IAPR

International Association for Pattern Recognition, Inc.
An affiliate member of the International Federation for Information Processing

NEWSLETTER

EDITOR'S COMMENTS

I am very pleased to accept the responsibility of being the IAPR Newsletter Editor. Both the Association and the Newsletter are relatively new arrivals and I would appreciate your assistance in providing suggestions and material to me. I view the Newsletter as a rather informal communication channel and am prepared to publish any pertinent information related to pattern recognition. Of course, the latter is to be interpreted in its most general sense. Although formal papers are not appropriate, short reviews and comments are indeed welcome. In particular, I would like to hear about the goings on around the world, from areas perhaps most of us do not know very much about.

During the coming academic year, I will be on Sabbatical at the Computer Science Department of the Hebrew University in Jerusalem, Israel. You may send items for publication either to me at:

Computer Science Department
Institute of Mathematics
The Hebrew University of Jerusalem
Givat Ram, Jerusalem
ISRAEL

or to Mr. Peter Sander at the McGill address shown above. In either case, please clearly mark your envelope with "IAPR Newsletter".

I will attempt to publish the next issue by next September.

Martin D Levine

M.D. Levine

IAPR NEWS

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3480 University Street
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D-8000
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Lorentzweg 1
2628 CJ Delft
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11 Linköping, Sweden

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Troy, N.Y. 12181
U.S.A.

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Physics Dept.
University of Hawaii Manoa
Honolulu, Hawaii 96822
U.S.A. Tel. (808) 737-1220 (home)

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Dept. of Applied Physics
Delft University of Technology
Lorentzweg 1, 2628 CJ Delft
The Netherlands
Telephone: 015 - 785390

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DK-2800 Lyngby
Denmark

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Berkeley, CA 94720
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After 1-7-1979:
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Princeton University
Princeton, N.J. 08540
U.S.A.

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6th IJCPR :   Tech. Universität München
8-Munchen 2, Arcisstr. 21
W-Germany
Telephone: 089-8383

NITPIC

..... Dr. Judith Prewitt of the National Insitute of Health in Bethesda has been appointed the Chairwoman of the IEEE Biomedical Pattern Recognition Subcommittee Task Force on Data Bases and Portable Software ..... A Federation of Image Analysis System Users [FIASU] is being organized by John T. Dalton, Code 933.1, NASA/Goddard Space Flight Center, Greenbelt, MD 20771, Tel. (301) 344-6276. The main purpose of the group is to promote the scientific application of image processing and remote sensing technology ..... Over 530 people registered for the 4th IJCPR in Kyoto, Japan last November. Of the 280 papers submitted, 211 were accepted for presentation ..... The University of Maryland and the Rensselaer Polytechnic Institute have jointed in a collaborative effort, funded by the National Science Foundation, to develop portable software for image processing applications. At the University of Maryland, the study is under the direction of Professors Richard G. Hamlet and Azriel Rosenfeld; at Rensselaer Polytechnic Institute, it is under the direction of Professor Herbert Freeman. Researchers with an interest in the project or having software they would like to have included in a general portable image processing package, are invited to contact any of these investigators ..... The Sixth Man-Computer Communications Conference, sponsored by the Canadian Man-Computer Communications Society and the National Research Council of Canada, was held in Ottawa, Canada on May 29-30, 1979 ..... The Fifth IJCPR will be held in Miami, U.S.A. and the 1982 Sixth IJCPR will take place in Münich, Germany ..... At the recent Workshop on Computer Analysis of Time-Varying Imagery, a need was expressed for a set of dynamic picture files to be made available to the research community for the purpose of experimentation ..... There will be a segmentation session at the 1979 Pattern Recognition and Image Processing Conference to be held in Chicago in August. If you want the standard image which will be used for papers in this session, contact Prof. Robert Haralick, Dept. of Electrical Engineering, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061 ..... Plans are afoot to organize a 1979 regional pattern recognition conference in Sweden .....

CONFERENCE REPORTS

PROCEEDINGS OF 4TH INTERNATIONAL JOINT CONFERENCE ON PATTERN RECOGNITION

The Proceedings of the 4th International Joint Conference on Pattern Recognition have been reprinted by the IEEE Computer Society. The conference was held in Kyoto, Japan, 7-10 November 1978. Some 200 papers were presented, covering virtually every aspect of pattern recognition and ranging from the theoretical to the applied. To obtain a copy of the proceedings, write to IEEE Computer Society, P.O. Box 639, Silver Spring, Maryland 20901, U.S.A. The cost is U.S. $40 per copy. (U.S. $30 for IEEE Computer Society members).

