. Becker and R. Kashya)

MAXIMUM ENTROPY IMAGE RECONSTRUCTION BY DIFFERENTIAL EQUATIONS
X. Zhuang and E. Ostevold, VPISU

MAXIMUM A POSTERIORI IMAGE ESTIMATION IN SIGNAL-DEPENDENT NOISE
R. Kasturi, J. F. Walkup and T. F. Krile, Pennsylvania State University

LINEAR SHIFT-VARIANT PROCESSING OF 2-D SIGNALS
R. Bamler, Technische Universitaet Muenchen, FRG

IMAGE RESTORATION BY MULTIPLE REGRESSION ANALYSIS APPROACH
N. Otsu and T. Kasvand, National Research Council

AN IMAGE FILTERING ALGORITHM BASED ON SELECTIVE AVERAGING
D. Z. Shang and C. C. Li, University of Pittsburgh

MULTIPURPOSE LOW-LEVEL VISUAL PROCESSING
L. Jacobson and H. Wechsler, University of Minnesota

Monday, July 30, 2:00 - 3:30 p.m.

SPEECH I (Chairmen: J. Karhonen and D. J. Burr)

AUDITORY SCENE ANALYSIS (INVITED)
A. S. Bragman, McGill University

DIPHONE SPOTTING WITH MARKOV CHAINS
R. Gemelio, R. Pieraccini, F. Raineri and R. Rullent, CSELT

SPEAKERS AND VOWEL INDEPENDENT RECOGNITION OF CV INITIAL PLOSIVES
S. Kitazawa and S. Doshita, Kyoto University

PHONOTOPIC MAPS - INSIGHTFUL REPRESENTATION OF FEATURES
T. Kohonen, K. Makisara and T. Saramaki, Helsinki University of Technology

MOBILE ROBOTICS (Chairmen: S. Tsuji and J. Crawley)

PATH PLANNING IN A THREE DIMENSIONAL ENVIRONMENT
R. Ruff and N. Ahuja, University of Illinois

DISTANCE MEASURING METHOD USING ONLY SIMPLE VISION
H. Itoh, A. Miyauchi and S. Ozawa, Keio University

TRAJECTORY PLANNING PROBLEMS, I: DETERMINING VELOCITY
K. K. Gupta and S. W. Zucker, McGill University

REPRESENTING WORKSPACE AND MODEL KNOWLEDGE FOR A ROBOT
M. Shneier, E. Kent and P. Mansbach, National Bureau of Standards

PROJECTED LIGHT GRIDS FOR SHORT RANGE NAVIGATION OF ROBOTS
J. LeMoigne and A. M. Waxman, University of Maryland

DYNAMIC WORLD MODELING AND POSITION ESTIMATION FOR A MOBILE ROBOT
J. J. Crowley, Carnegie-Mellon University

QUADTREES (Chairmen: S. Levialdi and N. Ahuja)

PROCESSING GEOGRAPHIC DATA WITH QUADTREES
H. Samet, A. Rosenfeld, C. A. Shaffer and R. E. Webber, University of Maryland

MODEL-GUIDED SEGMENTATION USING QUADTREES
L. W. Tucker, Cornell Medical Center

APPROXIMATION AND COMPRESSION OF IMAGES USING QUADTREES
H. Samet, University of Maryland

PROGRESSIVE REFINEMENT OF 3D IMAGES USING CODED BINARY TREES
D. M. Hardas and S. N. Srihari, SUNY at Buffalo

THE QUADCODE AND APPLICATION IN IMAGE PROCESSING
S.-X. Li and M. H. Loew, The George Washington University

IMAGE PYRAMIDS AND PARTITIONS
D. Lucas and L. Gibson, Interactive Systems Corporation

IMPLEMENTATION AND COMPLEXITY (Chairmen: A. Inoue and G. Toussaint)

ALTERNATIVE HIERARCHIES FOR CELLULAR LOGIC
S. L. Tanimoto, J-P. Crettez and J-C. Simon, University of Washington

THE PYRAMID COMPUTER FOR IMAGE PROCESSING
R. Miller and Q. F. Stout, SUNY

ON THE REUSE OF LABEL LOCATIONS IN REAL TIME COMPONENT LABELLING
A. C. Fong, IBM Research Laboratory

HIERARCHICAL CODE ACCUMULATORS FOR SEQUENTIAL MODE ESTIMATION
C. M. Brown, University of Rochester

OBJECT IDENTIFICATION AND ORIENTATION ESTIMATION
D. Cyganski and J. A. Orr, USA

DIGITAL DISKS AND A DIGITAL COMPACTNESS MEASURE
C. E. Kim and T. A. Anderson, Washington State University

Monday, July 30, 4:00 - 5:30 p.m.

CLASSIFICATION ALGORITHMS I (Chairmen: J. Kittler and P. Swain)

THE SELECTION OF SIGNIFICANT DOCHOTOMOUS FEATURES
X. Li and R. C. Dubes, Michigan State University

A MULTI-CATEGORY DECISION NETWORK OF DICHOTOMOUS DECISION TREES
D. L. Tebbe, Harris Corporation, USA

A "NOT TOO FAR"-NEIGHBOUR DECISION RULE
L. Miclet, E.N.S.T., France

CONTEXTUAL DECISION RULES FOR OBJECTS IN LATTICE CONFIGURATIONS
J. Kittler and J. Foglein, SERC Rutherford Appleton Laboratory, UK

MULTI-DECISION SPACE MAPPED INTO AN OPTIMUM DECISION SPACE
H. M. Kalayeh, Object Recognition Systems, Inc., USA

AN ADAPTIVE NON-PARAMETRIC CLASSIFICATION ALGORITHM
M. Usai, Universite de Technology de Compiegne, France

SEGMENTATION I (Chairmen: T. Chang and P. Selfridge)

BOUNDARY DETERMINATION OF OBJECT SURFACES VIA TEXTURE
D. Brzakovic and J. T. You, University of Florida

SPLIT-AND-MERGE SEGMENTATION OF SLAR-IMAGERY
J. J. Gerbrands and E. Backer, Delft Universty of Technology, Netherlands

AN AUTOMATIC THRESHOLDING ALGORITHM AND ITS PERFORMANCE
J. Kittler, J. Illingworth, J. Foglein and K. Paier, SERC Rutherford Appleton Lab, UK

MAGNIFICATION OF DIGITISED PICTURES, FOR OBJECT RECOGNITION
J.A.C. Bernsen, Philips Research Labs, The Netherlands

A SPLIT-AND-MERGE ALGORITHM FOR SEGMENTATION OF NATURAL SCENES
B. A. Parvin, Ford Aerospace and Communications Corporation, USA

SEGMENTATION OF BINARY SCENES WITH CONNECTIVITY ALGORITHMS
T. Kasvand and N. Otsu, National Research Council

RELAXATION AND INFERENCE (Chairmen: M. Berthod and R. Hummel)

STOCHASTIC RELAXATION, GIBBS DISTRIBUTIONS, AND RESTORATION OF IMAGES
S. Geman and D. Geman, University of Massachusetts

A PROBABILISTIC INFERENCE SYSTEM
A.K.C. Wong and D.K.Y. Chiu, University of Waterloo

IMAGE MATCHING BY A PROBABILISTIC RELATION LABELING PROCESS
A. Goshtasby and C. V. Page, University of Kentucky

AN ALGORITHM FOR THE CONSISTENT LABELING PROBLEM
S. Nishihara and K. Ieda, University of Tsukuba, Japan

SOLVING LABELING PROBLEMS HAVING THE SEPARATION PROPERTY
L. G. Shapiro, Virginia Polytechnic Institute and State University

GRAPH OPTIMAL ISOMORPHISM WITH APPLICATION TO PATTERN ANALYSIS
M. You and A.K.C. Wong, University of Waterloo

SHAPE TRANSFORMS (Chairmen: A. J. Dutta and O. Mitchell)

FINDING AXES OF SKEWED SYMMETRY
S. A. Friedberg and C. M. Brown, University of Rochester

SKELETONS IN DERIVED GRIDS
G. Bertrand, Ecole Superieur d'Ingenieurs en Electrotechnique et Electronique, France

PAST PIECEWISE NON-LINEAR APPROXIMATION
L-D. Wu and X-Y. Luo, Fudan University, People's Rep. of China

MEDIAL-AXIS BASED SHAPE SMOOTHING
C. R. Dyer and S-B. Ho, University of Wisconsin

AUGMENTED MEDIAL AXIS TRANSFORM
N. Anuka and W. Huff, University of Illinois

NEAR OPTIMAL TRANSFORM ENCODING OF CLOSED PLANAR CURVES
G. S. Zebele and J. Kublowitz, Clarkson College

Tuesday, July 31, 9:30 - 10:30 a.m.

EFFICIENT DATA STRUCTURES (Chairmen: A. Rosenfeld and F. Backer)

QUENCHING POINTS IN DISTANCE LABELED PICTURES
C. Arcelli and G. Sanniti di Baja, Institute di Cibernetica, Italy

HIERARCHICAL IMAGE REPRESENTATION FOR OPTICALLY SCANNED DOCUMENTS
G. Nagy and S. Seth, University of Nebraska-Lincoln

WAVEFORM CORRELATION BY TREE MATCHING
Y-C. Cheng and S-Y. Lu, Exxon Production Research Co., USA

AN OPTIMAL DISTRIBUTED STORAGE DEVICE FOR ASSOCIATIVE SEARCH
S-Y. Oh, University of Illinois at Chicago

A TREE ALGORITHM FOR TWO-DIMENSIONAL CONVOLUTION
P. J. Varman and I.V. Ramakrishnan, University of Maryland

FAST DISCRIMINATION BETWEEN HOMOGENEOUS AND TEXTURED REGIONS
I. Dinstein, A. C. Fong, L. M. Ni and K. Y. Wong, IBM Research Laboratory, USA

ORIENTAL CHARACTER RECOGNITION (Chairmen: K-S. Fu and T. Sakai)

LINE FILTERING FOR SEGMENTATION OF HANDPRINTED CHINESE CHARACTERS
S. Mori and T. Sakakura, Nippon-Schlumberger, Takai University, Japan

A NEW PROBABILISTIC MODEL FOR CHINESE CHARACTER RECOGNITION
V-L. Ma and J-S. Jour, National Taiwan University

A SYNTACTIC-SEMANTIC APPROACH FOR DESCRIBING CHINESE CHARACTERS
J-W. Tai, Academia Sinica, People's Republic of China

MODIFIED DISCRIMINANT FUNCTIONS FOR CHINESE CHARACTERS
F. Kimura, T. Harada, S. Tsuruoka and Y. Miyake, Engineering Mie University, Japan

A NEW APPROACH TO MACHINE RECOGNITION OF CHINESE CHARACTERS
Y. Liu and T. Kasvand, National Research Council

RECOGNITION OF CHINESE AND JAPANESE CHARACTERS
K. Yamamoto, H. Yamada and R-I. Oka, Electrotechnical Laboratory, Japan

CONTOUR MATCHING FOR HANDPRINTED CHINESE CHARACTER RECOGNITION
H. Yamada, Electrotechnical Laboratory, Japan

REMOTE SENSING (Chairmen: R. Woodham and W. A. Davis)

EVIDENCE ACCUMULATION FOR REASONING IN IMAGE UNDERSTANDING
V.S-S. Hwang, T. Matsuyama, L. S. Davis and A. Rosenfeld, University of Maryland

ANALYZING REMOTELY SENSED DATA ON THE MASSIVELY PARALLEL PROCESSOR
S. C. Cox, J. C. Tilton and J. P. Strong, NASA/Goddard Space Flight Centre

OUTCOME OF AN NSF-SPONSORED 3-DAY WORKSHOP ON REMOTE SENSING
P. H. Swain, Purdue University

APPLICATION OF DIGITAL TERRAIN MODEL IN REMOTE SENSING
T. Shibata, University of Southern California

A COMPUTER VISION SYSTEM FOR THE ANALYSIS OF AERIAL SCENES
C. A. Harlow, R. W. Conners, and M. M. Trivedi, Louisiana State University

DETECTION AND SUB-PIXEL LOCATION OF OBJECTS IN AERIAL IMAGERY
M. L. Akey and O. R. Mitchell, Purdue University

APPLICATIONS I (Chairmen: L. Pau and M. Shneier)

SOFTWARE FOR LOCATING AND IDENTIFYING SURFACE DEFECTS IN WOOD
R. W. Conners, C. W. McMillin, R. Vasquez-Espinosa, Louisiana State University

AN INDUSTRIAL APPLICATION OF TEXTURE ANALYSTS
M. Borghesi, V. Cantoni and M. Diani, Pavia University, Italy

SEAMSIGHT: A PARALLEL/PIPELINED VISION SYSTEM FOR SEAM TRACKING
I. Masaki, General Motors Research Laboratories, USA

COMPARISON OF VARIOUS FILTER SETS FOR DEFECT DETECTION IN TEXTILES
F. Ade, N. Lins and M. Unser, ETH-Zentrum, Switzerland

A SURVEY OF SIX INTERNATIONAL CONFERENCES ON PATTERN RECOGNITION
E. S. Gelsema, Vrije Universiteit, Netherlands

STEREO PROCESSING OF AERIAL IMAGES
D. L. Smitley and R. Bajcsy, University of Pennsylvania

Tuesday, July 31, 11:00 a.m.- 12:30 p.m.

