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Information Processing in Medical Imaging

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Proceedings

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Preface

The fifteenth international conference on Information Processing in Medical Imaging (IPMI) was held June 9-13, 1997 on the campus of Green Mountain College in Poultney, Vermont, USA. Following the very successful 1995 IPMI meeting held in Brest, France, this conference was the latest in a series of biennial meetings where new contributions to the processing and analysis of medical images were critically discussed and extended.

We received 96 full paper submissions to this meeting; of these, only 27 were accepted as oral presentations. The three or four papers in each section of the proceedings correspond to the actual oral sessions at the meeting, and each session comprises three or four representative works at the leading edge of an important area. (However, this quantization led to a few cases of strange categorical bedfellows.) The papers were presented in a single track, received the bulk of the discussion time during the course of the meeting, and were each given 14 pages in the proceedings. This year, 31 submissions were accepted as poster presentations. For the first time at IPMI, the posters were each given 6 pages in the proceedings in order to better document some of the excellent submissions that could not be presented orally.

It was our intent that IPMI97 recapture some of the flavor of previous IPMIs, where the applied mathematics common to the separate areas of image analysis, image reconstruction, and image quality assessment would unify the meeting, and would encourage equal numbers of submissions from each of these areas. While the breadth of topics was considerable, the representation was not equal; as in recent IPMIs, image analysis continued as the dominant topic.

The first session concerns, in a general sense, the construction of shape models from examples, and matching procedures useful in these endeavors. The construction of abstract shape models, the topic of the first two papers, often depends ultimately on the operations of identifying, and then matching, homologous landmarks across sets of images. The third paper presents the formulation of an algorithm to carry out these procedures, and proposes a novel means of sidestepping the laborious task of identifying homologies.

While the three papers in session 1 deal mostly with analyses and models independent of specific medical applications, the topic of the related fifth session is concerned more with registration and mapping problems that arise in specific modalities. Of note here is the introduction of physical models of tissue deformation into the registration problem. The fourth paper in this session is not concerned with registration *per se*, but with efficient means of transforming images once suitable mappings have been computed.

Traditionally, IPMI has included a session on novel imaging methods and modalities, since these carry concomitant challenges in information processing. The papers in the second session concern the novel modalities of elastic imaging, electrical impedance tomography (the topic of the previous IPMI Erbsmann Award paper), and optical tomography. Image reconstruction is the problem that arises in the latter two modalities. The fourth paper, whose subject is actually a novel image representation rather than a modality, falls neatly into

the spirit, if not the content, of this session.

Segmentation continues as a formidable challenge for medical image analysis, with widespread application foreseen for practical and robust methods. The papers in session 3 illustrate the continuing maturation of segmentation models and algorithms as applied to anatomical images. As this area matures, it is interesting to note that segmentation methods are becoming increasingly anatomically specific, with models tuned to stable anatomical features such as major brain sulci. In this same vein, one may also observe, as in the first paper, that effective medical segmentation may need to make use of a collection of empirical procedures, rather than relying on an algorithm derived from a single overarching principle.

Session 4 is something of a hybrid. The first two papers, dealing with image quality, concern detection and estimation tasks given a statistical model of an image. The mathematical difficulties here often limit one to using unrealistic models of signal and background, and the extension to more realistic statistical models, as discussed in the first paper, represents a real advance. The second paper concerns the approximation of ML and MAP estimates of object parameters that are nonlinear functions of the observed noisy image data, a topic of importance in applications such as quantitation in nuclear medicine. The last two papers also focus on statistical models of low-level data, but not in the context of image quality *per se*. The fourth paper deals with the implications for PET reconstruction of realistic *non*-Poisson models of projection data, and the third paper with new mixture models for clustering, for example, the types of multidimensional data acquired in MR imaging, with implications for segmentation.

The maturation of PET and SPECT and the advent of fMRI have introduced new statistical information processing problems concerning the analyses of activation and functional data in neuroscientific and clinical studies. This is the direct concern of the first three papers in session 6, which address the fascinating challenges of inferences from spatiotemporal functional data. The last paper in this session introduces a statistical method to derive a model of normality from sets of SPECT brain images.

