AD-A278 488

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94 4 20 107

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE

3. REPORT TYPE AND DATES COVERED
Final Report 01 Jun 93 - 30 Sep 93

4. TITLE AND SUBTITLE
1993 Information Processing in Medical Imaging Meeting (IPMI)

5. FUNDING NUMBERS
F49620-93-1-0352

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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8. PERFORMING ORGANIZATION REPORT NUMBER
AFOSR-TR- 94 0193

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9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
AFOSR/NE
110 Duncan Avenue, Suite B115
Bolling AFB DC 2033280001

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
2305/DS

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release;
distribution unlimited.

UNLIMITED

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

A SYMPOSIUM WAS HELD

14. SUBJECT TERMS

DTIC QUALITY INSPECTED 3

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASS	UNCLASS	UNCLASS	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

Grant No. F49620-93-1-0352

AFOSR-TR- 94 0193

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Final Report of 1993 Information Processing in Medical Imaging Meeting

The 1993 Information Processing in Medical Imaging (IPMI) meeting was held June 14-18, 1993 on the campus of Northern Arizona University in Flagstaff Arizona. The conference chairman was Dr. Harrison H. Barrett, a Regents Professor in the Departments of Radiology, Optical Sciences, and Applied Mathematics at the University of Arizona. The conference co-chairman was Dr. Arthur F. Gmitro, an Associate Professor in the Departments of Radiology and Optical Sciences at the University of Arizona. Drs. Barrett and Gmitro were ably assisted in the organization of the meeting by Ms. Lynn Mascarela of the office of Continuing Medical Education at the University of Arizona, and by Ms. Jane Lockwood and Ms. Debbie Spargur of the Department of Radiology at the University of Arizona.

The meeting was held in the traditional workshop-style of IPMI with a limited number of participants and a single session of talks at any one time. There were thirty five oral presentations organized in nine sessions over the five day conference. Additionally, two sessions were devoted to the viewing and discussion of thirty two poster presentations. A copy of the conference program is included with this report. The talks were presented in the Cline Library theater, which provided an excellent environment for a meeting of this size. There were 114 participants who attended the meeting, 66 from the United States and 48 from other countries. A complete list of the conference attendees is included with this report. The attendees were housed together in the Mountain View dormitory on the University of Northern Arizona campus and dined together in the University cafeteria. This secluded and somewhat constrained environment was very successful in fostering scientific discussion, as well as providing an interesting, albeit sparse, setting for social interaction among the participants.

The thirty five oral presentations were selected from approximately one hundred submitted papers. Full papers were required six months prior to the meeting so that the accepted papers could be published in the proceedings. The proceedings of the meeting were published by Springer-Verlag as volume 687 of its Lecture Notes in Computer Science series. A copy of the proceedings is included with this report. Also included is a list of the poster presentations. These were also selected from the original submissions, but unfortunately, due to space limitations could not be included in the published proceedings.

One of the trademarks of IPMI meetings is an unwritten rule that each speaker is given as much time as needed to present his or her work and that the discussion following the presentation is never interrupted for any reason. Although this format makes for difficult scheduling and some overly long sessions, the atmosphere was, as typical of IPMI meetings, one of lively interchange and in-depth discussion.

There were three main scientific themes of the 1993 IPMI meeting. The first and most strongly debated topic had to do with how one extracts useful information regarding large-scale structures from images. A variety of techniques for identifying and/or segmenting significant structures contained within an image were presented. These

included deformable model-based matching methods, novel shape descriptors that capture the essential character of underlying structures, statistical pattern recognition methods, and neural network approaches. The second theme focused on obtaining better tomographic images through improved reconstruction methods. The new reconstruction methods were obtained by incorporating prior knowledge into the reconstruction process and/or by better understanding the data acquisition process. The final theme, which was discussed throughout the meeting, was one of methodologic evaluation. How does one know that the method one has developed is really doing what it intended to do. In the case of image reconstruction, this equates to the question of how does one show that the reconstructed images is really "better"? In the case of information extraction, it relates to showing that the extracted information is correct?

Although the emphasis of the meeting was clearly on medical imaging, the techniques and issues discussed were in many cases germane to almost any type of imaging. There is a strong cross fertilization of ideas arising in the context of medical imaging and other application areas. This was evident in the discussions at the meeting.