3-D VISION I (Chairmen: C. M. Brown and J. Mundy)

SURFACE CLASSIFICATION USING CHARCTERISTIC CONTOURS
I. K. Sethi and S. N. Jayaramamurthy, Wayne State University

MATCHING PERSPECTIVE VIEWS OF 3-D OBJECTS
W. K. Gu, J. Y. Yang and T. S. Huang, University of Illinois at Urbana-Champaign

A STEREO VISION ALGORITHM USING PERSPECTIVE DISTORTIONS
S. Castan and J. Shen, Universite Paul Sabatier, France

3-D SHAPE ANALYSIS USING MOMENTS AND FOURIER DESCRIPTIONS
A. P. Reeves, R. J. Prokop, S. E. Andrews and F. P. Kuhl, Cornell University

HIGH PRECISION MARK POSITION SENSING FOR 3-D RANGE ACQUISITION
M. Idesawa, RIKEN: The Institute of Physical and Chemical Research, France

RECONSTRUCTION FROM PROJECTIONS OF A MULTIPLE OBJECT 3-D SCENE
Y. Bresler and A. Macovski, Stanford University

COMPUTATIONAL GEOMETRY (Chairmen: G. Nagy and Q. F. Stout)

EFFICIENT PLANAR EMBEDDING OF TREES FOR VLSI LAYOUTS
M. Ahuja, University of Illinois

COMPUTING VERTEX DISTANCE BETWEEN CROSSING CONVEX POLYGONS
G. T. Toussaint, McGill University

ON THE CIRCUIT COMPLEXITY OF PLANAR OBJECTS
A. Albrecht, Humboldt University, DRG

A LINEAR TIME ALGORITHM FOR COMPUTING THE VISIBILITY POLYGON
S. K. Ghosh, Tata Institute of Fundamental Research, India

MESH-CONNECTED COMPUTER ALGORITHMS FOR GEOMETRIC PROPERTIES
Q. F. Stout and R. Miller, SUNY at Binghampton

DIGITAL REALIZATION OF THE LABELED VORONOI DIAGRAM
T. Matsuyama and T-V. Phillips, University of Maryland

LINEAR FEATURES (Chairmen: H. Fredman and N. N. Abdelmalak)

EXTRACTING LINEAR FEATURES
B. Burns, A. Hanson and E. Riseman, University of Massachusetts

KARHUNEN-LOEVE LINE FITTING AND A LINEARITY MEASURE
N. Otsu, Electrotechnical Laboratory, Japan

A HYBRID VECTORIZATION ALGORITHM
T. Pavlidis, Bell Labs

A SEGMENTED IMAGE DATA BASE (SID) FOR IMAGE ANALYSIS
D. Cruse, C. J. Oddy and A. Wright, Marconi Research Centre, USA

RECOGNITION OF LINE SHAPES
T. Kasvand and N. Otsu, National Research Council

REPRESENTATION OF DIGITAL LINE SEGMENTS AND THEIR PRE-IMAGES
T. A. Anderson and C. E. Kim, Washington State University

HUMAN PERCEPTION (Chairmen: A. Bregman and J. M. Tenenbaum)

A COMPUTER MODEL OF HUMAN RETINAL VISUAL PROCESSING
D. Heeger and J. Nachmias, University of Pennsylvania

A MODEL OF HUMAN SYMMETRY DETECTION
B. A. Schaefer, Communications Research Centre, Canada

PERCEPTION OF ORGANIZATION IN A RANDOM STIMULUS
B. J. Smith, Communications Research Centre, Canada

RECEPTIVE FIELDS AND THE RECONSTRUCTION OF VISUAL INFORMATION
S. W. Zucker and R. A. Hummel, McGill University

THE MULTI-LAYER VISUAL MODEL AND THE PERCEPTUAL CONSTANCIES
J-P. Crettez and S. L. Tanimoto, Universite Pierre et Marie Curie, France

A MODEL OF HUMAN RECOGNITION OF CHARACTERS
K. Ikeuchi, Electrotechnical Laboratory, Japan

Tuesday, July 31, 1:30 a.m.- 3:00 p.m.

MOTION II (Chairmen: T. Huang and W. Martin)

CORRESPONDENCE ANALYSIS FOR TARGET TRACKING IN INFRARED IMAGES
J.P. Gambotto, ETCA/CTME, France

AN INTEGRATION SPATIO-TEMPORAL MODEL FOR IMAGE MOTION ESTIMATION
R. K. Schalkoff and J. Labuz, Worcester Polytechnic Institute

MOTION ANALYSIS OF ISOLATED TARGETS IN INFRARED IMAGE SEQUENCES
J.P. Gambotto and T. S. Huang, University of Illinois at Urbana-Champaign

DETERMINING MOTION PARAMETERS USING GUIDED RANGE SENSING
M. J. Magee and J. K. Aggarwal, The University of Texas

THE RELATIONSHIP BETWEEN OPTICAL FLOW AND SURFACE ORIENTATION
Y. Alloimonos and C. M. Brown, The University of Rochester

ESTIMATION OF GENERAL 2-D MOTION PARAMETERS IN TV SCENES
R. Lenz, Technische Universitaet Muenchen, FRG

APPLICATIONS II (Chairmen: M. Aoki and R. C. Gonzalez)

A STRUCTURAL CLASSIFIER FOR SHIP TARGETS
B. A. Parvin, Ford Aerospace and Communication Corp., USA

A SYSTEM FOR THE RE-IDENTIFICATION OF MOTOR VEHICLES
E. Pfannerstill, Institute fur Nach. und Daten. der TWTH AACHEN, FRG

RECOGNITION OF UNDERWATER TRANSIENT PATTERNS
C. H. Chen, Southeastern Massachusetts University

A SURVEY OF AIRCRAFT CLASSIFICATION ALGORITHMS
J. F. Gilmore, Georgia Institute of Technology

THE IMPACT OF TERRAIN MODELS AND SIMULATION FOR SHUTTLE SAR MISSIONS
V. H. Kaupp, H. C. MacDonald and W. P. Waite, University of Arkansas

A CLUSTERING METHOD FOR ANALYSIS OF EARTHQUAKE DATA
W. Biquan, C. Zuyin and M. Ziufang, Institute of Geophysics, People's Republic of China

VLSI IMPLEMENTATION (Chairmen: P. E. Danielsson and S. Tanimoto)

VLSI SYSTOLIC ARRAYS FOR SIGNAL AND IMAGE PROCESSING (INVITED)
H. T. Kung, Carnegie-Mellon University

SPACE-TIME DOMAIN EXPANSION FOR HIERARCHICAL SCENE MATCHING
H. D. Cheng, W. C. Lin and K-S. Fu, Purue University

ISP: A DEDICATED LSI FOR GRAY IMAGE LOCAL OPERATIONS
T. Fukushima et al., Hitachi Ltd., Japan

VLSI IMPLEMENTATION OF A REAL-TIME IMAGE CONVOLVER
M. K. Selmane and C. R. Allen, University of Newcastle-upon-Tyne

IMAGE PROCESSING AND SHAPE (Chairmen: S. Tamura and H. Wechsler)

THE MEDIAN FILTER: AN APPRAISAL AND A NEW TRUNCATED VERSION
E. R. Davies, Royal Holloway College, UK

EDGE CLASSIFICATION AND EXTRACTION OF SHAPE FEATURES
A. Perves and C. Y. Suen, Concordia University

SHAPE ESTIMATION FROM TOPOGRAPHIC PRIMAL SKETCH
T-C. Pong, L. G. Shapiro and R. M. Haralick, VPISU

PROJECTION FILTER RESTORATION OF DEGRADED IMAGES
H. Ogawa and N. Nakamura, Tokyo Institute of Technology

AN APPROACH TO A GENERALIZED TECHNIQUE FOR IMAGE ENHANCEMENT
T. K. De and B. N. Chatterji, Indian Institute of Technology

TOWARDS A SYSTEMATIC STUDY OF SHAPE MEASURES
F. Veillon, Laboratoire IMAG, France

Tuesday, July 31, 3:30 a.m.- 5:00 p.m.

CHARACTER RECOGNITION (Chairmen: S. Mori and C. Suen)

A DOCUMENT UNDERSTANDING SYSTEM
K. Kubota, O. Iwaki and H. Arakawa, Nippon T & T, Japan

TREE CLASSIFICATION FOR HANDWRITTEN CHARACTER RECOGNITION
M. Shridhar and A. Badreldin, University of Windsor

HISTOGRAM CLASSIFIER FOR HANDWRITTEN SIGNATURE CHARACTERIZATION
J-J. Brault and R. Plamondon, Ecole Polytechnique de Montreal

A HIERARCHICAL SYSTEM FOR HANDWRITTEN NUMERAL RECOGNITION
B. Schaeken et al., Vrije Universiteit Brussel, Belgium

SEGMENTATION AND RECOGNITION OF CHARACTERS AND SYMBOLS FOR DIAGRAMS
M. Furuta et al., Information Technology Promotion Agency, Japan

SOME EXPERIENCE IN THE REAL-TIME PROCESSING OF HANDWRITING
B. R. Gaines et al., CADRE Information Transfer Systems, Canada

SPEECH II (Chairmen: H. Niemann and D. O'Shaughnessy)

NATURAL LANGUAGE PROCESSING (INVITED)
R. Perrault, SRI International

SEMANTIC AND PRAGMATIC REASONING IN SPEECH UNDERSTANDING
A. Brietzmann and H. Niemann, Universitaet Eriangen, FRG

CONTINUOUS SPEECH RECOGNITION BASED ON KNOWLEDGE ENGINEERING
R. Mizoguchi and O. Kakusho, Osaka University

SEGMENTATION II (Chairmen: Y. Matsuyama and R. Haralick)

ITERATIVE SEGMENTATION USING CONTEXTUAL COLOR AND SHAPE
J. M. Chassery and C. Garvay, Universite Scientifique et Medicale de Grenoble, France

IMPROVING THE TOPOGRAPHIC PRIMAL SKETCH USING CONTRAST
S. Gu and R. M. Haralick, VPISU

SIMULATION STUDIES OF A PARALLEL HISTOGRAMMING ALGORITHM FOR PASM
J. T. Kuehn and H. J. Siegel, Purdue University

A MAPPING METHOD FOR COMPUTER COLOR VISION
S. Tominaga, Osaka Electro-Communication University, Japan

A SEMANTICALLY-BASED MULTI-LEVEL EDGE DETECTION SYSTEM
R. J. Beattie, Napier College, UK

REGION GROWING AND GLOBAL LABELING IN IMAGE ANALYSIS
F. Badui'i and J. Jayawardena, Portland State University

3-D ROBOTICS I (Chairmen: M. Sato and J-O. Eklundh)

ACQUIRING AND USING INFORMATION CONCERNING 3-D OBJECT SHAPES (INVITED)
J. Schwartz, New York University

A FAULT TOLERANT SENSOR SCHEME
T. Henderson, E. Shilcrat and C. Hansen, University of Utah

STATE RECOGNITION ALGORITHMS FOR ROBOT ASSEMBLY CONTROL
G. Reyman, Technical University of Wroclaw, Poland

A FAST FILTERING OPERATOR FOR ROBOT STEREO VISION
D. J. Burr, Bell Laboratories

Wednesday, August 1, 9:00 - 10:30 a.m.

SYSTEMS (Chairmen: A. Guzman and B. Prasada)

CLADYN, COMPRESSOR FOR COLOR TV AND MULTISPECTRAL IMAGES
G. E. Lowitz and P. Cassagne, S. A. Matra, France

PWIP-1: A SMALL SIZE HIGH SPEED IMAGE PROCESSOR
K. Deguchi, JH. Inouchi and I. Morishita, University of Tokyo

DORIAN: A SEMANTIC-ORIENTED INFORMATION SYSTEM IN GERMAN
D. Schmedding, A. Tissen and C. Moraga, Universitaet Dortmund, FRG

INTERACTIVE PICTURE PROCESSING USING ICEPIC USER INTERFACE
S. Linnainmaa, Technical Research Center of Finland

EYE MOVEMENT ANALYSIS SYSTEM USING FUNDUS IMAGES
H. Kawai, S. Tamura and K. Kani, Osaka University

PATTERN RECOGNITION (Chairmen: E. S. Gelsema and M. Goldberg)

ON SUBSPACE CLUSTERING
E. Oja and J. Parkinen, University of Kuopio, Finland

EXPERIMENTAL STUDY OF COMBINED LINEAR MAPPING METHOD
V. T. Kissiov and M. E. Aladjem, Bulgarian Academy of Science

PREMETRIC SPACES AND PATTERN RECOGNITION
J-P. Auray, G. Duru, M. Lamure and M. Terrenoire, Universite Lyon, France

OPTICAL FEATURE EXTRACTION VIA THE RADON TRANSFORM
G. Gindle and A. Gmitro, Yale University

ON A NEW UNIFIED APPROACH TO PATTERN RECOGNITION
L. Goldfarb and T.Y.Y. Chan, University of New Brunswick

BLOCK DETECTION IN A NORMALIZED KOLMOGOROV METRIC SPACE
P. G. Gulak and E. Shwedyk, University of Manitoba

APPLICATIONS III (Chairmen: J-I. Toriwaki and C. C. Li)

MELODY ANALYSIS OF JAPANESE FOLK SONGS BASED ON PRODUCTION SYSTEM
K. Tsuboi and M. Ishizuka, University of Tokyo

ANALYSIS OF DIGITAL IMAGES OF THE SHROUD OF TURIN
R. M. Haralick, VPISU

A NEW APPROACH TO GUIDING THE BLIND VIA COMPUTER VISION
M. Adjouadi, University of Florida

LABELING METHOD AND CHEMICAL SUBSTRUCTURE ISOMORPHISM
J. Xu and J-G. Li, Shanghai Jiao-Tong University

DESCRIPTIONS OF WEATHER MAPS FOR WEATHER MAP DATABASES
Y. Yoshida, K. Tanamori and T. Fukumura, Nagoya University

3-D VISION II (Chairmen: O. Gaugeras and R. Bajcsy)

CONSTRUCTING A DEPTH MAP FROM IMAGES
K. Ikeuchi, Electrotechnical Laboratory, Japan

A DISTANCE MEASURE BASED ON TREE-GRAPH GRAMMARS
A. Sanfeliu, Instituto de Cibernetica, Spain

GEOMETRICAL CONSTRAINTS AND CLUSTERING FOR 3D OBJECT POSE
G. Stockman and J. C. Esteva, Michigan State University

GEOMETRIC STRUCTURES FOR 3-D SHAPE REPRESENTATION
J-D. Moissonnat, INRIA, France

ON PRESENTATION AND PERCEPTION OF 3D-IMAGES
R. Lenz et al., Linkoeping University, Sweden

3-D RECONSTRUCTION OF OBJECTS FROM RANGE DATA
B. C. Vemuri and J. K. Aggarwal, University of Texas at Austin

Wednesday, August 1, 11:00 a.m. - 12:30 p.m.