WORKSHOP ON REPRESENTATION OF THREE-DIMENSIONAL OBJECTS

A workshop on the representation of three-dimensional objects, sponsored by the U.S. National Science Foundation, was held at the University of Pennsylvania during 1-2 May 1979. Organizer of the workshop was Professor Ruzena Bajcsy. Some 25 papers were presented. The major topics covered were graphics, visual perception, theoretical issues of object representation, applications of 3D modelling, generalized cylinders, spherical representations, curves and folded surfaces, and relational objects representations. A proceedings containing most of the

papers was distributed. Copies may be obtained by writing to Mr. George Otto, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, PA 19104, U.S.A. Send U.S. $2.00 to cover postage for North America or surface mail to Europe; US$7.00, for airmail to Europe; elsewhere, write for quotation.

WORKSHOP ON COMPUTER ANALYSIS OF TIME-VARYING IMAGERY

A Workshop on Computer Analysis of Time-Varying Imagery was held in Philadelphia on April 4 and 5, 1979, sponsored by the IEEE Computer Society's Technical Committee on Machine Intelligence and Pattern Analysis and the Department of Computer and Information Science of the University of Pennsylvania. The Workshop brought together over 125 interested participants, almost 75 more than expected! Over 60 papers were presented, covering a wide spectrum of topics in change detection, object tracking, vector field segmentation methods, theory and control structures, movement representations, data compression and restoration, medical applications, non-medical applications, real-time image processing hardware, and interactive systems. The primary goal of the Workshop was to bring together researchers in moving image or multiple image analysis to present techniques, share results, and discuss future plans. From informal comments gathered at the Workshop, the participants felt it was a success, although rather cramped in terms of presentation and discussion time. Such seems to be the price of success, however, and all sessions were very well attended.

A summary of the Workshop is being prepared by General Chairman Norman Badler of the Computer and Information Science Department of the University of Pennsylvania and Program Chairman J.K. Aggarwal of the Department of Electrical Engineering at the University of Texas at Austin. It will appear as a preface to selected papers in a Special Issue of IEEE Transactions on Pattern Analysis and Machine Intelligence in early 1981. Copies of abstracts of papers presented at the Workshop are available for $9.00 (U.S.) each from WCATVI, c/o Dr. Norman Badler, Computer and Information Science, Moore School/D2, University of Pennsylvania, Philadelphia, PA 19104. Checks should be made payable to WCATVI.

WORKSHOP ON CONTROL STRUCTURES AND KNOWLEDGE REPRESENTATION IN IMAGE AND SPEECH UNDERSTANDING

held at the University of Maryland on April 3-4, 1979.

The purpose of this Workshop was to focus attention on problems of control and representation in the analysis of perceptual data. Approximately 60 people attended from both the image and speech understanding communities. The Workshop was organized by R. Reddy and A. Rosenfeld,

and sponsored by the National Science Foundation and the Office of Naval Research.

THE 78 EUROPEAN WORKSHOP ON AUTOMATED HUMAN CYTOGENETICS

On November 30 and December 1, 1978, the '78 European Workshop on Automated Human Cytogenetics took place in Lyngby, Copenhagen. The Workshop was sponsored by the European Community and organized by Drs. P.W. Becker and E. Granum. Complimentary copies of the Workshop "Proceedings" with resumes of all papers plus other pertinent information may be obtained on a first come first served basis by writing Dr. Peter W. Becker, Electronics Lab., DTH Bldg. 344, 2800 Lyngby, Denmark.

CONFERENCES AND WORKSHOPS

5TH INTERNATIONAL CONFERENCE ON PATTERN RECOGNITION

Miami Beach, Florida, December 1-4, 1980. Co-sponsored by IAPR and the IEEE Computer Society

CALL FOR PAPERS

Topics of Interest

Research papers on all aspects of pattern recognition are invited, including the following topics:

METHODOLOGIES: statistical, structural and syntactic methods, clustering techniques.

PREPROCESSING AND FEATURE EXTRACTION: Image enhancement and restoration, line drawings, waveform analysis, shape and texture analysis.

APPLICATIONS: character recognition, speech recognition, robot vision, medical and biomedical applications, scientific and industrial applications, remote sensing, applications in societal and environmental problems.