A goal of IPMI meetings is to encourage the participation of new young investigators. The 1993 meeting was particularly successful in this regard. Over half of the presentations were made by individuals eligible for the Francois Erbsmann Prize, which is awarded to the best presentation by a scientist under thirty five years of age who is making his or her first presentation at an IPMI meeting. The 1993 Francois Erbsmann Prize was awarded to Jeffery Fessler of the University of Michigan for his presentation "Tomographic Reconstruction Using Information-Weighted Spline Smoothing". This was an excellent presentation describing a method for incorporating a more accurate model of the statistical properties of the data into a noniterative tomographic reconstruction algorithm. This method promises to improve the reconstructed image quality in both emission tomography and transmission tomography.

In conclusion, the 1993 IPMI was extremely successful. It brought together an international group of distinguished researchers in a relaxed but highly focused atmosphere, where the latest ideas in the processing of medical imagery could be presented, dissected, criticized, and refined. It reinforced existing collaborative efforts and created many new ones. It encouraged new ideas and increased participation in the field by young investigators, and hopefully, it expanded the frontiers of knowledge in this exciting and ever evolving scientific discipline.

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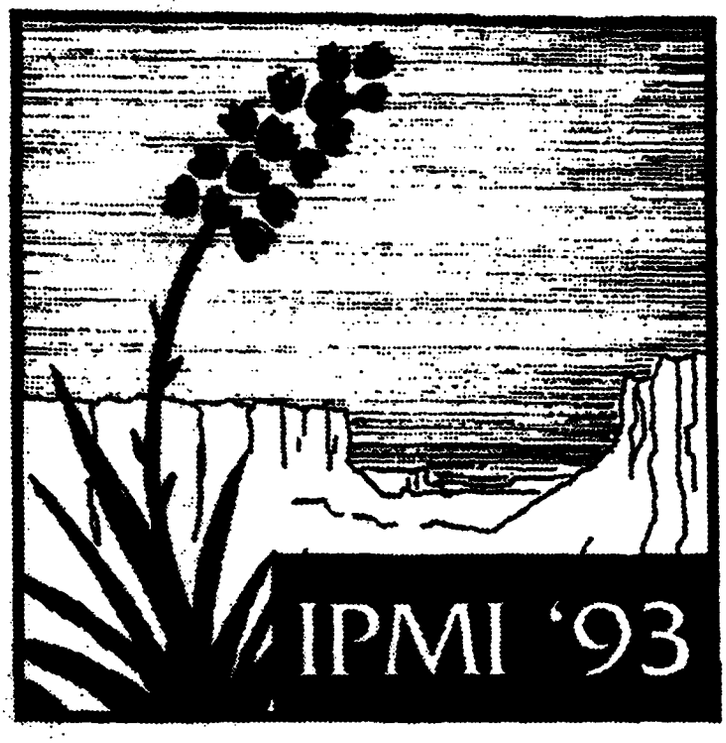
Arthur F. Gmitro

PROGRAM



XIIIth International Conference on Information Processing in Medical Imaging

June 14-18, 1993

Dubois Conference Center
Northern Arizona University
Flagstaff, Arizona

Conference Organizers:
Dr. Harrison H. Barrett *Dr. Arthur F. Gmitro*
Department of Radiology
University of Arizona College of Medicine
Tucson, Arizona

XIIIth INTERNATIONAL CONFERENCE ON
INFORMATION PROCESSING IN MEDICAL IMAGING

Welcome to the thirteenth IPMI. As attendees here in beautiful northern Arizona, you are part of a tradition extending back to the early days of digital imaging. This conference holds a special place in the hearts of many longtime IPMI-goers. No other conference in our field can provide the spirited interactions and the stimulation that occur regularly at this one. To the IPMI veterans, we say welcome back, and thanks for continuing to make our conference the unique event it is. To first-time attendees, we extend a special welcome and an invitation to join the fray, to contribute your insights and criticisms of the ideas offered here. Let's all join in the give and take that lend vitality and excitement to our endeavors.

The conference staff, listed on the next page, joins with us in offering to assist you in any way in making your stay more enjoyable and productive.