CHARACTER RECOGNITION II (Chairmen: S. Watanabe and T. Kasvand)

SEGMENTATION AND EXTRACTION OF HANDWRITTEN SIGNATURE PATTERNS
F. Lamarche and R. Plamondon, Ecole Polytechnique de Montreal

STRUCTURAL RECOGNITION OF HANDWRITTEN NUMERALS
W. Verschueren, B. Schaeken, Y. Rene de Cotret and A. Hermanne, Vrije Universiteit Brussel, Belgium

A KNOWLEDGE BASED SCRIPT READER
R.M.K. Sinna, Indian Institute of Technology

LEARNING OF HAND-PRINTED CHARACTERS WITH LINGUISTIC INFORMATION
T. Sagawa, E. Tanaka, M. Suzuki and M. Fujita, Utsunomiya University, Japan

NON-LINEAR MATCHING METHOD FOR HANDPRINTED CHARACTER SCRIPT
J. Tsukumo and K. Asai, NEC Corporation, Japan

USE OF KNOWLEDGE IN THE VISUAL INTERPRETATION OF CURSIVE SCRIPT
S. N. Srihari and R. Bozinovic, SUNY at Buffalo

MOTION III (Chairmen: B. Radig and W. Thompson)

MOTION DETECTION IN IMAGES: EVALUATION OF FEATURE DETECTORS
R. Kories and G. Zimmermann, FIID, FRG

DETERMINING 3-D MOTION/STRUCTURE OF A RIGID BODY
B. L. Yen and T. S. Huang, University of Illinois

DETECTION OF MOVING OBJECTS USING LINE IMAGE SEQUENCE
M. Aoki, Seikei University, Japan

MOTION DETECTION IN RADAR IMAGES
A. M. Abidi and R. C. Gonzales, University of Tennessee

ANALYZING OBJECT MOTION BASED ON OPTICAL FLOW
W. B. Thompson, K. M. Mutch and V. A. Berzins, University of Minnesota

3-D ROBOTICS II (Chairmen: J-C. Simon and T. Kanade)

3-D OBJECT REPRESENTATION OF VISION AND ROBOTICS (INVITED)
O.D. Faugeras, Institut Natinal de Recherche en Informatique et en Automatique, France

RANGE IMAGING SYSTEM FOR 3-D OBJECT RECOGNITION
S. Inokuchi, K. Sato and F. Matsuda, Osaka University

TACTILE INFORMATION PROCESSING - THE BOTTOM UP APPROACH
R. Bajcsy and G. Hager, University of Pennsylvania

QUADTREES II (Chairmen: A. Gagalowitz and C. Dyer)

MINIMAL QUADTREES
A. Klinger, N. Alexandridis and G. Reynolds, UCLA

A VOLUME/SURFACE OCTREE REPRESENTATION
C. H. Chien and J. K. Aggarwal, University of Texas at Austin

EFFICIENT OCTREE REPRESENTATION OF MOVING OBJECTS
W. Osse and N. Ahuja, University of Illinois

A NOTE ON THE PROPERTIES AND APPLICATIONS OF THE HYBRID QUADTREE
V. Raman and S. S. Iyengar, Louisiana State University

PYRAMIDAL ALGORITHMS FOR IMAGE PROCESSING
A. Merigot, B. Zavidovique and F. Devos, Institute d'Electronique Fundamentale, France

Wednesday, August 1, 12:30 p.m., Conference Luncheon
Luncheon Speaker: Gordon B. Thompson
Topic: Getting 1984 in Focus

Wednesday, August 1, 2:30 p.m. **Poster Session**

FINGERPRINT DATA COMPRESSION
N. N. Abdelmalak, T. Kasvand, D. Goupil and N. Otsu, NRC

AUTOMATIC HANDLING OF OVERLAPPING WORKPIECES
N. Ayache, J-D. Boissonnat, B. Bollack and B. Faverjon, INRIA

EXPERT SYSTEM FOR MULTI-SPECTRAL LAND-USE MAPPING
P. W. Bain, M. J. Carlotto and V. T. Tom, The Analytic Sciences Corp, USA

GRAPH MATCHING BY PARALLEL OPTIMIZATION METHODS
M. Berthod and M. Thonnat, INRIA

ROAD SURFACE STRUCTURE AND PATTERN ANALYSIS
L. Besse and G. Csikos, Federal Institute of Technology, Switzerland

REGION DETECTION BASED ON AN HOMOGENEOUS SET OF LOCAL OPERATORS
A. Boubekraoui, B. Zavidoique and J. Rivaillier, ETCA/LIMSI, France

DETERMINATION OF NATURAL NUMBER OF CLUSTERS PRESENT IN A DATA SET
S. Chandrasekhar, National Remote Sensing Agency, India

ON A MIXED APPROACH TO DIGITAL PICTURE ANALYSIS
C. H. Chen and C. Yen, Southeastern Massachusetts University

APPLICATIONS OF THE RANKING TRANSFORMS WITH THE VAP
A. Comazzi and A. Favre, University of Berne

IMPROVED EXCITATION BASED ON CLASSIFICATION AND PERCEPTUAL CRITERIA
M. Copperi and D. Sereno, Centro Studi a Laboratori Telecommunicazioni s.p.a., Italy

A SCENE ANALYSIS SYSTEM SIMULATING THE PERIPHERAL VISUAL PERCEPTION
J. Dengler and J. Bille, University of Heidelberg

TASF, A STENOTYPE-TO-FRENCH TRANSCRIPTION SYSTEM
A-M. Derouault and B. Meriadlo, IBM France Scientific Centre

DIFFERENT STATES OF A DOCUMENT'S CONTENT
W. Doster, AEG-Telefunken Communication Systems AG, FRC

INTELLIGENT DETECTION OF LEFT VENTRICULAR BOUNDARIES
J. S. Duncan, Yale University

A METHOD TO CLASSIFY SPREAD SHAPES BASED ON THE 'POSSIBILITY THEORY'
V. Di Gesu and M. C. Maccarone, Instituto di Fisica Cosmica and Applicazioni della Informatica del C.N.R., Italy

IN A SET-THEORETICAL APPROACH RELATED TO THE GRAPH THEORY IN CLUSTERING
F. El-Sibai and H. Emptoz, Institut National des Sciences Appliquees de Lyon

APPLICATION OF NONLINEAR ADAPTIVE LAYERED NETWORKS
A. S. Gevins et al., EEG Systems Laboratory

AUTONOMOUS NAGIVATION THROUGH IMAGE UNDERSTANDING
J. F. Gilmore, George Institute of Technology

SYMBOLIC SCENE MATCHING
C. Granger, INRIA, France

LOCAL FEATURE EXTRACTION FOR MODEL-BASED WORKPIECE RECOGNITION
H. Grasmueller et al., Siemens AG, FRG

A CLUSTER SEPARATION MEASURE FOR THE FCV FAMILY OF ALGORITHMS
R. W. Gunderson and T. Jacobsen, Utah State University

ON A DISTINCTIVE FEATURE OF TONE 3 IN CHINESE
Z. Guotian, Harbin Institute of Technology

DEPTH RECOVERY FROM SURFACE NORMALS
G. Healy and R. Jain, University of Michigan

THREE-DIMENSIONAL RECONSTRUCTION OF MARKER PATTERNS
G. A. Heyler, The Johns Hopkins University

MARKOV PROBABILISTIC MODELS FOR TEXTURE-BASED IMAGE SEGMENTATION
H. Huang, University of Southern California

A PRACTICAL SOLUTION USING A NEW APPROACH TO ROBOT VISION
D. L. Hudson, Octak Inc., USA

OPTICAL FILTERING TECHNIQUES IN DIGITAL IMAGE ENHANCEMENT
P.J.S. Hutzler, Gesellschaft fuer Strahlen und Umweitforschung, FRG

A NEW TYPE OF MINIATURIZED OPTICAL RANGE SENSING SCHEME
M. Idesawa, RICKEN, Japan

TRANSCRIPTION OF JAPANESE FOLKLORE
M. Imai and S. Inokuchi, Osaka University

ANALYSIS OF INTERACTIONS BETWEEN LANDSAT AND DIGITAL TERRAIN DATA
W. M. Johnstone and M. E. Jernigan, University of Waterloo

AN INTERACTIVE HIERARCHICAL CLUSTERING SCHEME
G. Karam, M. Goldberg, L. D. Tran and M. Alvo, University of Ottawa

ALGEBRAIC THEORY OF PATTERN RECOGNITION
O. K. Khanmamedov, Institute of Cybernetics Academy Sciences, USSR

HANDWRITING RECOGNITION ACCURACY VERSUS RESOLUTION AND SAMPLING
J. Kim and C. C. Tappert, IBM Watson Research Centre

PERFORMANCE EVALUATION OF KERNEL AND K-NN CLASSIFICATION RULES
A. Krzyzak, Concordia University

DISTRIBUTION-FREE CONSISTENCY AND THE RATES OF CONVERGENCE
A. Krzyzak, Concordia University

COMPONENTS OF HANDPRINTED CHARACTER STYLE
T. T. Kuklinski, Pencept Inc., USA

RECOGNITION OF MICROANEURYSMS IN DIABETIC FLUOROANGIOGRAPHIES
B. Lay, C. Baudoin and J. C. Klein, Ecole Nationale Superieure des Mines de Paris

APPLICATION OF NONLINEAR ADAPTIVE FILTERS FOR IMAGE ENHANCEMENT
Y. H. Lee and S. A. Kassam, University of Pennsylvania

A FINGERPRINT AUTOMATION RECOGNITION SYSTEM WITH MICROCOMPUTER
Z-R. Li and D-P. Zhang, Harbin Institute of Technology

DEFECT DETECTION OF WELDING SEAMS
Z-R. Li, D-P. Zhang and Q-K Deng, Harbin Institute of Technology

OCR IN THE U.S. POSTAL SERVICE: PRESENT STATUS AND FUTURE NEEDS
S. J. Long, D. P. D'Amato and M. Sack, Arthur D. Little, Inc.,

A PATTERN RECOGNITION INSTRUMENT OPERATING IN THE FIELD
P. Malvache, Y. Buravamd M. Usai and B. DuBuisson, CEN/Cadarche, France

THE UNFAMILIAR WORLD OF GRAY GEOMETRY
R. A. Melter, Southampton College, USA

INTERACTIVE CHROMOSOME ANALYSIS FOR THE STUDY OF BARLEY VARIETIES
C. Merritt and I. Craig, National Research Council

THE DESIGN OF BIT-PARALLEL SYSTOLIC FILTER ALGORITHMS
P. L. Mills, Cambridge University, UK

SCENE MATCHING USING DEFOCUSED IMAGES
D. F. Mix and K. C. Overman, University of Arkansas

MODELING IN COMPUTER DIAGNOSIS OF PULMONARY VASCULATURE
G. E. Moore, AT&T Information Systems

SYMBOL IDENTIFICATION IN GEOGRAPHICAL MAPS
D. A. Morean and R. Kasturi, The Pennsylvania State University

REPRODUCING AND RECOGNITION AT HUMAN INSTANTANEOUS MEMORY
S. J. Mrchev, Mulgaria

HEART DISEASE DIAGNOSIS USING CLASSIFICATION OF SPECTRAL PATTERNS
V. Neagoe, S. Gruenwald, G. Mueller and A. Voiceulescu, Romania

PATTERN RECOGNITION FOR STRUCTURAL ANALYSIS IN GEOLOGY
P. T. Nguyen and L. Asfar, S. Simon, IBM-France

LSI ORIENTED ARCHITECTURE FOR CELLULAR FEATURE EXTRACTION
R-I. Oka, Electrotechnical Laboratory, Japan

PICTURE RESTORATION BY OTHOGONAL EXPANSION
M. Pawlak, Technical University of Wrocklaw, Poland

ADAPTATION IN INTEGRATION PROPERTIES OF VISUAL SYSTEMS
R. B. Pinter, University of Washington

RELAXATION MATCHING TECHNIQUES - A COMPARISON
K. E. Price, University of Southern California

DYNAMIC SCENE ANALYSIS AND VIDEO TARGET TRACKING
R. A. Samy, R. A. and C. A. Bozzo, CSEE-CETIA

DISTRIBUTED COMPUTING FOR VISION
P. G. Selfridge and S. Mahakian, AT&T Bell Laboratories

PROTOTYPE SIMULATION FOR IDENTIFICATION OF BIDIMENSIONAL PATTERNS
D. C. Suraqui, Dasur Pattern Recognition Ltd., Israel

COMPUTERIZED PATHOGRAPHIC ANALYSIS OF FAMOUS PAINTER'S WORKS
I. Suzuki, M. Miyamae and T. Kaminuma, Tokyo Metropolitan Institute of Medical Science

A LINEAR PROCESSOR ARRAY FOR VIDEO RATE IMAGE PROCESSING
E. Swane, SINTEF, Norway

ADAPTIVE ON-LINE HANDWRITING RECOGNITION
C. C. Tappert, IBM Research Center

PYRAMID STRUCTURES IN DYNAMIC SCENES
B. H. Thomas and W. N. Martin, University of Virginia

KALMAN WINDOW FILTER IMAGE RESTORATION ALGORITHM
P. Thomas and R.G.S. Asthana, McMaster University

MULTIRESOLUTION SEGMENTATION OF REMOTELY SENSED DATA
J. C. Tilton and S.C. Cox, NASA/Goddard Space Flight Center

A PARTICULAR INTERPOLATION TECHNIQUE APPLIED TO PICTURE RESTORATION
P. Tremelat, J.J. Lefebvre and P. Vibert, Commissariat a l'Energie Atomatique, France