Magnetic resonance is the theme of papers in the last session. In addition to fMRI, the cornucopia of new imaging methods stemming from this modality continues unabated twenty-six years after the first crude MR images were generated at Stony Brook. Just one example: the amazing capability of MR to "tag" tissue parcels has generated a set of image tracking problems useful to cardiac MR, and the first two papers represent recent advances in this area. The latter two papers, dealing with motion correction and volume measurement, address important practical concerns of MR imaging.

IPMI has been lauded as a unique forum for the interchange of ideas in medical image processing and analysis. The editors, naturally, concur, and feel duty bound to add their own observations. IPMI is unique in format, of course, with its (in)famous unlimited discussion periods raging into the night. One could characterize IPMI as a vortex that draws in ideas from our sister communities

in applied mathematics, physics, electrical engineering, computer science, and statistics to fertilize advances specific to medical imaging, but this could also be said of other meetings. More than other meetings, however, IPMI demands that contributions pay attention to the real constraints that arise in medical imaging practice. Aesthetic, self-consistent theories, of, say, anatomical image segmentation are challenged if these cannot possibly adapt to the ambiguities of the heterogeneous and complex anatomy of the human body. Latitude is necessary, of course, and the demands of medical practice are not enforced to the point of commercial viability (Is the new reconstruction algorithm too slow to be clinically practical?) or validation extensive enough for government approval (Has the promising new segmentation method been rigorously tested on a large patient population?). These areas are properly addressed in other meetings. These freedoms, suitably tempered by adherence to constraints, thus frame the unique role of IPMI.

New Haven — James S. Duncan
Stony Brook — Gene R. Gindi

March, 1997

Acknowledgments

The XVth IPMI conference was made possible by the efforts of a number of dedicated people. The organizers would first like to thank profusely the Scientific Committee, whose timely, critical reviews ensured that the conference was scientifically first-rate. Second, we thank the many researchers who submitted manuscripts for consideration and regret that we had to turn down a significant number.

IPMI97 would truly not have been possible without the constant help and indulgence of Carolyn Meloling at Yale University. She single- handedly dealt with all of the mailings, organized the paper submissions and reviews, and was constantly there to help with the numerous details related to organizing this meeting. In addition, we appreciate the help and advice of Paul Saunders and Dick Stark from Green Mountain College.

We also gratefully acknowledge the support and encouragement of Debbie Brown and Kathy Duncan over the past several years, especially in some of the IPMI "crunch" times.

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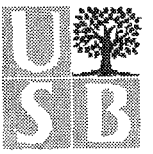

Francois Erbsmann Prize

Francois Erbsmann, one of the founders of IPMI, died tragically soon after the first IPMI. In his honor a cash award is given at each meeting for the best paper presented by a young scientist making his or her first IPMI presentation. At the 1995 IPMI meeting in Brest, France, the following awards were made:

Erbsmann Prize Winner (best paper):
Maurits Konings, University Hospital Utrecht

Honorable Mention: Gary Christensen, Washington University
Honorable Mention: Paul Hemler, Stanford University

Congratulations to these young scientists on their outstanding efforts.

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Table of Contents

1 Shape Models and Matching

Automatic Construction of Eigenshape Models by Genetic Algorithm
A.C.W. Kotcheff and C.J. Taylor 1

Quadratic Variation of Deformations
F.L. Bookstein 15

The Softassign Procrustes Matching Algorithm
A. Rangarajan, H. Chui and F.L. Bookstein 29

2 Novel Imaging Methods

Acoustic and Elastic Imaging to Model Disease- Induced Changes in Soft Tissue Structure
P. Chaturvedi, M.F. Insana and T.J. Hall 43

2D Intravascular E.I.T. Using a Non-iterative, Non-linear Reconstruction Algorithm
M.K. Konings, C.J. Bouma, W.P.Th.M. Mali, and M.A. Viergever 57

Optimal Data Types in Optical Tomography
M. Schweiger and S.R. Arridge 71

Using Spatial-Temporal Images for Analysis of Gated Cardiac Tomographic Data: The "M-Mode" Revisited
I. Buvat, M.L. Bartlett, A.N. Kitsiou, J.M. Carson, G. Srinivasan, K.A. Nour, C.C. Chen, V. Dilsizian and S.L. Bacharach 85