IMPLEMENTATIONS: digital systems, special processors, optical techniques, interactive systems, data structures, data bases, innovative computer architectures.

PAPER SUBMISSION: Four copies of a draft of the full-length paper should be submitted by April 1, 1980, to the Program Chairman: Professor Y.T. Chien, Dept. of EE & CS, U-157, University of Connecticut, Storrs, CT 06268, Tel: (203) 486-4825. A full paper will be either a long paper (about 6000 words) or a short paper (not more than 3000 words) which may include those reporting on last minute results. Each paper should contain a 200-word summary. A long paper will have about 25 minutes for presentation, and a short paper will have about 15 minutes. Authors should identify clearly their preference of either long or short at the top of their draft

papers. There will be the possibility of reducing a long paper to a short presentation according to the judgements of the reviewers. It is expected that long papers will be more thoroughly reviewed for acceptance and *most of the papers included in the program will be for short presentations.* All papers accepted for presentation will be included in the Conference Proceedings.

Authors will be notified concerning the acceptance of their papers by July 1, 1980, and will receive kits for typing their manuscripts. A camera-ready copy of the accepted paper should be returned to the publications chairman by Sept. 1, 1980. The official language of the conference and the proceedings is English.

For further information write to: 5-ICPR, P.O. Box 639, Silver Spring, MD 20901, U.S.A.

WORKING CONFERENCE ON PATTERN RECOGNITION IN PRACTICE

Areas	: biomedical applications geology meteorology remote sensing high energy physics interactive systems
Location	: Amsterdam
Date	: May 21-23, 1980
Number of Participants	: 60 - 80
Scope	: The working conference on Pattern Recognition in Practice will bring together researchers from such diverse areas as biomedical data processing, geology, meteorology possibly others to discuss the application of pattern recognition theory in practical situations. Many theoretical ideas have been advanced in the past. How to use these in practice is often less clear. Both the success and the problems encountered in such efforts are relevant topics to the conference theme. The conference will try to highlight the question hos interactive systems for pattern recognition can be used to help solve such problems and what the capabilities of such systems will have to be.
Conference Chairmen	: L.N. Kanal, Ph.D. E.S. Gelsema, Ph.D.
Conference Secretariat	: E.S. Gelsema, Ph.D. Free University, Medical Faculty Department of Medical Informatics v.d. Boechorstraat 7, Amsterdam The Netherlands telephone: 020 - 5483306

NATO ADVANCED STUDY INSTITUTE

MAP DATA PROCESSING
Maratea, Italy - 18-29 June 1979

A Nato Advanced Study Institute (ASI) on the subject of map data processing will be held in Maratea, Italy 18-29 June 1979. The objective of the ASI is to further the dissemination of knowledge in computer cartography and those areas of computer graphics, image processing, pattern recognition, and software engineering that impact on map data processing.

The ASI will consist of tutorial lectures and panel discussion sessions. Ample time will be provided for informal discussions among the participants. The lectures will cover both underlying principles and techniques as well as recent research results and applications. Major topics are:

* map data representation
* conversion of map data
* data structures for map data processing
* management of large map data bases
* algorithms for map data analysis
* software systems for map data processing
* applications involving geographic map data
* applications involving thematic map data
* applications involving biomedical map data

No registration fee is charged to accepted applicants. A limited number of NATO grants are available for partial travel support. Persons interested in participating should at once contact either of the ASI co-directors:

Professor H. Freeman
Computer Engineering Program
Rensselaer Polytechnic Institute
Troy, New York 12181
U.S.A.

Professor G.G. Pieroni
Dipartimento di Matematica
Università della Calabria
Roges di Rende, Cosenza 87030
Italy

IEEE COMPUTER SOCIETY CONFERENCE ON PATTERN RECOGNITION AND IMAGE PROCESSING

A three-day conference on PATTERN RECOGNITION AND IMAGE PROCESSING (PRIP '79) will be held at the Hyatt Regency, Chicago O'Hare, Monday through Wednesday, August 6-8, 1979. The conference is sponsored by the Machine Intelligence and Pattern Analysis Committee of the IEEE Computer Society. PRIP '79 occurs during "Chicago Computer Visualization" week (August 6-10, 1979). SIGGRAPH '79 will join us on August 8 and ACM SIGPC (Personal Computing '79) will join us on August 10. A large trade show of graphics and image processing equipment is planned.