AUTOMATIC VERIFICATION OF SEAL-IMPRESSION PATTERN
K. Ueda and Y. Nakamura, Nara Technical College, Japan

COMPARISON OF DIGITAL FILTERING AND THE LAPLACE OPERATOR
R. Vaknine, W. J. Lorenz and W. Schlegel, Institute of Nuclear Medicine, FRG

POWER SPECTRUM APPLIED TO MEDICAL B-SCAN IMAGES
R. Vaknine, and W. J. Lorenz, Institute of Nuclear Medicine, FRG

RECOGNITION OF SYMMETRICAL PATTERNS IN IMAGES
A. A. Vasiliev, USSR Academy of Science

EDGE PRESERVING TEXTURE ANALYSIS
P. W. Verbeek and D. J. deJong, Delft University of Technology

IMAGE RESTORATION BY A SIMPLE ITERATIVE METHOD
P. Vibert and V. Frachet, Commissariat a l'Energie Atomatique, France

MICROPROGRAMMABLE IMAGE PROCESSORS FOR A VISION SYSTEM
I. Virtanen and M. Pietikaeinen, University of Oulu, Finland

FORM-INVARIANT TEXTURE RECOGNITION
W. Wilhemi, Academy of Sciences of the GDR

WELL-WRITING BASING ON ON-LINE CHARACTER RECOGNITION
T. Yamasaki, S. Inokuchi and Y. Sakurai, Kagawa University

ON-LINE ALPHANUMERIC HANDWRITTEN CHARACTER RECOGNITION
P.J. Ye, H Hugli and F. Pellandini, Universite de Neuchatel

ON-LINE HANDWRITTEN CHINESE CHARACTER RECOGNITION
P.J. Ye, H Hugli and F. Pellandini, Universite de Neuchatel

A CLASS OF STABLE FEATURE EXTRACTORS FOR TIME-VARYING IMAGERY
G. Zimmermann, FIID, FRG

RECONSTRUCTION OF THREE-DIMENSIONAL LIGHT MIROSCOPE IMAGES
G. Zinser, A. Erhardt and J. Bille, University of Heidelberg

ELECTROSTATIC PULSE CLASSIFIER
P. E. Zwicke and D. Rosenbush, United Technologies Corporation

<u>Thursday, August 2, 9:00 - 10:30 a.m.</u>

CHARACTER RECOGNITION III (Chairmen: K. Yamamoto and K. Paton)

DEVELOPMENT OF ON-LINE HANDWRITTEN CHARACTER INPUT EQUIPMENT
T. Sakai, J. Odaka and T. Yoida, Nippon T & T., Japan

RECOGNITION OF HANDWRITTEN ARABIC WORDS AND SENTENCES
A. Amin, G. Masini and J-P. Haton, Centre de Recherche en Informatique de Nancy

ON-LINE RECOGNITION OF SHORTFORMS IN HANDWRITTEN SHORTHAND
C. G. Leedham and A. C. Downton, University of Southampton

A MIROCOMPUTER SYSTEM TO RECOGNIZE HANDWRITTEN NUMERALS
G. Y. Tang, P-S. Tzeng and C-C. Hsu, National Taiwan University

ON-LINE CURSIVE SCRIPT RECOGNITION USING STROKE LINKAGE RULES
T. Wakahara and M. Umeda, Nippon T & T., Japan

PLANE CURVE CLASSIFICATION THROUGH FOURIER DESCRIPTORS
S. Impedovo, Universita di Bari, Italy

DATA STRUCTURE AND CODING (Chairmen: J. A. Weaver and H. Samet)

MULTI-DIRECTIONAL GRADIENT CODES FOR POSITION DETERMINATION
K. P. Lam, National Research Council

ON THE ORDER OF EXAMINING DATA-POINTS IN SSD TEMPLATE MATCHING
Y. I. Gold, The University of Connecticut

ADAPTIVE TRANSFORM CODING BASED ON CHAIN CODING CONCEPTS
J. A. Saghri and A. G. Tescher, The Aerospace Corporation

PRINCIPLES AND STRATEGIES OF HIERARCHICAL COUNTOUR CODING
G. Hartmann, Universitat-Gesamthochschule-Paderborn, FRG

TABULAR REPRESENTATIONS OF PICTORIAL DATA USING REGION CODING
P. Badi'i and K. Sorooshian, Portland State University

GRAPH REPRESENTATION OF A HIERARCHICAL SURFACE MODEL
L. DeFloriant, B. Falcidieno and C. Pienovi, Instituto per la Matematica Applicata, Italy

SEGMENTATION III (Chairmen: E. R. Davies and A. Mitchie)

ANALYSIS OF MEDIAN FILTER CHARACTERISTICS FOR CONTOUR EXTRACTION
T. Gotoh, T. Toriu and E. Tamamoto, Fujitsu Labs Ltd., Japan

PLANES AND QUADRICS DETECTION USING HOUGH TRANSFORM
Y. Muller and R. Mohr, Centre de Recherche en Enformatique de Nancy

SIMPLE ALGORITHMS FOR SEGMENTING TEXTURED-IMAGES
P. S. Cohen, D. B. Cooper, J. F. Silverman and E. B. Hinkle, Brown University

IMAGE ANALYSIS BASED ON DESCRIPTION GRAPHS WITH CONTOUR CODING
N. Bartneck, AEG-Telefunken, FRG

SCENE SEGMENTATION FROM MULTIPLE THRESHOLD AND TEXTURE
G. Y. Xu and K-S. Fu, Purdue University

UNSUPERVISED SEGMENTATION BY USE OF A TEXTURE GRADIENT
D. Wermser, Universitaet Hanover, FRG

IMAGE UNDERSTANDING (Chairmen: M. Nagao and J.Y Tsotsos)

KNOWLEDGE ORGANIZATION AND CONTROL IN IMAGE UNDERSTANDING (INVITED)
T. Matsuyama, Kyoto University

A FRAME-LIKE KNOWLEDGE REPRESENTATION SYSTEM FOR COMPUTER VISION
M. Numao and M. Ishizuka, University of Tokyo

MATCHING AN IMPRECISE OBJECT DESCRIPTIONS WITH MODELS
N. A. Khan and R. Jain, The University of Michigan

USE AND REPRESENTATION OF KNOWLEDGE IN IMAGE UNDERSTANDING
H. Bunke and G. Sagere, Friedrich-Alexander-Universitaet Erlangen-Nuernberg, FRG

RS-AUTOMORPHISMS AND SYMMETRICAL OBJECTS
C. Schlieder and B. Radig, Universitaet Hamburg, FRG

Thursday, August 2, 11:00 - 12:30 a.m.

BIOMEDICAL APPLICATIONS II (Chairmen: K. Hohne and J. Prewitt)

HUMAN BODY RECONSTRUCTION FROM A SINGLE PICTURE
H. J. Lee and Z. Chen, National Chiao Tung University

SYNTACTIC ANALYSIS OF NOISY INPUT STRINGS FOR HEART-VOLUME CURVES
H. Bunke, K. Grebner and G. Sagere, Friedrich-Alexander-Universitaet Erlangen-Nuernberg, FRG

A COMPARISON OF IMAGE FEATURES IN DIAGNOSIS OF CORONARY DISEASE
E. E. Gose et al., University of Illinois at Chicago

AN ALGORITHM FOR SEGMENTING WHITE AND RED BLOOD CELLS
D. Cheng, Academia Sinica, People's Republic of China

COMPUTER-AIDED MEASUREMENT OF TRANVSERSE AXON SECTIONS
W. J. Geckle and R. E. Henkins, The Johns Hopkins University

3-D RECONSTRUCTION OF CORONARY ARTERY FROM CINE-ANGIOGRAMS
M. Yachida, S. Iwai and S. Tsuji, Osaka University

SHAPE MATCHING (Chairmen: K. Ikeuchi and T. Pavlidis)

ATTRIBUTED STRING MATCHING WITH MERGING FOR SHAPE RECOGNITION
W-H. Tsai and S-S. Yu, National Chiao Tung University

A SIMPLIFIED SEARCHING APPROACH IN SHAPE MATCHING
S. Tian, SUNY

SHAPE COMPARISONS USING GENERALIZED PATTERN-MATCHING
W. U. Grosky and Y. Lu, Wayne State University

FINDING CORRESPONDENCES IN TIME-VARYING SHAPE BOUNDARIES
G.G. Pieroni and M. F. Costabile, Universita della Calabria

A NEW BETTER VERSION OF THE CHAMFER MATCHING ALGORITHM
G. Borgefors, National Defence Research Institute, Sweden

SHAPE MATCHING BY CORRELATING RELATIONAL MODELS
H. S. Lee and N. V. Thakor, Northwestern University

HARDWARE IMPLEMENTATIONS (Chairmen: M. Yachida and A. Klinger)

AN EFFICIENT THINNING ALGORITHM FOR LARGE SCALE IMAGES
A. Nakayama, F. Kimura, Y. Toshida and T. Fukumura, Nagoya University

REAL-TIME EDGE DETECTION FOR IMAGE PROCESSING
C. D. McIlroy, W. Monteith and R. Linggard, The Queen's University of Belfast

A CONCURRENT LANGUAGE FOR DESCRIBING NETWORKS OF FRAMES
A. Giordana, Universita di Torino, Italy

INCREMENTAL LABELING OF GRAPHS FROM AN IMAGE SEQUENCE
R. E. Blake, University of Tennessee

IMPLEMENTATION OF A CONNECTED SPEECH RECOGNITION ALGORITHM
D. Wood and R. B. Urquhart, Hirst Research Centre, UK

TEXTURE II (Chairmen: M. Unser and C. Harlow)

A STOCHASTIC MODEL BASED TECHNIQUE FOR TEXTURE SEGMENTATION
R. L. Kashyap and A. Khotanzad, Purdue University

LOCAL LINEAR TRANSFORMS FOR TEXTURE ANALYSIS
M. Unser, Ecole Polytechnique Federale de Lausanne

SYNTHESIS OF NATURAL TEXTURES ON 3-D SURFACES
A Gagalowicz and S. D. Ma, University of Maryland

TEXTURE ANALYSIS BY THE SELF-ORGANIZATION METHOD
M. Ogata and M. Sato, Tokyo Institute of Technology

ADJACENCY GRAPHS ON A DIGITIZED FIGURE SET AND TEXTURE ANALYSIS
J-I. Toriwaki, Y. Yashima and S. Yokoi, Nagoya University

TIME SERIES MODELING FOR TEXTURE ANALYSIS
Y. C. Jau and R. T. Chin, University of Wisconsin

TEXTURE REPRESENTATION AND SYNTHESIS BY VECTOR QUANTIFICATION
F. Schmitt, M. Goldberg, N. Ngwa-Ndifor and P. Boucherm University of Ottawa

Thursday, August 2, 1:30 - 3:00 a.m.

SPEECH III (Chairmen: R. de Mori and M. Takagi)

AUTOMATIC SELECTION OF WORD TEMPLATES FOR SPEECH RECOGNITION
C. Favareto and C. Vincenzi, ELSAG s.p.a., Italy

TELEPHONE SPEECH RECOGNITION USING A HYBRID METHOD
Y. Takebayashi et al., Toshiba Corporation

MATCHING FOR CONNECTED SPOKEN WORD RECOGNITION
S-I. Nakagawa, Toyohashi University of Technology

SENTENCE RECONSTRUCTION FOR POSTPROCESSING OF CONTINUOUS SPEECH
O. Venta, Helsinka University of Technology

EVALUATION OF PROCEDURES FOR REFERENCES IN SPEECH RECOGNITION
A. Mokeddem, H. Hugli, and F. Pellandini, Universite de Neuchatel

SOME TOOLS FOR SPEAKER-INDEPENDENT, ISOLATED WORD RECOGNITION
G. Rigoll and K. P. Faehnrich, FIAP, FRG

THEORY (Chairmen: P. A. Devijer and R. Conners)

DIRECLADIS OR A NEW METHOD OF DIMENSIONALITY REDUCTION
S. Watanabe, University of Hawaii

UNSUPERVISED CONSTRUCTION OF DECISION NETWORKS
R. G. Casey, S. K. Chai and K. Y. Wong, IBM Research Laboratory

PATTERN RECOGNITION BY MARKOVIAN DYNAMIC PROGRAMMING
Y-L. Ma, National Taiwan University

ON UNCOMPLETELY DETERMINED MODEL OF FUNCTION APPROXIMATION
V. Brailovsky, USSR

MAPPING THE LOCAL INFORMATION CONTENT OF A SPATIAL IMAGE
G. E. Lowitz, S. A. Matra, France

COMPLEXITY AND APPROXIMATION: FOUNDATIONS OF PATTERN RECOGNITION
B. R. Gaines, University of Toronto

SIGNATURES AND SHAPE (Chairmen: L. G. Shapiro and A. Oosterlink)

A NEW METHOD FOR RECOGNITION AND POSITIONING OF 2-D OBJECTS
N. Ayache and O. D. Faugeras, INRIA

SHAPE INFORMATION FROM ROTATED SCANS
F. W. Sinden, Bell Laboratories

REALTIME ON-LINE SYMBOL RECOGNITION USING DYNAMIC PROGRAMMING
P. Lu and R. W. Brodersen, University of California

ON-LINE HANDWRITTEN SIGNATURE RECOGNITION
G. Lorette, Universite Paris XII

REGISTRATION OF LOCALLY DISTORTED IMAGES
M. Yanagisawa, S. Shigemitsu and T. Akatsuka, Yamagata University

RECONSTRUCTING A NETWORK OF THREE-DIMENSIONAL CURVES
W. M. Blune, P. V Sankar and J. Sklansky, University of California at Irvine

DRAWING ANALYSIS (Chairmen: R. W. Conners and F. Leberl)

RECOGNITION OF DESIGN DRAWINGS AND MAPS (INVITED)
M. Ejiri, Hitachi Central Research Laboratory

AUTOMATIC DIGITIZING SYSTEM FOR PWB DRAWINGS
W. Kikkawa, M. Kitayama, K. Miyazaki, H. Arai and S. Arato, NEC Corporation, Japan

TOPOLOGY BASED ANALYSIS OF SCHEMATIC DIAGRAMS
F.C.A. Groen and R.J. van Munster, Institute of Applied Physics, Netherlands

Thursday, August 2, 3:30 - 5:00 a.m.