3 Segmentation

Automated Segmentation of Brain Exterior in MR Images Driven by Empirical Procedures and Anatomical Knowledge
A.J. Worth, N. Makris, J.W. Meyer, V.S. Caviness,Jr., D.N. Kennedy 99

Automated 3D Segmentation Using Deformable Models and Fuzzy Affinity
T.N. Jones and D.N. Metaxas 113

Segmentation of Medical Image Objects Using Deformable Shape Loci
D. Fritsch, S.M. Pizer, L. Yu, V. Johnson, and E. Chaney 127

Mapping the Cerebral Sulci: Application to Morphological Analysis of the Cortex and to Non-Rigid Registration
M. Vaillant and C. Davatzikos 141

4 Image Quality and the Statistical Character of Measured Data

Bayesian Detection of Random Signals on Random Backgrounds
H.H. Barrett and C.K. Abbey 155

Approximate Distributions for Maximum Likelihood and Maximum *a Posteriori* Estimates Under a Gaussian Noise Model
C.K. Abbey, E. Clarkson, H.H. Barrett, S.P. Müller and F.J. Rybicki 167

Continuous Gaussian Mixture Modeling
S. Aylward and S.M. Pizer 176

New Statistical Models for Randoms- Precorrected PET Scans
M. Yavuz and J.A. Fessler 190

5 Registration/Mapping

Registration of 3D Medical Images Using Simple Morphological Tools
J.B.A. Maintz, P.A. van den Elsen and M.A. Viergever 204

Deformation for Image- Guided Interventions Using a Three Component Tissue Model
P.J. Edwards, D.L.G. Hill, J.A. Little and D.J. Hawkes 218

Registration of Abdominal CT and SPECT Images Using Compton Scatter Data
K. Sjögreen, M. Ljungberg, K. Erlandsson, L. Floreby and S.-E. Strand .. 232

Definition of Volume Transformations for Volume Interaction
T. Schiemann and K.H. Höhne 245

6 Statistical Models in Functional Neuroimaging

Nonlinear Versus Linear Models in Functional Neuroimaging: Learning Curves and Generalization Crossover
N. Mørch, L.K. Hansen, S.C. Strother, C. Svarer, D.A. Rottenberg, B. Lautrup, R. Savoy and O.B. Paulson 259

Synthetic Resampling Methods for Variance Estimation in Parametric Images
R. Maitra 271

Space- Time Statistical Model for Functional MRI Image Sequences
H. Benali, I. Buvat, J.L. Anton, M. Pélégrini, M. DiPaola, J. Bittoun, Y. Burnod and R. DiPaola 285

Jackknifing a Normal Database for Regional Cerebral Blood Flow SPECT Obtained Using Principal Components
A.S. Houston 299

7 MR Image Analysis and Processing

Generating 3D Cardiac Material Markers Using Tagged MRI
W.S. Kerwin and J.L. Prince 313

Identification of Myocardial Tags in Tagged MR Images Without Prior Knowledge of Myocardial Contours
T.S. Denney, Jr. 327

An Autofocus Algorithm for the Automatic Correction of Motion Artifacts in MR Images
D. Atkinson, D.L.G. Hill, P.N.R. Stoyle, P.E. Summers and S.F. Keevil. . 341

Measurement of Global and Regional Cerebral Volume Changes By Integrating Boundary Shifts Between Registered Serial 3D MR Scans
P.A. Freeborough and N.C. Fox 355

8 Posters

8.1 Segmentation/ Structural Models

Automatic Detection of Sulcal Bottom Lines in MR Images of the Human Brain
G. Lohmann, F. Kruggel and D.Y. Von Cramon 369

Segmentation and Interpretation of MR Brain Images Using an Improved Knowledge- Based Active Shape Model
N. Duta and M. Sonka 375

Gaussian Random Fields on Sub-manifolds for Characterizing Brain Surfaces
S.C. Joshi, A. Banerjee, G.E. Christensen, J.G. Csernansky, J.W. Haller, M.I. Miller and L. Wang 381