The program will consist of submitted and invited papers. The program topics will include:

. Image Segmentation
. Image Filtering & Segmentation
. 2D and 3D Shape Analysis
. Color and Multispectral Image Analysis
. Statistical & Structural Pattern Recognition
. Pictorial Data Bases and Data Structures
. Special Purpose Image Processing Hardware
. Theoretical Issues of Representation and
    Recognition of 3D and 2D Imagery
. Clustering
. Machine and Human Vision
. Natural Language and Vision
. Texture Analysis
. Applications
    (remote sensing, Medical, Industrial,
    reference and others)

CONFERENCE COMMITTEE:

Robert M. Haralick - General Chairman

Technical Program Committee:
S.D. Shapiro, Co-Chairperson
R. Bajcsy, Co-Chairperson

L. Davis	F. Jelinkek
O. Faugera	J. Kulick
H. Freeman	H. Nagel
K.S. Fu	T. Pavlidis
J. Jarvis	A. Rosenfeld
A. Sawchuk	A. Tanimoto

BRITISH PATTERN RECOGNITION ASSOCIATION 1980 CONFERENCE ON PATTERN RECOGNITION

This is a call for contributions to the 1980 Conference on Pattern Recognition organised by the British Pattern Recognition Association. The conference will be held in Oxford, 9-11 January 1980, and aims to bring together researchers and practitioners to discuss the state of the art and directions for progress in pattern recognition. Broad U.K. participation is expected, but participants from other countries will be particularly welcome. Abstracts of papers, including survey papers, may be submitted; and the organisers will also gladly consider proposals for exhibits and posters. Topics include (but are not limited to)

pattern recognition theory (statistical and
    syntactic methods, clustering)
processing and recognition or speech and
    other waveforms
image and line drawing processing
applications of pattern recognition (bio-
    medical, industrial, social and physical
    sciences, remote sensing, etc.)
scene analysis
robotics
artificial intelligence
hardware and software systems

For contributed papers three copies of an abstract of 300-500 words, should be sent to: Dr. Josef Kittler, Nuclear Physics Laboratory, Keble Road, Oxford OX1 3RH, England, Tel: 0865-59911,

no later than 1 July 1979.

Full texts of papers should be submitted at the time of the conference. Selected papers will be published after the conference.

Anyone who wishes to contribute an exhibit, or poster, should also notify Dr. Kittler.

Enquiries can be addressed either to Dr. Kittler or to Dr. Frank Harris, both at the above address.

COURSES

FOURTH SUMMER COURSE

ON

STATISTICAL PATTERN RECOGNITION

10 - 14 SEPTEMBER 1979

CAMBRIDGE UNIVERSITY

PROGRAMME

The course will feature a selective survey of fundamental methods of statistical pattern recognition together with a detailed treatment of a number of advanced topics.

Several example classes will be aimed at familiarizing the participants with the material presented. The course will include two seminars on application of pattern recognition methods to specific problems in which a step by step description of the design of practical pattern recognition systems will be outlined. Ample time will be devoted to discussion of algorithmic and practical aspects of pattern recognition techniques.

LECTURERS

Pierre DEVIJVER, Philips Research Laboratory,
        Avenue Em. Van Becelaere 2,
        B-1170, Brussels, Belgium

Josef KITTLER, IBM Research Fellow, Image
        Analysis Group, Nuclear
        Physics Dept., Oxford
        University, Keble Road,
        Oxford, OX1 3RH.

REGISTRATION AND ADDITIONAL INFORMATION

Address registration forms and any inquiries to Mr. M.D.C. Dyne, Institute of Sound and Vibration Research, The University, Southampton SO9 5NH, England.

SHORT COURSE IN
AUTOMATIC VISUAL INSPECTION

WHERE   : The University of Southampton

WHEN   : September, 1979

ADDITIONAL
INFORMATION : Dr. Bruce G. Batchelor
               Department of Electronics
               The University
               Southampton, SO9 5NH
               England
               Tel: Southampton
                    0703 559122 Ext. 377/2495

SHORT COURSE IN
COMPUTER IMAGE PROCESSING

The principles of computer representation of images and computer image processing will be discussed in a five-day intensive course conducted at Rensselaer Polytechnic Institute during the period of August 13-17, 1979.

The course will introduce the participants to all major facets of computer image processing - mathematical techniques, computer algorithms, hardware systems, software systems, and application areas. Demonstrations will be given during a tour of RPI Image Processing Laboratories.