FUZZY METHODS (Chairmen: R. Lopez de Mantaras and O. Tretiak)

THE AUTOMATIC RECOGNITION OF AUTOMOBILE'S TYPE
Y-J. Li, Shangai Institute of Mechanical Engineering

TFI - A FUZZY ISODATA CLUSTERING ALGORITHM
P. Chen and Z-Y. Chen, Beijing Polytechnic Institute

NEW RESULTS IN FUZZY CLUSTERING
R. Lopez de Mantaras and L. Valverde, Universitat Politecnica de Barcelona

ON FUZZY CLASSIFICATION
L O. Hall and A. Kendel, The Florida State University

FUZZY ENHANCEMENT IN IMAGE PROCESSING
R-B. Tang, Shangai Institute of Computer Technology

STATISTICAL-FUZZY METHOD AND FUZZY-STATISTICAL METHOD
T. Duchun, Academia Sinica

CLASSIFICATION (Chairmen: D. Dutta Majumder and L. Devoyre)

BAYES PATTERN CLASSIFICATION IN MARKOV CHAINS
P. A. Devijver, Philips Research Laboratory, Belgium

A FAST ROBUST ESTIMATOR FOR APPLICATIONS TO IMAGE PROCESSING
C. A. Pomalaza-Raez, Clarkson College

A NONPARAMETRIC SEQUENTIAL MULTIPLE COMPOSITE HYPOTHESIS TEST
S. Fielsher and E. Shwedyk, University of Manitoba

FEATURE SELECTION AND CONSTRUCTIVE INFERENCE
J. Segen, ATT&T Bell Laboratories

EFFICIENT ERROR ESTIMATION FOR GAUSSIAN CLASSIFIERS
T. E. Flick and L. K. Jones, Naval Research Laboratory

MICROELECTRONIC INSPECTION (Chairmen: M. Ishizuka and A. Malowany)

AUTOMATIC INSPECTION OF VLSI MASKS
S. Arunkumar and S.V. Reddy, Indian Institute of Technology

PERFORMANCE EVALUATION OF ALGORITHMS FOR VISUAL INSPECTION
O. Silven, T. Piironen, M. Elsila and M. Pietikaeinen, University of Oulu, Finland

WIRESIGHT: ROBOT VISION FOR DETERMINING THREE-DIMENSIONAL GEOMETRY
S. Tsuji, M. Yachida and H-L. Guo, Osaka University

AN AUTOMATIC VISUAL INSPECTION SYSTEM FOR LSI PHOTOMASKS
K. Okamoto et al., Hitachi Ltd., Japan

SYNTACTIC METHODS (Chairmen: H. Pletikainen and M. Watanabe)

INDUSTRIAL COMPUTER VISION USING LEARNING TECHNIQUES
D. J. Braunegg and R. C. Gonzalez, University of Tennessee

REGULAR INFERENCE FOR SYNTACTIC PATTERN RECOGNITION: A CASE STUDY
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E. Skordalakis and G. Papakonstantinou, NRC "Democritos", Greece

For further details, contact:

ICPR Conference Secretariat
3450 University Street
MONTREAL, QU
H3A 2A7

Telephone: 514-392-6744

PROCEEDINGS OF CSCSI/SCEIO CONFERENCE 1984

London, Ontario **15, 16 and 17 May 1984**

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Martin Kay, XEROX PARC (INVITED)

A THEORY OF DISCOURSE COHERENCE FOR ARGUMENT UNDERSTANDING
Robin Cohen, University of Toronto

SCALAR IMPLICATURE AND INDIRECT RESPONSES TO YES/NO QUESTIONS
Julia Hirschberg, University of Pennsylvania

GENERATING CORRECTIVE ANSWERS BY COMPUTING PRESUPPOSITIONS OF ANSWERS, NOT OF QUESTIONS, OR MIND YOUR P's, NOT Q's
Robert Mercer and Richard Rosenberg, University of British Columbia

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Mostafa Aref and Gordon McCalla, University of Saskatchewan

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David Coles and Larry Rendell, University of Guelph

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CSCSI/SCEIO SURVEY

CANADIAN ARTIFICIAL INTELLIGENCE IN THE NEXT DECADE: FUNDING, STRATEGIES AND THE ROLE OF THE CSCSI/SCEIO
Nick Cercone, President and Gordon McCalla Vice-President, CSCSI/SCEIO

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27 May - 1 June 1984 **Ottawa, Ontario**

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Nadia Magnenat-Thalmann and D. Thalmann, Universite de Montreal

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K. T. Fishkin and B. A. Barsky, University of California

TOWARDS EXPRESSIVE ANIMATION FOR INTERACTIVE CHARACTERS
A. Marion, K. Fleischer, and M. Vickers, Atari Sunnyvale Res. Lab

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K.-T. Huang and M. M. Zloof, IBM Thomas J. Watson Research Center

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A COLOUR REAL-TIME ANIMATION SYSTEM
A. S. Malowany and B. Kashef, McGill University

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PRIMITIVES IN COMPUTER GRAPHICS
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McGill University
Electrical Engineering Department
Computer Vision and Robotics Laboratory
Progress Report, October 1982 - September 1983

RESEARCH PROJECTS: BIOMEDICAL IMAGE PROCESSING

The Automatic Classification of Lymphocyte Subsets by Means of 2D-Locomotory Patterns and Pseudopod Kinetics

Lymphocytes are known to play a major role in host defense mechanisms. To better understand this role, the movement of cells and the factors which affect their motion have to be studied. To achieve this objective, a rule-based biomedical image processing system has been developed, capable of analyzing the structural change in the shape of moving cells from sequences of pictures.

New techniques are being developed to study the locomotion of nonrigid objects. Different types of skeletonization schemes, also known as symmetric or medial axis transformations, have been used in an attempt to improve the dynamic measurements of cell geometry (dynamic structure analysis, dynamic shape analysis). The system will enable us to characterize the pseudopod kinetics of T cell subgroups. These kinetics will be examined for random locomotion, and positive and negative chemotaxis. The objective is to provide the system with certain pattern recognition rules which will be able to classify the three subgroups of lymphocytes according to their dynamic morphological behaviour. The final rule-based system will be implemented using a high level, general purpose rule-based production system language.

A. R. Dill, M. D. Levine, P. R. Noble, Y. Youssef

A System for Tracking and Quantifying White Blood Cell Movement

A software package has been designed to facilitate the tracking and quantification of the dynamics of blood cell motion in 2D. For the kind of motion human cells display, a continuous Markov chain model can be employed to find the most likely direction towards which the cells will head. Our application of the Markov chain model quantifies the probability of the cells ultimately moving in a certain direction into four or five different states. The five states represent four different angles with respect to the X-axis in a Cartesian coordinate system and a waiting state. The program has been written for the Faculty of Dentistry HP85 computer system which incorporates a bit pad, graphics plotter and disc drive. Communications software has been written for the VAX 11/780 computer in the Computer Vision and Graphics Laboratory.

The software package is being extended to allow the cell shape to be specified by inputting points along the cell's contour rather than a single point at the cell's center. Currently, the main effort involves the development of a system for tracking and quantifying the dynamics of blood cell motion in 3D.

A. R. Dill, M. D. Levine, G. W. McCartney, P. Noble, C. E. Smith, K. Sung, Y. Youssef

Study of the Geometry of Circulating Platelets

Blood platelets appear to play a central role in homeostatis, the particular mechanism by which the vascular system is protected from death due to bleeding after injury. Platelet shape change is usually considered to be the first event for the participation of platelets in homeostatis and thrombosis. The purpose of this research is to develop a system for automated analysis of the geometry of circulating platelets.

At present, very little quantitative study of platelet geometry has occurred, due to the difficulty of tracking the morphology as the platelet undergoes motion in 3D. The underlying computer vision problem is that of estimating the complete 3D shape of the platelet from a sequence of 2D views. We consider the problem as having three distinct components:

1. local surface estimation (i.e. the shape of a projected view),
2. extraction of independent measurements (elimination of overlap between views), and
3. the estimation of global shape based on measures over the image sequence.

The desired output from the system will be a classification of individual cells into shape classes based on geometrical features. The major research effort is in the development of a suitable model, of 3D shape which incorporates a notion of coarse fine approximation, representation based on intrinsic properties of the surface, and a means of incremental refinement. This representation will allow considerable morphological detail to be included in the model.

F. Ferrie, M. Frojmovic (Dept. of Physiology), M. D. Levine

3D Tracking of Cell Locomotion

An important feature of human cells is their motion in zig-zag patterns. In the past the studies of cell dynamics have been carried out in two dimensions. This provides a restricted picture of the cell's trajectory and pseudopod kinetics. The goal of this project is to study and characterize the behavior of white blood cells in three dimensions. The initial research involves the determination of the description of the locomotory paths of a group of cells using a continuous-time Markov chain model. Computerized optical sectioning is being employed to capture the dynamic data.

M. D. Levine, G. W. McCartney, P. Noble

The Shape of Osteoclasts

Osteoclasts are the cells that affect the re-absorption of bone. They are subject to hormonal control, and under various pathological conditions can begin to metabolize bone at dangerously high rates. This state of high activity is reflected in the volume of the cell which increases substantially from the normal level. Such volumes have traditionally been estimated from a small number of measurements within a parametric model for the cell, such as an ellipsoid. This project is an application of computer graphics techniques to actually rendering full 3-D displays of osteoclasts under normal and abnormal conditions. The process begins with tracings made from serial sections which provide the frame onto which a triangulated surface can be placed. Indications are that normal osteoclasts are shaped rather like a banana, while overactive ones are much more spherical.

Y. Leclerc, S. W. Zucker, M. Kay (Montreal General Hospital)

Interpretation of 3-D Computerized Tomography Images

Computerized tomography has revolutionized non-invasive diagnostic imaging. It actually has the capability of producing 3-dimensional images in the form of a stack of 2-dimensional ones, each of which is a "slice" through a portion of a patient. Our long-term goal in this project is to actually match organs from a diagnostic image with those in an electronic atlas. This will then permit (i) indexing organs by their names; and (ii) the capability for "digital surgery", or the manipulation of actual organ images by, say, computer graphics techniques.

The actual goals of the project are much more modest, and we are currently applying optimization and AI (rule-based systems) techniques in a novel way to matching 3-D images of the spine.

Peter Sander, S. W. Zucker, M. Raminsky (Montreal General Hospital)

RESEARCH PROJECTS: CONCEPTUAL PERCEPTION AND PSYCHOPHYSICS

Orientation Selection and Grouping Evidence for Type I and Type II Processes

Oriented entities are a fundamental construct of early vision, and we consider the oriented structures that can explicitly arise from collections of dots; i.e., dot grouping. Psychophysical demonstrations suggest that there are two types of such grouping processes, separated according to several accuracy, or specificity, requirements. The first of these, Type I groupings, are very accurate with regard to spatial specificity. They usually result in smooth, one-dimensional contours with singularities in curvature and endpoints. The second of these Type II groupings, are much coarser in their spatial specificity. They result in smooth "flow" patterns, with no endpoints and much less orientation change (or curvature) resolution.

The point of this project is to study the what, why, and how questions associated with these two types of grouping: what is being constructed (abstractly, a vector field of orientations); why it is being constructed (to enable surface inferences from monocular cues); and how it could be constructed (in a way that is not inconsistent with basic neurophysiological constraints). The final result is a computational (relaxation) model that essentially uses lateral inhibition among orientation selective operators to satisfy a given optimization criterion. It is a special case of a response matching problem, with the specific constraints introduced from the differential geometry of curves. It is related to our other project on optimal curve finding. Since this model is essentially syntactic in its operation, criteria must exist that delimit when its results could be valid. One criterion is formulated as a size/density constraint that functions conjointly with the existence of orientation structure. The following two projects are aimed at properly establishing the required psychophysical differences.

S. W. Zucker

Curvature Sensitivities in Type I/Type II Dot Patterns

Random dot Moire patterns (RDMP's) provide a convenient class of type II patterns for psychophysical experimentation. This project is aimed at quantifying the human observer's ability to discriminate between sinusoidal and triangular RDMP's, since this is one of the criteria that distinguish between Type I and Type II patterns. Preliminary results suggest that the visual system is most sensitive to sinusoids whose (local) radius of curvature is about 0.3 degrees of visual angle. Type I patterns, on the other hand, exhibit a sensitivity around 1.5 minutes, or an order of magnitude higher, for dots a little larger than a minute in diameter.

The mathematical application of spline approximation techniques suggests that it is the path length of dots lying along a well-defined contour that distinguishes between Type I and Type II patterns. Precise mathematical estimates of the changeover can be made, and these, too, appear consistent with the psychophysics.

M. Link, S. W. Zucker

Size Density Constraints in Perceptual Grouping

The size/density constraint arises as a direct consequence of any theory of orientation selected that is based on data from neural processes modelable as operator convolutions. Our models, for example, use directional second derivative operators, or, rather more precisely, an approximation to them as differences of Gaussians. It follows that if the spatial pattern (in our case, a dot pattern) were such that the operator convolutions were not sensitive to it (in our case the dots were too sparse within its spatial support or receptive field), then one would expect psychophysical manifestations of this difference. In our case, then, one would expect psychophysical differences in the percept available from sparse as opposed to dense dot patterns.

This project is aimed at checking this size/density hypothesis, using subjective effects that are apparent in line-like patterns. Two are being used. The first is emergence of subjective contours when endpoints are smoothly aligned, and the second is the "sun illusion" or the regional brightness difference that results when line endpoints delimit a smooth region. Indications are that, when the dot density is on the same order as the dot diameters, say 3-4 times it, dotted lines cause the same effects as solid lines. When the density is decreased below this cutoff, the effects rapidly change. Furthermore, the changes are not due to local contrast changes, because they are no-replicable when contrast is explicitly varied.