Harry Barrett

Art Gmitro

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ACKNOWLEDGEMENTS

The organizers of this conference gratefully acknowledge the financial support of:

National Institutes of Health, Clinical Center

National Institutes of Health, Div. of Computer Research and Technology

U. S. Air Force Office of Scientific Research

U. S. Air Force Phillips Laboratory

We are also very appreciative of the following companies who provided support for speakers at the conference:

Kodak Research Laboratories

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IPMI XIII

Monday, June 14

8:00 **Welcome and conference overview**
Harry Barrett and Art Gmitro, Univ. of Arizona

Session 1. Shape Description with Deformable Models
Presider: James Coggins, Univ. of North Carolina

8:15 A Feature Space for Derivatives of Deformations
F.L. Bookstein, W.D.K. Green, Univ. of Michigan

9:00 Non-Rigid Motion Analysis in Medical Images: a Physically Based Approach
C. Nastar, N. Ayache, INRIA, France

9:45 Coffee

10:15 The Use of Active Shape Models for Locating Structures in Medical Images
T.F. Cootes, A. Hill, C.J. Taylor, J. Haslam, Univ. of Manchester

11:00 Parameterized Feasible Boundaries in Gradient Vector Fields
M. Worring, A.W.M. Smeulders, L.H. Staib, J.S. Duncan, Yale Univ.

11:40 Multi-Resolution Stochastic 3D Shape Models for Image Segmentation
B.C. Vemuri, A. Radisavljevic, C.M. Leonard, Univ. of Florida

12:20 Break for lunch

Session 2. Abstract Shape Description
Presider: Fred Bookstein, Univ. of Michigan

2:00 Higher-Order Differential Structure of Images
B.M. ter Haar Romeny, L.M.J. Florack, A.H. Salden, M.A. Viergever, Utrecht Univ.

2:45 Symbolic Description of 3-D Structures Applied to Cerebral Vessel Tree Obtained from MR Angiography Volume Data
G. Gerig, Th. Koller, G. Szekely, Ch. Brechbühler, O. Kübler, ETH-Zentrum

3:20 Multiscale Medial Analysis of Medical Images
B.S. Morse, S.M. Pizer, A. Liu, Univ. of North Carolina

4:00 Coffee

4:20 Arrangement: A Spatial Relation Comparing Part Embeddings and Its Use in Medical Image Comparisons
H.D. Tagare, F. Vos, C.C. Jaffe, J.S. Duncan, Yale Univ.

5:00 Characterizing First- and Second-Order Patches Using Geometry-Limited Diffusion
R.T. Whitaker, Univ. of North Carolina

5:35 Break for dinner

Session 3. Poster overviews
Presider: Andrew Todd-Pokropek, University College, London

7:30 Short presentations to introduce posters

Tuesday, June 15

Session 4. Knowledge-based Systems
Presider: James Duncan, Yale Univ.

8:00 Spatial Knowledge Representation for Visualization of Human Anatomy and Function
R. Schubert, K.H. Höhne, A. Pommert, M. Riemer, Th. Schiemann, U. Tiede, IMDM, Hamburg

8:40 A Strategy for Automated Multimodality Image Registration Incorporating Anatomical Knowledge and Imager Characteristics
D.L.G. Hill, D.J. Hawkes, N. Harrison, C.F. Ruff, UMDS, London

9:20 Model-Based Recognition of Anatomical Objects from Medical Images
G.P. Robinson, A.C.F. Colchester, L.D. Griffin, UMDS, London

10:00 Coffee

Session 5. Neural Networks
Presider: Gene Gindi, SUNY-Stony Brook

10:30 A Multiscale Approach to Image Segmentation Using Kohonen Networks
S. Haring, M.A. Viergever, J.N. Kok, Utrecht Univ.

11:15 Segmentation of Magnetic Resonance Brain Images Using Analog Constraint Satisfaction Neural Networks
A.J. Worth, D.N. Kennedy, Massachusetts General Hospital

12:00 Break for lunch

2:00 **Workshop on Object Shape and Definition Approaches**
Presider: Steve Pizer, Univ. of North Carolina

Session 6. Novel Imaging Methods
Presider: Art Gmitro, Univ. of Arizona

7:00 Fast, Non-Linear Inversion for Electrical Impedance Tomography
K. Paulson, W. Lionheart, M. Pidcock, Oxford Brookes Univ.