The course is of value to all engineers and computer scientists who are now using or intending to use computer image processing in their work. It will also be of interest to technical managers who wish to obtain an understanding of computer image processing and how it can be applied to a variety of applications involving the computer enhancement, compression, restoration, coding and interpretation of photographic images. Some of the relevant application areas are remote sensing of material resources from aerial and satellite images, map data processing, robot "vision" for automatic assembly, automatic inspection, and computerized tomography.

The course director is Professor Herbert Freeman of RPI. Other lecturers are Professors Lester Gerhardt (RPI), James Modestino (RPI), Azriel Rosenfeld (University of Maryland), and Henry Start (RPI).

The FEE is $495. For more information contact: Mr. Richard J. Teich, Office of Continuing Studies, Rensselaer Polytechnic Institute, Troy, New York 12181. Phone (518) 270-6442.

IFIP CONGRESS 80

IFIP Congress 80, the 8th World Computer Congress, is the next in a series of triennial meetings sponsored by the International Federation for Information Processing (IFIP). Representing the information processing interests of its 39 member countries, IFIP has held congresses in Paris, Munich, New York, Edinburgh, Ljubljana, Stockholm and Toronto. These have been major occasions for the world-wide exchange of information among developers and users of information processing techniques and technology.

The 8th World Computer Congress and Exhibition will be held at two locations: starting in Tokyo (Japan) from 6th-9th October, and continuing in Melbourne (Australia) from 14th-17th October 1980. The program will contain three types of sessions:

Invited Papers, relating to broad areas of information processing.

Submitted Papaers, reporting on significant current developments in information processing.

Panel Discussions, exploring the present state of the art and current trends and involving audience participation.

To assist authors a pamphlet entitled INSTRUCTIONS AND AIDS FOR AUTHORS has been prepared and individuals considering submitting a paper should write for a copy of the pamphlet to:

    Program Committee
    IFIP Foundation
    40, Paulus Potterstraat
    1071 DB Amsterdam
    The Netherlands.

IEEE COMPUTER SOCIETY TECHNICAL COMMITTEE ON MACHINE INTELLIGENCE AND PATTERN ANALYSIS

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Biomedical Pattern Recognition	- Jack Sklansky
Data Bases	- Judith Prewitt
Image Processing and Data Structures	- K. S. Fu
Pattern Recognition Techniques	- Theodosius Pavlidis
Speech Recognition and Understanding	- Stephen Levinson

AUTOMATIC IMAGERY PATTERN RECOGNITION COMMITTEE, ELECTRONIC INDUSTRIES ASSOCIATION

After almost ten years of varied activities to further the discipline of digital image processing, the Automatic Imagery Pattern Recognition (AIPR) Committee of the Electronic Industries Association is undergoing transformation. The AIPR has accepted an invitation to become a sub-committee of the Machine Intelligence and Pattern Analysis (MIPA) Technical Committee of the IEEE Computer Society. This subcommittee will retain its AIPR initials, but the name will change slightly to Applied Imagery Pattern Recognition, to reflect and emphasize the distinguishing characteristic of our program. The invitation was extended by Professor Herbert Freeman, Chairman of the MIPA Committee. Acceptance was voted unanimously by the AIPR at its business meeting at the Electronic Industries Association on November 27, 1978.

The AIPR intends to continue its traditional activities including publication of the Digital Image Processing Buyer's Guide; and the Directory of the Image Processing/Pattern Recognition Community; the sponsorship with federal agency co-sponsorship of annual symposia; the promulgation of standards related to digital image processing; the surveys of government requirements; and so forth. Expanded activities will include newsletters and improved coordination with the other MIPA subcommittees.

RESEARCH CENTERS

NEW IMAGE PROCESSING CENTER AT RPI

Rensselaer Polytechnic Institute has been awarded a major equipment grant by the National Science Foundation to help set up an image processing center. The new equipment to be installed consists of a PRIME 550 computer with 0.5 MB of ECC memory, two 80-MB disk drives, and a DeAnza 512 x 512 x 8 full-color image processing system. The PRIME computer will serve as the central computer for four separate image processing laboratories which will be interconnected by it. The PRIME in turn will be linked to the Institute's IBM 3033 computer. Total value of the new equipment is in excess of $250,000. The center will be under the direction of Professor Herbert Freeman. Participating will be Professors L. Gerhardt, J. Modestino, H. Stark and J. Woods, all of the Electrical and Systems Engineering Department.