S. W. Zucker, S. Davis

Type I/II Distinctions in Optical Flow: The Fox and the Forest

The Type I/Type II distinction has a direct extension from the spatial into the spatio-temporal domain; that is, within the class of processes typically known as (short term) optical flow. In particular, consider the metaphor of a fox chasing a rabbit through the forest. The fox must have detailed information about the path that the rabbit is covering, or the rabbit could elude it. On the other hand, the fox is only grossly concerned with the structure of the forest through which he is passing; he only needs to be informed of large structure changes. Most changes will be caused by local detailed structure, such as trees, passing into and out of occlusion relationships with one another. These two situations, from the point of view of the fox, correspond to Type I optical flow (the rabbit) and Type II optical flow (the forest), respectively. Other examples of the distinction arise if one considers the theoretical problem of inferring three-dimensional structure from the path swept out by a well-defined contour, or from a waterfall. Psychophysical and theoretical investigations are currently in progress to quantify these differences, and first indications are that they are equivalent to those already found just in the spatial domain for early orientation selection.

S. W. Zucker

Functional Implications of De-Blurring and Receptive Field Structure

Our theoretical research into optimal de-blurring filters for Gaussian blur leads to operators with basic structural similarities to the receptive fields that have been physiologically observed early in the visual system. In this project we are attempting to isolate the causes of blur - from physiological optics and limited depth of field to temporal smear problems in early vision to de-blurring. It appears that de-blurring is explicitly or implicitly implicated in the choice of operators for early orientation selection and for the interpolation underlying visual hyper-acuity.

S. W. Zucker, B. Kimia

RESEARCH PROJECTS: COMPUTER GRAPHICS

A Parallel Microprocessor System for Real Time Computer Animation

The general objective of this research is the application of parallelled microprocessor units for rendering and animating color TV raster images in real time. The configuration and evaluation of a modular multiprocessor system is a recent development offering greatly improved bandwidth per dollar but requiring significant new research in software. Continued evolution toward cheaper hardware systems precipitates new challenges such as increasing the size of the data bases of models, their additional complexities when special lighting and texture effects are included to incorporate more "realism", and finally the human perceptual aspects associated with these animated displays. An additional long term goal for this system of parallel microprocessor units involves real time image analysis applications with the addition of a TV camera and frame grabber hardware in place of the color display monitor. Currently the hardware construction and debugging of a prototype color display system GRADS - Graphic Real Time Animation Display System - is underway. The notable feature of this system is its ability to support real time animation of computer generated images using the raster scanned television monitor for obtaining full color ranges in the images. Since the task of animating a raster color image exceeds the memory bandwidth of a single computer, a superior architecture was adopted using multiple data busses and supporting the concurrent operation of parallelled processor units. The system uses a video frame buffer which is read out continuously to a television display system while offering random picture access to the microprocessors. The design is modular so that the number of parallelled microprocessors as well as the number of lanes used in the video frame can be expanded to suit the requirements of a particular problem. The display system can operate in two resolutions: 256 x 256 or 512 x 512, and is programmable using a command register to support the increasing display capabilities as the number of installed memory planes is increased from one to a maximum of fifteen. The display system hardware involves five functional sub-assemblies: the microprocessor units, the graphics controller, the frame buffer memory, the television sequencer, and the interface to the host computer. Additional details and operating characteristics of the overall graphics system appear in thee individual project summaries given below.

A. S. Malowany

A Microprogrammable Microprocessor Module

The project involves the design and evaluation of a 16 bit word size micro computer module based on the 2903 bit sliced microprocessor. The microcoding memory of 32K bytes RAM can be dynamically overlayed from the host computer system to realize multiple instruction sets. A local memory of 6K words is paged for efficiently double buffering the output data destined to the video frame. Three ports allow this local memory to be serviced by the host computer interface, the graphics controlled, and the 2903 ALU. Additional hardware features include a programmable clock, loop counters, interrupt controller, status register, microcode sequencer and program control units.

T. Addona, S. K. Chong, A. S. Malowany

Microcoding the 2900 Microprocessor Module

This project involves developing microcode software for operating the 2900 Microprocessor Module in the GRADS system. The main objectives are the realization of high level graphic primitives such as point, line, and polygon. In addition the real-time operating system requirements associated with the management of input/output buffers and interrupts are supported. The software is being developed using GPMA - General Purpose MacroAssembler. For testing, the M2900 SIMULATOR program, written in FORTRAN, is

used. A 2900 microcode trace facility is also available.

D. Chau, A. S. Malowany

Programming the 8086 Microprocessor for GRADS

This project involves developing software associated with operating an Intel 8086 microprocessor as one of the paralleled modules in GRADS. The main objectives are the realization of high level graphic primitives and operating system services previously described for the 2900 microprocessor. These are currently being developed in 8086 assembler using cross assembler and debugging facilities of a CP/M system provided with dual CPUS (8085/8088). The 16 bit word size can efficiently support 256 x 256 resolution displays in single precision arithmetic. High level languages will be available.

R. Haag, K. Mendu, A. S. Malowany

A Z8000 Microprocessor Module

This design of the GRADS microprocessor module uses the Zilog Z8000 16 bit microprocessor and is provided with 32K of program/stack memory and 32K of data segment memory. The memories are multiported to support DMA transactions to the HCI and graphics controler as in the other module versions. Interrupt capabilities are supported. A ROM monitor and a serial interface for a terminal are included to permit stand-alone operation when desired.

R. Robert, A. S. Malowany

Programming the Z8000 Module for GRADS

This project parallels the implementations previously described for the 2900 and 8086. It is curently being implemented directly in machine code and debugging is performed using a Z2800 CPU card which is compatible with the S100 bus.

N. Kashef, A. S. Malowany

The Host Computer Interface

This module is responsible for efficiently linking up the S100, Unibus, and the paralleled microprocessor computers in GRADS. It realizes a DMA facility, linking all computer memories. Packing and unpacking facilities accommodate the 8, 16, 20 or 40 bit word sizes. Any computer in the GRADS system may request the DMA machine and command transfers between any of the memories once the arbitration has granted its use. The HCI also supports the interrupt system and the Status/Control registers of the microprocessor network. These are used to co-ordinate the operation of the GRADS system.

R. Pancholy, A. S. Malowany

An Operating System for Animating Color Displays

This project involves the design of the operating system requirements for GRADS. Here a host computer system supervises the execution of high level graphic instructions being executed on an array of parallelled microprocessor modules, feeding a color display system based on a frame buffer. The applications involve real-time animation of computer generated images.

N. Partovi, K. Sung, A. S. Malowany

Computer Generated Animations on the GRADS System

The objective is the real-time execution of computer generated images using the GRADS system. Three-dimensional models for aircraft simulator daylight visual systems are envisaged.

G. Carayannis, S. Chong, A. S. Malowany

RESEARCH PROJECTS: COMPUTER VISION

Optimal Curve Finding as a Response Matching Problem

The feature detection process is often composed of two essentially different stages. The first of these is the convolution of a local operator, such as an elongated "line detector", over an image. The second stage is an evaluation, or interpretation, of the response of this operator. If it were possible to build perfectly accurate feature operators, then the above process would be trivial. One could, for example, evaluate a line operator at several orientations around a point, and then simply take the maximal response as a certain indication of the presence of a line (with a given orientation) at that point. The response of real line operators is ambiguous, however, and requires a more serious interpretation effort.

There are two premises underlying our interpretation system. The first is that the interpretation should be an optimal one, so that, e.g., it could be computed by a relaxation network. The second is the sense in which it should be optimal. It is an explication of the (contextual) constraints that should exist between operator responses. The general idea is illustrated by the following example.

Consider the problem of interpreting a binary image of thin curves into local oriented segments. (This is really the line finding problem alluded to above as it could arise, e.g. in the interpretation of the zero-crossings of a differential operator.) A local line operator evaluated over such an image would give a particular response characteristic, say as a function of the underlying segment's orientation. Given that there was a unique, straight segment with no noise, it would be maximal when they were oriented identically, and would drop off as one was rotated. Such expected response characteristics could be measured or computed for more general situations as well. It is these expected responses that are the basis for our constraints: the interpretation system should find the line most likely to give the response characteristics observed for the image under analysis. Or, in other words, the answer is the line pattern L for those that would be expected, given L. While this could be done for operator responses of one size, the constraints to which it gives rise are weak ones. Much stronger constraints arise when operators of different size are considered simultaneously. The larger ones then restrict the context within which the smaller ones are to be interpreted.

Pierre Parent and S. W. Zucker

Texture Discrimination Using Multiple Image Representations

The co-occurrence based approach to texture discrimination can be viewed as one of finding summary statistical representations for the information in textural patterns. Functions of these statistics then provide the feature vectors for standard pattern classifiers. In an empirical study we found that, for certain classes of patterns, features of intensity and edge co-occurrences, taken together, were more powerful (for discrimination) than features of either one individually. And, in other studies, we found that more "abstract" edge features could pollute the classification process. The reason for this, we believe, is based on the amount of texture structure captured by the texture representation. The purpose of this project is to determine useful measures of texture structure, so that they can be

applied to real discrimination tasks. The particular task domain under study is remotely-sensed SAR imagery.

Pierre Lamoureux, Kamal Gupta, Steven Zucker

Deblurring Gaussian Blur

Most imaging systems have an inherent point (line) spread degradation inherent within them. In this project we are considering the special case of deterministic Gaussian blur, as it may arise in, say computerized tomography applications. Since the optimal inverse (i.e. de-blurring) filter is physically unrealizable, we have solved for the pseudo-inverse using a Hermite polynomial approximation. The result for 3rd order approximations strongly resembles the Laplacian of a Gaussian, while higher order approximations have additional side lobes. We have also found the symbolic inverse for discrete approximations.

B. Kimia and S. W. Zucker

A Rule-Based Low Level Image Segmentation System

A major problem in robotics vision is the segmentation of images of natural scenes in order to understand their content. This project presents a new solution to the image segmentation problem that is based on the design of a rule-based expert system. General knowledge about low level properties of an image is formulated into production rules. A number of processes employ the rules to segment the image into uniform regions and connected lines. In addition to the knowledge rules, a set of control rules are also employed. These include meta-rules that embody inferences about the order in which the knowledge rules are matched. They also include focus of attention rules that determine the path of processing within the image. A third set of rules contains the strategy. Different rule ordering and focus of attention strategies are selected according to a set of performance parameters. These measure the quality of the segmentation output at any point in time. Experiments with the knowledge rule have resulted in an optimal set based on output quality and processing efficiency. Overall system performance has been shown to be qualitatively and quantitatively superior to previous segmentation algorithms.

M. D. Levine, A. Nazif

3D Dynamic Scene Interpretation

The aim of scene analysis is to be able to recover the three-dimensional structure underlying its two-dimensional projected view. As a first step in this process, it is necessary to be able to represent 3D shape and extract this information from a 2D image. Much work has been done in the recovery of shape information from monocular depth cues such as shading, contour, and texture. There has also been considerable investigation of shape representation in Computer Vision as well as the Graphics and CAD/CAM fields.

Our research is concerned with dynamic scene analysis. Therefore we are interested in representations of shape that are intrinsic to the object, support a notion of coarse-fine description, and admit to incremental refinement. Our model takes as its input local estimation of surface orientation obtained through shading and contour cues. At each successive frame, new information is integrated into the model, and the description refined further. Ultimately, after a sequence of views, the description is sufficiently precise for higher level interpretation.

We intend to apply this research in two areas: robotics applications where the camera is in motion about an object, and in biomedical analysis of cells undergoing motion in 3D. At present, investigations have been concluded on the single-view surface model. Our present efforts are directed towards the interframe correspondence problem and the ultimate

representation of shape from a global viewpoint.

F. Ferrie, M. D. Levine

An Expert System for Scene Interpretation

The objective of a computer vision system is the achievement of a correct and consistent interpretation of an image. By interpretation we mean in the sense of a description of the given picture or scene, i.e. "seeing and naming". Previous research at this laboratory has been directed towards such a system but as two disjoint systems, the substitute for the lost sense of vision. The desired abilities low level segmentation process and the high level interpretation. Currently, our research is concerned with the development of an integrated system with top-down feedback.

A modular computer vision system of this nature is presently under implementation. A rule-based low level image segmentation system was designed and has been implemented by A. Nazif as a production system. This production system employs a fuzzy decision-making paradigm to set both the processing strategy and the data selection strategies. The basis for this dynamic mechanism is a number of performance parameters that are designed to measure the qualify of the segmentation at any instant. This system, re-implemented in the production language, OPS5, comprises the low level processing stage of this computer vision expert.

As a modular entity, the high level processing stage will employ a cooperative and competitive strategy to achieve labeling consistency. We are particularly interested in the initial inferences made about the possible labelings of regions in the image base upon integration of several bodies of evidence and its sensitivity to the relaxation process. The success of the high level interpretation is obviously dependent upon the resulting segmentation. Subsequently, a facility is necessary to provide for the refinement, coarsening or correction of the segmentation based on the interpretation. Such a mechanism employing fuzzy reasoning about the combined evidence from the low level segmentation and high level interpretation is proposed. Several issues are involved in the development of such an "expert system". Foremost is the representation of a computer vision system as an expert. The central issues from the artificial intelligence perspective are those concerning the creation and management of a knowledge base, the utilization of inexact or plausible reasoning schemes as inference mechanisms and the encoding, organization and use of strategies.

W. Hong, M. D. Levine

RESEARCH PROJECTS: ROBOTICS

A Robot Facility

A robot laboratory is being developed for experimenting with inspection, assembly and repair tasks. The primary application area is related to hybrid circuits. A local area ETHER network is being created to achieve the communication between the supervisor, robot and sensory computers. These are the VAX 11/780 presently in the Computer Vision and Robotics Laboratory, and two additional VAX 11/750's, respectively. A PUMA 260 robot is available, and the purchase of a second industrial robot is under consideration. Also available are such devices as a computer controlled microscope, frame grabber and display, and array cameras. An integrated robot workstation is being designed.