7:35 Inverse Methods for Optical Tomography
S.R. Arridge, M. Schweiger, Univ. College London

8:10 Feature-Guided Acquisition and Reconstruction of MR Images
Y. Cao, D.N. Levin, Univ. of Chicago

8:45 Reconstruction of a Three-Dimensional Volume from a Motion-Corrupted Two-Dimensional Data Set in Magnetic Resonance Imaging
W.E. Smith, J.K. Riek, A. Murat Tekalp, SAIC and Univ. of Rochester

Wednesday, June 16

Session 7. Tomographic Reconstruction
Presider: Yves Bizais, University Hospital, Nantes

8:00 A Framework for Incorporating Structural Prior Information into the Estimation of Medical Images
V.E. Johnson, Duke Univ.

8:40 Bayesian Reconstruction for Emission Tomography via Deterministic Annealing
G. Gindi, A. Rangarajan, M. Lee, I.G. Zubal, SUNY-Stony Brook

9:20 Analytical Considerations of Photon Attenuation and System Response Function in SPECT Reconstruction
X. Pan, C.T. Chen, J.N. Aarsvold, W.H. Wong, Univ. of Chicago

10:00 Coffee

10:30 MAP Image Reconstruction Using Wavelet Decomposition
Z. Wu, Univ. of Pennsylvania

11:10 Tomographic Reconstruction Using Information-Weighted Spline Smoothing
J.A. Fessler, Univ. of Michigan

11:45 A 3-D Filtered-Backprojection Reconstruction Algorithm for Combined Parallel- and Cone-Beam SPECT Data
C. Wu, M.N. Wernick, C.-T. Chen, Univ. of Chicago

12:25 Break for lunch

Afternoon: Conference excursion

Thursday, June 17

Session 8. Image Sequences
Presider: Randy Brill Univ. of Massachusetts

8:00 Foundations of Factor Analysis of Medical Image Sequences: A Unified Approach and Some Practical Implications
H. Benali, I. Buvat, F. Frouin, J.P. Bazin, R. Di Paola, Institut Gustave-Rousy, France

8:40 Bayesian Identification of a Physiological Model in Dynamic Scintigraphic Data
M. Samal, M. Karny, D. Zahalka, Charles Univ., Prague

9:20 Image Registration for the Investigation of Atherosclerotic Plaque Movement
K. Shields, D.C. Barber, S.B. Sherriff, Royal Hallamshire Hospital, Sheffield

10:00 Coffee

Session 9. Statistical Pattern Recognition
Presider: Bob Wagner, Center for Devices and Radiological Health

10:30 Using Statistical Pattern Recognition Techniques to Control Variable Conductance Diffusion
T.S. Yoo, J.M. Coggins, Univ. of North Carolina

11:10 Adaptive Noise Equalization and Image Analysis in Mammography
N. Karssemeijer, Univ. of Nijmegen

11:50 Continuous Voxel Classification by Stochastic Relaxation: Theory and Application to MR Imaging and MR Angiography
D. Vandermeulen, R. Verbeeck, L. Berben, P. Suetens, G. Marchal, Katholieke Universiteit Leuven

12:30 Break for lunch

2:00 **Poster Session**

7:30 **Poster Discussion Session**
Moderators to be announced

Friday, June 18

Session 10. Image Quality
Presider: Harry Barrett, Univ. of Arizona

8:00 Multivariate Gaussian Pattern Classification: Effects of Finite Sample Size and the Addition of Correlated or Noisy Features on Summary Measures of Goodness
R.F. Wagner, D.G. Brown, J.P. Guedon, K.J. Myers, K.A. Wear, Center for Devices & Radiological Health

8:45 Gabor Function Based Medical Image Compression
M.P. Anderson, M.H. Loew, D.G. Brown, Center for Devices & Radiological Health

9:30 Coffee

10:00 Announcements and award presentations

10:15 Measuring Detection and Localization Performance
R.G. Swensson, Harvard Medical School

11:00 Methods for Estimating the Efficiency of Human and Computational Observers in Ultrasonography
M.F. Insana, T.J. Hall, Univ. of Kansas

11:45 Closing remarks

POSTER PRESENTATION LIST

Improved Image Reconstruction in Positron Emission Tomography Using *A Priori* Anatomical Information
Babak A. Ardekani, Michael Brown, and Brian F. Hutton