SUSIE (SOUTHAMPTON UNIVERSITY SYSTEM FOR IMAGE EVALUATION)

- a system for the prototyping of automatic visual inspection and picture processing

SUSIE is an interactive computer system for analyzing images. These can be presented in a variety of forms, see below. SUSIE responds vivaciously within a second or so to simple mnemonic instructions typed on its keyboard. In minutes, an experienced user can explore a large picture-processing repertoire. If a feature of interest is clearly visible to the naked eye, then SUSIE will almost certainly be able to isolate it. Further analysis may then be performed in a satellite (Fortran) processor, also under the direction of the SUSIE user. Only personal experience reveals the full potential of an interactive system like SUSIE. It is important to note however that SUSIE is a sophisticated prototyping system for exploring various image analytic techniques.

For further details contact: Dr. B.G. Batchelor, The Wolfson Industrial Unit, Department of Electronics, The University, SOUTHAMPTON, SO9 5NH, U.K., Tel: 0703-559122.

BOOKS

PATTERN RECOGNITION IDEAS IN PRACTICE

Edited by BRUCE G. BATCHELOR
University of Southampton, England

How does man build a machine that can perform "human" functions? Pattern recognition - a product of our highly technological society - is a multifaceted discipline. It is devoted to the design of machines that can perform such tasks as responding to a verbal command, reading typed numerals, recognizing vehicles from aerial photographs, inspecting artifacts or natural products, and performing medical diagnoses. This provocative, highly instructional book focuses on the practical considerations, rather than the mathematical theory, involved in the process of pattern recognition, as well as its impact on such fields as electronics, optics, statistics, psychology and ergonomics, programming, and systems engineering. The latest innovations in methodology and technology are examined first, followed by special problems encountered in designing devices to serve in a wide variety of industrial and biomedical areas.

The book offers a self-contained, self-explanatory treatment of the subject, sufficiently technical for professional research and development workers, yet not too overwhelming for advanced undergraduate and postgraduate students. Research workers and engineers, as well as mathematicians dealing with the theoretical aspects of pattern recognition, will find it an excellent overview of this exciting area.

Plenum Publishing Corp.
502 pages, illus.   1978 $39.50

DIGITAL IMAGE PROCESSING

KENNETH R. CASTLEMAN
Jet Propulsion Laboratory
California Institute of Technology

Prentice-Hall Signal Processing Series,
Alan V. Oppenheim, ed.

July 1979 Copyright, approx. 432 pp. cloth
(21236-5) $25.00

The author constructs *both a theoretical and practical framework* for students by examining the rationale behind each technique, its applications, limitations, and performance. Theoretical developments are followed by real example applications, and specific examples instruct students in the proper use of the techniques.

As a self-teaching text for professionals in related fields, the book prepares the reader to use digital image processing as a *tool to solve real problems, create practical working systems,* and *assist in research projects.*

Because the text stresses an intuitive understanding of digital image processing as a tool rather than a mathematical discipline, the level of mathematical rigor is reasonably relaxed. In addition, the text includes a review of areas which some students may already be familiar with, but for others it provides important background material. These areas include - *relevant topics of Fourier Optics, Linear System Theory, Random Processes,* and *Signal Detection Theory.*

THESES, PAPERS & REPORTS

Allan, R.A., "Radar Target Recognition Using Low Frequency Resonance Techniques", Ph.D. Thesis, University of Southampton, Southampton, S09 5NH, 1979.

Haralick, Robert M., and Elliott, Gordon, "Increasing the Search Efficiency for Constraint Satisfaction Problems", Department of Electrical Engineering, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061, March 1979.

Abstract

In this paper we explore the number of consistency checks made by a tree search in order to solve binary constraint satisfaction problems. We show analytically and experimentally that the two principles of first trying the places most likely to fail and remembering what has been done to avoid repeating the same mistake twice improve the standard backtracking search. We experimentally show that a lookahead procedure called forward checking (to remember the future) which employs the most likely to fail principle performs better than standard backtracking, Ullman's, Waltz's, Mackworth's, and Haralick's discrete relaxation or Gaschnig's backmarking.

Shaheen, S.I., "Image Segmentation and Interpretation Using a Knowledge Database, Ph.D. Thesis, Department of Electrical Engineering, McGill University, Montreal, June 1979.

Ting, D., "Intermediate Level Processing for a Computer Vision System, M.Eng. Thesis, Department of Electrical Engineering, McGill University, March 1979.