P. R. Belanger, D. Chau, M. D. Levine, A. S. Malowany, P. Parent, K. Sung, and S. W. Zucker

Manipulator Control Along a Trajectory

We are developing a theory of manipulator control using acceleration feedback. It turns out that such fedback, with reasonably high gain, cam "swamp out" nonlinearities. The theory is done for a single-joint paradigm, and is being extended to the multi-joint case. The problem of acceleration and velocity estimation from shaft encoder measurements remains to be solved.

P. R. Belanger, J. Studenny

Use of Force Measurements for Position Estimates

Force measurements can be viewed as position- and torque input-dependent quantities. As such, they can be incorporated in an estimation algorithm. The arm dynamics are linearized about the operating point, but the contact surface is not linearized. An extended Kalman filter is to be used to obtain position estimates.

P. R. Belanger, M. Blauer

A Control Interface for the PUMA 60

The lack of an appropriate interface seems to be the bane of most control people in robotics. Two tasks are necessary: 1) reading the joint angles and 2) setting the joint torques. These two tasks must be performed whenever commanded. Given the seemingly inextricable coupling between the microprocessors and the interface, it appears necessary to build a separate interface, where 1) counter outputs are available on demand and 2) the set point to the motor current loop can be altered at will.

P. Belanger

Manipulator Simulation

It is essential for control studies that a dynamic simulator of the manipulator be available. Given the literature, the writing of a simulation program appears to be relatively straightforward. It would be desirable to have a graphics display showing a "stick form" manipulator motion.

P. R. Belanger

Manipulator Parameter Identification

It is often difficult to measure such basic parameters as moments of inertia without taking the arm apart. Friction is even more difficult, because it is position dependent. It is proposed to use parameter identification techniques to estimate manipulator parameters. By physically immobilizing all joints but one, the motion of the remaining joint can be described as a second-order system with friction, and is amenable to standard least-squares techniques.

P. R. Belanger

A Visual Inspection System for Hybrid Circuits

The design of a rule-based system for the inspection of hybrid circuits during different stages of manufacturing is proposed. The tasks to be performed include the visual inspection of the substrate, conductors, dielectric layers, resistivities, and overglaze layers, as well as the verification of the presence and position of discrete components. In order to make the system efficient, different algorithms are proposed for each particular inspection

problem. For example, in some cases it is efficient to use the existing model of a particular part of the circuit in order to perform the inspection, whereas in other cases it is more effective to have symbolic descriptions of the probable defects. The approach is to design as a general inspection system which will be able to handle different kinds of circuits as well as hybrids, by expanding the data base and the number of rules.

R. T. Carnegie (Northern-Telecom), C. J. Eskenazi, M. D. Levine, B. Prasada (BNR)

Component Verification for Hybrid Circuit Boards

A major aspect in the assembly of hybrid circuits is the placement of discrete components. Clearly, it is important that the correct component be used and that it be placed at the proper orientation. Computer vision is being employed to accomplish this task, which is made difficult by the complex geometry patterns appearing underneath the components on the circuit board.

R. T. Carnegie (Northern-Telecom), M. D. Levine, B. Prasada (BNR), K. Sung

Visual Inspection of Solder Joints

Inspection of all of the solder joints is an important aspect in the assembly of hybrid circuits. This project is concerned with developing a computer vision system for examining the quality of solder joints and deciding whether or not they are defective. If it is found that a solder weld is bad, e.g. incorrect shape, poor wetting, cold joint, not enough solder on the joint, cracks, etc., the circuit would be handed over to a robot so that repairs could be effected. Joint acceptability is based on comparing the specular reflection patterns for specific types of solder connections. In many cases, because of the position of the discrete components, these can only be viewed at specific angles. Therefore, a PUMA 260 robot is being used to present the hybrid circuit for viewing by the microscope and computer-controlled solid state television camera. Experiments with the system are underway.

M. D. Levine, P. Merrill, R. Raby (Digital Equipment)

Repair of Hybrid Circuits Using Robots

After a hybrid circuit is visually inspected, the defects that are found are usually repaired manually. This project is examining the feasibility of employing a PUMA 260 robot to perform such tasks as soldering and desoldering. Various kinds of sensory information will be reuired as feedback signals for the controlling program. This type of repair must be done whle viewing the circuit under magnification.

D. Chau, M. D. Levine, J. Lloyd, A. S. Malowany, K. Sung

Intelligent Robot Control for Hybrid Circuit Assembly and Repair

A central issue in robotics involves the design of an appropriate control hierarchy, particularly when the robot has access to visual feedback. The robotics research currently being undertaken by this laboratory will consider the issue of enabling a robot manipulator to perform simple repair operations on hybrid electronic circuits. One of the objectives of this research will be to devise a system which is capable of receiving a high level request [such as (REMOVE ITEM CIRCUIT-BOARD)] and outputting an appropriate sequence of low level robot commands which will allow the robot to carry out the desired task. In formulating the sequence of low level commands, attention will have to be directed in general to the context of the request and specifically to visual feedback as the request is carried out.

D. Chau, J. Lloyd, M. D. Levine

A Computer Vision System with Color For a Robot Workstation Facility

This project involves the design of a television color camera frame grabber system to realize a vision system for the robot workstation facility. Its architecture is selected to integrate a high performance microprocessor to obtain real-time performance for the envisaged image processing algorithms

W. Chong, A. Gauthier, Y. Boudreault, A. Malowany

Real-Time Operating Systems for a Robot Facility with Computer Vision

A robot workstation facility is being developed for the assembly, inspection and repair of hybrid integrated circuit components. It incorporates a PUMA 260 robot, translation and rotation stages, soldering peripherals, and a computer vision system based on a color frame grabber with a high performance microprocessor. This project addresses the operating system requirements and its implementation.

M. Hazan, D. Kossman, A. S. Malowany

Networking a Multiprocessor Robotic System

This project addresses the networking requirements for the multiprocessors of the robot workstation facility previously described. The essential characteristics for this design are bandwidth, reliability and recovery procedures suitable for an industrial environment.

F. Stella, A. S. Malowany

Recognition of Three-Dimensional Objects

One of the most important problems in robotic vision is the identification of objects in three dimensions. The shape of a solid object can be characterized by its outline and shading pattern, often from only one view. If the problem is further constrained to a class of objects in which the recognition task becomes one of differentiation, it becomes possible to label objects as functions of their intrinsic properties.

Our approach here is to characterize objects based on properties of their differential geometry, which are often inferable from shading and occluding contour. This appears to be particularly well-suited to robotics applications as the wide range of shapes encountered can be easily accomodated at a fundamental level. We are presently adapting the results of related research to the development of algorithms for this purpose.

F. Ferrie, M. D. Levine

Toward a Complexity Theory of Path Planning Problems

The search for a path connecting an initial point with a (set of) final points is known as the path planning problem (PPP). The structure of a path planning problem is dependent on *a priori* constraints on the path and on the environment. Because of the complexity of the general problem, global solutions are expensive and uninformative, and have inspired most researchers to concentrate on sub-problems in which different aspects of the environment are highly constrained. For example, many have concentrated on the problem of finding paths through static, two-dimensional worlds, and have discovered algorithms that are global and efficient.

The principal criticism of the static, 2-dimensional prolem is that solutions to it do not generalize to fuller versions of PPP. This project is an attempt to approach PPP from the other direction - to consider the full problem of computing paths through 3-dimensional,

time-varying environments. Our goal is to develop a computational theory of the complexity of specialized PPP's on highlighting the issues around (i) local/global perspectives on the environment; (ii) how much computational effort should be expended; and (iii) on which aspects of the problem should the computations be concentrated. Clearly they are all inter-related. This perspective on PPP suggests different sub-problems than those that have already been addressed, and resuls have been obtained to date on 1-dimensional (parameterized) paths through time varying environments. While this problem has much in common with the static, 2-dimensional problem, it permits formal statements with regard to issues (i) - (iii) above.

K. Gupta, S. W. Zucker

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University of Waterloo
Computer Graphics Laboratory

Fall 1983 Review CS-83-33

Research in the Lab is primarily centered on the modeling of sculpted surfaces, interaction techniques, hardware for scan conversion and anti-aliasing, visible surface computation, illumination models and programming methodology. Most of the students involved are pursuing a masters or a doctorate in computer graphics in conjunction with faculty research.

Laboratory Hardware

The principal graphics display, purchased in 1979 with funds provided by an NSERC equipment grant, is an Adage/Ikonas raster display system. The Ikonas consists of a 512 x 512 by 32-bit deep frame buffer feeding parallel 256-word red, green and blue colour maps via a 35-bit-in/34-bit-out cross bar switch, a high speed (200 ns) bit-slice microprocessor, micro-programmable matrix multiplication board, Motorola 68000 "multifunction peripheral controller", and real-time colour frame grabber. Microprograms may be written in assembly code or a subset of the C-language which allows the programmer to drop into assembly language to code time-critical inner loops. Host support is provided by a device driver for the C implementation of the CS 688 graphics package used in the Lab, and by a suite of special purpose commands.

Our second major piece of graphics hardware is an Evans & Sutherland Multi Picture System, funded in 1982 by an NSERC strategic equipment grant. The MPS is a refresh vector display with transformation and clipping hardware, and equipped with a tablet, joystick, light pen, knobs and a function box. For many applications, such as surface modeling, the MPS is more appropriate for the highly interactive design of (wire-frame) images, which can then be rendered more slowly as solidly shaded objects on the Ikonas. Host support is provided by a graphics package for the E&S Picture System 2 which was installed and modified for the MPS.

Our primary computer ("watcgl)", to which both the Ikonas and the MPS are connected, is a VAX 11/780 with eight megabytes of memory, two 256-megabyte removable disks, three 67-megabyte removable disks, and a triple density high speed tape drive. The VAX is connected to both the Gandalf and Sytek campus communication networks, and is also accessible via three 1200 baud dial-up ports. The VAX runs Berkeley Unix and is used solely for research in computer graphics. It was purchased in 1982 with funds provided by an Ontario BILD grant to replace our PDP 11/45 and upgrade our original Ikonas RDS 2000 display to an RDS 3000.

The Ikonas is also interfaced to a Honeywell Level 6 minicomputer which we share with the Software Development Group. The Level 6 runs an operating system called Thoth, which was developed by the University of Waterloo Software Portability Group and is of particular interest because it encourages the use of multiple processes and message passing. By mid-1984 we expect to have moved the work currently being done on the Level 6 to the Motorola 68000 attached to our Ikonas; we are now in the process of installing a similar operating system (Harmony).

Other graphics equipment available in the Laboratory includes:

- several Summagraphics Bit-Pad 5 Pressure Pen Tablets;
- a GTCO Digi Pad 5 Pressure Pen Tablet;
- several optical mice;
- an intelligent trackball
- an HP 7221C 8-pen plotter;
- a Dunn 631 colour camera
- two Sony 3/4" video tape recorders and editor;
- three HP 268A graphics terminals;
- a Keynote Designs KD404 graphics terminal;
- two Electrohome Telidon terminals.

We will shortly be acquiring an IBM PC-XT, equipped with a Winchester disk, digital mouse, and network interface. It will run an operating system called Port developed by the Software Portability Group.

Surface Modeling and Computer Aided Design

Surface modeling with splines is a major interest. Activity has centered on the use of B-splines and on the development of new Beta-spline techniques for computer aided design applications.

B-splines were introduced to computer graphics by Gordon and Riesenfeld in the mid-1970's. They provide a flexible and powerful means of smoothly assembling freeform parametric curves and surfaces from many polynomial "curve segments" or "surface patchs", and are a substantial improvement over the techniques introduced earlier. Unfortunately much of this power is often unused in computer graphics because the literature in B-spline mathematics is generally directed at numerical analysts and not at the general computer scientist; one of our obectives has been to make this material more readily accessible.

The Beta-spline curves and surfaces introduced recently are a generalization of the uniform cubic B-splines in which "geometric continuity" is enforced at the juncture of segments and patches, instead of the parametric continuity which is required of B-splines. More flexible and intuitive control of curve and surface shape results.

Spline Mathematics

Both the B-spline and Beta-spline approaches provide means of defining curve or surface as an approximation to a set of *control vertices* which the user specifies; movement of a control vertex changes the curve. The basic Beta-spline approach provides two additional global tension parameters (called β_1 and β_2) with which shape may be controlled. In the work referred to above, a technique was introduced for specifying distinct values of the shape parameters at each curve or surface joint in such a way as to retain geometric continuity while providing local control of tension.

A comprehensive treatment of all of the above material, together with a careful introduction to the mathematics of B-splines and Beta-splines (including a development of the "Oslo Algorithm" for control polygon/graph refinement) is provided by [Bartels 83a].

In addition to the results mentioned above, we have obtained a "divided difference" definition of the (cubic) Beta-splines which provides an alternative means of specifying distinct β values at each joint, and allows the parametric intervals corresponding to curve segments or surface patches to be of different lengths (*nonuniform knot spacing*). This definition of the Beta-splines is analogous to the traditional divided difference definition of the B-splines. A brief description appeared in [Bartels 83b]. A more detailed treatment is in preparation.

Spline Software

We have been pursuing software implementation of this material in parallel with the mathematical analyses. Software for the rendering of B-spline and Beta-spline curves and surfaces was integrated into our standard Ikonas software. Interactive tools have been designed for experimenting with various spline techniques on our Multi Picture System, including a package of routines for interfacing to the MPS.