A Paradigm for Using Multispectral Medical Images in Evaluating Tumor Response to Treatment
J. Camp and R. Robb

Precision and Accuracy of Regional Radioactivity Quantitation Using the Maximum Likelihood EM Reconstruction Algorithm
Richard E. Carson, Yuchen Yan, BettyAnn Chodkowski, Tieng K. Yap, Margaret E. Daube-Witherspoon

Affine-Transform Invariant Image Matching
Qin-sheng Chen, Michel Defrise, Frank Deconinck

Defining Optimal Feature Sets for Segmentation by Statistical Pattern Recognition
James M. Coggins and Changhua Huang

Magnetostatics and the Wave Equation
William J. Dallas

Combined SPECT and CT Imaging in the Quantification and Anatomical Localisation of Radionuclide Uptake
J.S. Fleming, A.A. Alaamer and S. Perring

Multi-scale Hierarchical Segmentation
Lewis Griffin

Image Quality and Image Sampling: Application to Tomographic Devices
Jean-Pierre Guedon, Yves Bizais, Michael Unser, Akram Aldroubi, Robert M. Gagne, Robert F. Wagner, Kyle J. Myers

Consistency Conditions for Sinograms in SPECT
Donald L. Gunter

Lumen Reconstruction from Two Angiograms
K. M. Hanson

Performance Evaluation of Intraoperative Probes in Tumor Detection
Neal Hartsough, Harrison H. Barrett, H. B. Barber

Multi-scale Linking Using Intensity Gradients
A.S.E. Koster, K.L. Vincken, C.N. de Graaf, M.A. Viergever

MR Image Processing to Improve Conspicuity of Inflammatory Myopathy Muscle Biopsy Sites -- Work in progress
Robert J. Kurland and Eric Newman

Statistical Methods for Paired Comparisons of SPECT Brain Images
Nicholas Lange, Lorcan A. O'Tuama, Johanna F. Stoeckler, S. Ted Treves

Automatic Tissue Segmentation from Computed Intrinsic MR Images
Z. Liang and J. MacFall

The Use of Visual Response Functions in Bayesian Reconstruction
Jorge Llacer, Bart M. ter Haar Romeny and Max A. Viergever

Automic Parameterization of Human Cortical Surfaces from MRI
David MacDonald, David Avis, Alan C. Evans

Multi-Parameter Image Visualization with Self-Organizing Maps
Armando Manduca

Simultaneous Determination of Activity and Attenuation Images from SPECT Projections
Stephen H. Manglos and Thomas M. Young

Quantification of LV Wall Thickening Using Image-Derived Strain
John C. McEachen II and James S. Duncan

Automated Anatomical Labelling of Magnetic Resonance Brain Images Using Multiresolution B-spline Deformable Models
Stephanie R. Sandor and Richard Leahy

On paradigms preceding AND succeeding Artificial Intelligence - interactive segmentation in "Creaception"
W. *Muller-Schauenberg*

Three-Dimensional Reconstruction Method of Blood Vessels Using a High-Speed X-Ray Rotational Projectional System
Noboru Niki, Yoshiki Kawata, Hitoshi Satoh and Tatsuo Kumazaki

Three-Dimensional Display of a Scalar Feature on a Shape: Application to Myocardial Scintigraphy
C. Perault. A. Loboguerrero and J. C. Liehn

Quantitation of Neuroanatomical Volumes from MRI
Andrew Simmons

Model-based Deformable Surface Finding
Lawrence H. Staib

Model-based Methods for Improved Reconstruction of Functional Images
E.M. Stokely and D.B. Twieg

Preliminary Segmentation of Mammograms Using Multiple Linked Self-Organising Neural Networks
J. Suckling. D.R. Dance. D.G. Corr. D.J. Lewis and S.G. Blacker

Improvement of Temporal Sampling of Dynamic Tomograpy Using Limited Angle Tomographic Reconstruction
Andrew Todd-Pokropek and H. Bergmann

Fully Automated CT and MR Brain Image Registration by Correlation of Geometrical Features
Petra A. van den Elsen. J. B. Antoine Maintz. and Max A. Viergever

Multicriterion Neural Network and Algorithm for Real-Time Image Reconstruction from Projections
Yuanmei Wang and Weixue Lu

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