Complementary work on rendering is being pursued. Illumination models are being studied in conjunction with the use of a ray-tracing algorithm for visible surface computation (see Figures 2, 3 and 4 in [Bartels 83c]). The primitive objects available are polygons, spheres, cylinders, fractal triangles and spline surfaces (rendered by subdivision). Objects are grouped (and in the case of splines, subdivided) into nested bounding boxes - if a ray misses the box, then it isn't tested against its contents. Diffuse, Phong, and Cook-Torrance shading models are available. Arbitrary images can be texture mapped onto polygons and spline surfaces. Software is used to construct surfaces of revolution and extrusion. In the former case, the user may interactively specify a profile and a cross section - as the profile is rotated it is scaled (with respect to its distance from the axis of rotation) by the cross section. For surfaces of extrusion a cross section is swept along an arbitrary path. The usual shading rules are available, including a Cook-Torrance module.

In parallel an entirely different approach is being taken, this software least-squares fits a multinomial surface to a set of points provided by the user. Recurrence relations based on orthogonal multinomials make it possible to construct these surfaces quickly and efficiently. Since parametric multinomials are actually being used, it is necessary to fix upon a parametric coordinate system (cylindrical, the unit square, etc.) and to associate particular values of the independent parameters u and v with each data point. Techniques from statistical pattern recognition are used to accomplish this task.

Benesh Dance Notation

For two years now we have been working to develop an interactive editor for Benesh Dance Notation. Curiously, satisfactory written languages for recording movement have been developed only in this century; it is a sad fact that much dance history has been lost because it was recorded nowhere but in the minds of the choreographer and

dancers. A difficulty both with Benesh and with Laban (the other commonly used notation) lies in the volume of data involved and the difficulty of editing and printing a score.

The Benesh editor is the prototype of a system which we would eventually like to install at the National Ballet of Canada in Toronto (see Figures 7 and 8 in [Bartels 83c]). Although our prototype runs on a VAX and generates output for our Ikonas display, we expect that it will soon be economically reasonable to implement our editor on a suitable workstation. We have applied to SSHRC for funds with which to study and extend our prototype, and to design such a workstation editor after having reviewed further usage of our editor by practising choreologists. With respect to a workstation environment, we are exploring the feasibility of using an IBM PC-XT based system and the Port operating system developed by the University of Waterloo Software Portability Group.

Colour

Because most of our work involves the use of a colour display, we have become interested in colour technology, the psychophysics of vision, the psychological aspects of colour usage, and in colour aesthetics. On the one hand we would like to apply knowledge from other fields to man-machine interaction problems; at the same time raster equipment offers an opportunity to conduct experiments which psychologists have heretofore found difficult to perform.

Results of our early studies have appeared in [Goetz 82a, Beatty 83a]. These represent an effort on our part to disseminate elementary information about the perception and use of colour which is not well known in the graphics community but is of great utility in using the low and medium cost colour displays and film recorders becoming widely available.

It is a remarkable fact that a number of seemingly elementary questions regarding colour are still open. One such question is simply "what is the best way of selecting a colour?" We are studying two aspects of this question.

It is well known that there are three degrees of freedom in specifying a colour; the range of all possible colours is appropriately represented by a volume in three space. We would like to know what set of axes are easiest to work with; red-green-blue and hue-saturation-value axes are the most common in computer graphics, and industry most often uses one of the CIE systems (XYZ, LAB or LUV), whereas commercial television uses the NTSC YIQ representation. Given any set of axes, we would also like to know what interaction technique is most easily used to alter coordinate values so as to select a colour.

We are therefore conducting a series of colour matching experiments in order to determine which of several coordinate systems and interaction techniques are most easily learned and used. Results from the first series of experiments will be used to guide further studies in which additional input devices, interaction techniques, coordinate systems and matching tasks will be examined.

Documentation Graphics

A major application of interest to us is that of "documentation graphics", in which one mixes text and graphics to produce visuals for oral presentation or illustrations for technical documents.

There are a variety of sources from which such graphic images may be obtained: digitized photographs; the graphical output from application programs; graphics languages; and interactive software systems for picture manipulation. We have chosen of late to concentrate our efforts on the interactive creation of images. The *Paint System* implemented

in the Computer Graphics Laboratory has provided a vehicle for the exploration of programming methodologies and user-interfacing techniques, in addition to yielding experience with picture creation *per se* [Plebon 82a, Beach 82a].

A Paint picture consists of an array (the *frame buffer*) of coloured picture elements (*pixels*) which are displayed on a colour monitor. A pointing device (a *graphics tablet* and *puck*) is used to locate a "paint brush" (an iconic *tracker*) on the monitor. When a button on the puck is depressed, Paint modifies image pixels with the current brush pattern. Several painting techniques have been implemented: copies of the brush may be rubber stamped; the brush pattern may be inked along the path traced by the tracker as the puck is moved across the tablet; the effect of an air brush can be produced by tinting pixels in a varied pattern about the brush.

Movement of the tracker can be constrained, say to horizontal or vertical lines, to obtain the "ruled" images more often needed in technical illustrations (Figure 9 [Bartels 83c]), or freehand images may be sketched (Figure 10 [Bartels 83c]). Paint is used by members of the Laboratory and others as a production facility for the preparation of 35mm slides, subject to availability of the Honeywell Level 6 on which Paint runs and contention for the Ikonas display. We have also arranged for various local artists to experiment with Paint, and we run an annual "Paint Content" to get "novice-user-feedback". Finally, a subset of Paint was implemented on the Port Workstations by members of the Software Portability Group, in consultation with Darlene Plebon.

As useful as Paint is, it nonetheless has limitations. A Paint image is simply an array of pixels; Paint has no structural knowledge about the contents of an image. Our next objective is to make it possible for the user to work with a hierarchical object structure describing the image in front of him. In addition to facilitating image manipulation, such a structure is preferable when imbedding images in documents or transmitting them across low speed lines.

Another member of the Laboratory is studying graphical style to develop a means of abstracting the graphical attributes of images so that they can be instantiated appropriately and automatically in a variety of media. This is analogous to the way in which text processing systems abstract such notions as title, author, section heading, paragraph, or journal reference and automatically generate typeset copy appropriate for a particular journal and output device. Of equal importance is the goal of obtaining consistently composed graphical images embodying the principles of good design followed by graphics designers and artists by emedding such "style rules" in a typesetting system. Yet another subject of great interest is the question of how best to implement automatic page layout of documents mixing graphics and text, and how interactive layout directives might interact with automatic layout to improve the result.

Firmware

The user of a vector display is manipulating lines, which can be done quite rapidly, while the user of a raster display is generally modifying areas on the screen. Performing these computations on a host computer and communicating new intensity values for tens or hundreds of thousands of pixels is a lengthy process. It is for this reason that one often arranges for special hardware, or a separate high-speed cpu like the Ikonas bit-slice micro-processor, to have direct access to the frame buffer.

The Ikonas Bit-slice

Using the Ikonas bit-slice effectively requires substantial effort since the architecture is highly parallel and computation is controlled by 64-bit-wide micro-instructions of considerable complexity. To facilitate debugging of bit-slice code, a simulator was provided

for the Ikonas micro-processor so that programmers can debug their code interactively in a totally controlled environment before moving code to the micro-processor itself.

Using the simulator, a firmware display processor was implemented on the micro. Nested segments, picking, highlighting and dragging (using the writemask and autoclear features of the image memory and frame buffer controller, respectively) are available. The basic primitives are lines (which may be anti-aliased), rectangles and triangles. A host interface to the display processor triangulates arbitrary convex polygons, which may be constant, Gourard or Phong shaded. This package has been used in a number of other projects, including the Benesh editor, VLSI editor, and two spline manipulation packages.

This work was substantially complete before the Lab acquired a matrix board for the Ikonas, and so the display processor does not provide for embedded transformations. We are considering other modifications, including the use of high precision coordinates to facilitate anti-aliasing and the anti-aliasing of triangles. Because the matrix board is actually a programmable micro-processor and is suitable for subdivision and forward differencing, we plan to add spline primitives to the display processor as well.

Since writing correct micro-programs is a tedious and error-prone activity, a compiler was implemented which translates a subset of C into micro-code for the bit-slice. The notion is that initialization code can be written in a higher level language so that the micro-programmer can concentrate on directly micro-coding the inner loops of an algorithm, if that is necessary. (The portions of our Paint program which were moved to the bit-slice for reasons of speed did not need such hand optimization.)

More recently, the compiler was retargeted for the bit-slice in a M68000-based workstation designed by Electrohome. Also, a completely new assembler was written for the Ikonas bit-slice which is an order of magnitude faster than the assembler supplied by Adage/Ikonas.

The CGL Trackball

Our experience with various tablets and "mice" has let us to conclude that the vendors of graphics input equipment have not taken full advantage of the flexibility to be had from the micro-processors commonly embedded in such devices. A comparative study was done of several input devices and then a more intelligent trackball/dial/button asssembly was designed, built and programmed.

Its communications protocol is designed for easy use, and it may be configured to report trackball or dial changes at fixed intervals, whenever a change exceeds a specified threshold, or when either a specified time has elapsed or a specified threshold movement has occurred. If desired, data may be queued within the trackball to avoid data loss due to most overload conditions. The trackball is now undergoing user testing and a paper describing its design is in preparation.

Scan Conversion and Anti-Aliasing

A particular interest has been the design and analysis of fast algorithms for rendering anti-aliased lines, circles, rings, ellipses, and triangles [Field 82a, Field 82b, Field 83a, Field 83b]. A characteristic of the algorithms developed is that they do not use floating point, multiplication, or table lookup operations within their inner loops. Thus they are ideal for hardware or firmware implementation. Figure 11 [Bartels 83c] illustrates the differences between several bilevel (not anti-aliased) and anti-aliased objects rendered by algorithms developed. (Figure 12 [Bartels 83c] illustrates the anti-aliasing of text.)

A VLSI circuit is being designed to implement a bilevel line algorithm, which will form the controlling logic for a circuit to draw anti-aliased lines. It is expected that plot

times of less than 200 ns per pixel will be achieved. A major component of the bilevel circuit has been sent for fabrication (Figure 13 [Bartels 83c]); testing should begin with the next few months.

Preliminary work on a second bilevel algorithm indicates that hardware implementation will achieve point plot times of less than 30 ns. Further work in this area will concentrate on the design and analysis of scan conversion algorithms for other primitive geometric objects and their eventual implementation. The Ikonas 3000 provides a convenient environment in which these algorithms (and the circuit mentioned in the preceding paragraph) can be tested.

A major goal of this research is to obtain viable alternatives to traditional scan-line-ordered image generation. The scan conversion techniques we develop will relieve much of the burden on the host machine. A consequence of this approach is that algorithms in the graphics pipeline, such as hidden surface analysis and shading, must now operate at the level of primitive objects. We are studying the applicability of techniques recently developed in the field of computational geometry for solutions to this problem.

The Tektronix Geometry Processor

The Geometry Processor is a high performance TTL micro-processor whose hardware and firmware have been designed to rapidly perform the matrix computations commonly needed in two and three dimensional graphics. The GP was designed and built by Tektronix, Inc.

Tektronix has given this hardware to the Computer Graphics Laboratory. The software, which was written for an older version of Unix running on a PDP 11/44, is being moved to our VAX. We are interfacing the GP to the VAX Unibus and to the Ikonas internal bus so that we can use the Ikonas bit-slice to scan convert polygons which have been transformed and clipped by the GP. The GP's firmware will be augmented with macro-instructions for subdividing B-spline and Beta-spline surfaces to form polygonal approximations which will then be scan converted by the Ikonas bit-slice. Eventually the Ikonas microprocessor will be augmented by custom scan conversion hardware.

Computer Animation

The Laboratory's work in animation is being pursued jointly with the French Animation Studio at the National Film Board. Techniques for improving the computer-based animation are being explored. The concentration is most heavily on the problem of smooth inbetweening for keyframe animation. A technique is being developed and implemented in which Hermite interpolation is used to smooth both the path followed by an animated object, and changes in its velocity. In a later generalization of this technique, intuitively simple ideas of curve bias, tension and "continuity" are translated into the tangent vectors from which Hermite interpolating curves are computed, further simplifying the process of inbetweening. The combined use of vector and raster graphics are also being experimented with, using a bi-pack camera, to eliminate rastering in computer generated animation.

The NFB is in the process of acquiring a computer to support further animation work. Related work on multi-plane animation is being done. At present tools for the manipulation of raster images are being implemented. These tools will enable rotation, skewing, or re-projection of raster images through an anti-aliasing filter and back into the frame buffer. Among other things, digitized or synthetic texture patterns can be mapped onto arbitrary digital cells of an animation frame (Figure 14 [Bartels 83c]).

Other Research Areas

Interactive Seating Layout

A tool for the interactive design of seating plans for theatres and auditoriums is being developed. Such design has previously been done in a strictly *ad hoc* way. Software that will allow the specification of a probability distribution for the height of viewers is being developed to interactively evaluate and modify a seating layout. The user will be able to: determine the probability that the stage will be visible from a given seat; given a height for the back row, establish a seating contour which yields a constant probability that the stage will be visible from every seat; maximize the probability of the stage being visible given a specified probability, size constraint or bias for some portion of the audience.

Interactive Graphical Graphics Debugging

An obvious area of application for the graphical interaction tehniques and ergonomic principles in which we are interested is the debugging of programs which embody these techniques and principles. By their very nature, graphics programs are likely to make use of complex linked data structures and list processing algorithms whose correctness is difficult to verify. Consequently we are exploring the design of interactive debugging systems specifically tailored for the graphics environment.

The goal is to design and implement a system, in a Pascal environment, for graphically displaying the dynamic behaviour of running programs. The immediate goal is to explore ways of visualizing program behaviour interactively. The long range motivation, of course, is to provide ourselves with a general purpose tool which we can use elsewhere in the Laboratory in developing graphics algorithms.

Interactive Stick Layout for VLSI

CGL facilities are being used to design an interactive program on our Ikonas for creating and editing bipolar VLSI circuits (Figure 15 [Bartels 83c]). The user manipulates a "stick" representation. Upon request the software will convert the stick representation to a mask layout; an algorithm is currently being designed for automatically compacting these masks, subject to specified design rules. The software makes extensive use of bit-slice firmware and the menu package.

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