Fuzzy Logic Approach to 3D Magnetic Resonance Image Segmentation
Y. Hata, S. Kobashi, N. Kamiura and M. Ishikawa 387

Comparison of Traditional Brain Segmentation Tools with 3D Self- Organizing Maps
D. Dean, K. Subramanyan, J. Kamath, F.L. Bookstein, D. Wilson, D. Kwon and P. Buckley 393

Finding the Brain Cortex Using Fuzzy Segmentation, Isosurfaces, and Deformable Surface Models
C. Xu, D. Pham and J. Prince 399

Statistical Modelling of Lines and Structures in Mammograms
R. Zwiggelaar, T.C. Parr, C.R.M. Boggis, S.M. Astley and C.J. Taylor ... 405

A Thinning Algorithm to Extract Medial Lines from 3D Medical Images
K. Palágyi and A. Kuba 411

Setting the Mind for Intelligent Interactive Segmentation: Overview, Requirements and Framework
S.D. Olabarriaga and A.W.M. Smeulders 417

Segmentation of Cerebral Vessels and Aneurysms from MR Angiography Data
D.L. Wilson and J.A. Noble 423

Computation of Efficient Patient- Specific Models from 3D Medical Images: Use in Virtual Endoscopy and Surgery Rehearsal
S. Aharon, B.M. Cameron and R.A. Robb 429

8.2 Quantitative Image Analysis

In Vivo Analysis of Trabecular Bone Architecture
W.J. Niessen, A.M. López, W.J. van Enk, P.M. Roermund, B.M. ter Haar Romeny and M.A. Viergever 435

Automatic Measurement of Vertebral Shape Using Active Shape Models
P.P. Smyth, C.J. Taylor and J.E. Adams 441

A Hybrid Approach for the Detection of Small Airways Disease from Computed Tomographic Images
G.-Z. Yang and D.M. Hansell 447

Computer Simulation of Convection and Diffusion Effects on Velocity Estimations from X-Ray Contrast Density Time Curves
S.P. Huang, B.E. Chapman, J.E. Muhlestein, D.D. Blatter and D.L. Parker 453

A Comparison of Retrospective Intensity Non-uniformity Correction Methods for MRI
J.G. Sled, A.P. Zijdenbos and A.C. Evans 459

8.3 Registration/ Mapping/ Tracking

A Robust and Efficient Algorithm for Image Registration
B.C. Vemuri, S. Huang, S. Sahni, C.M. Leonard, C. Mohr, T. Lucas, R. Gilmore, and J. Fitzsimmons 465

Automatical Adaptation of the Stereotactical Coordinate System in Brain MRI Datasets
F. Kruggel and G. Lohmann 471

Design of a Statistical Model of Brain Shape
L. Le Briquer and J.C. Gee 477

Automatic Landmark Identification Using a New Method of Non-rigid Correspondence
A. Hill, A.D. Brett and C.J. Taylor 483

Non-rigid Curve Correspondence for Estimating Heart Motion
H.D. Tagare 489

Tracking of Tagged MR Images by Bayesian Analysis of a Network of Quads
D. Lee, J.T. Kent and K.V. Mardia 495

8.4 Novel Imaging Methods

Noninvasive Skin Imaging
S. Cotton, E. Claridge, P. Hall 501

Modelling Interreflections in a System Based on the Differential Absorption of Light (DAL) for the Measurement of Range Images
R. Wolfe and D. Laurendeau 507

Quantitative Estimation of Scatterer Spacing From Back-scattered Ultrasound Signals Using the Complex Cepstrum
R.S. Mia, M.H. Loew, K.A. Wear and R.F. Wagner 513

Spatial Compounding of 3D Ultrasound Images
R. Rohling, A. Gee and L. Berman 519

8.5 Image/Structure Reconstruction

Cone Beam Imaging of a Section of a Long Object with a Short Detector
K.C. Tam 525

New Methods for SPECT Imaging and Pre-reconstruction Restoration
Y.-H. Liu, A. Rangarajan, D. Gagnon, M. Therrien, A.J. Sinusas, F.J.Th. Wackers and G. Zubal 531

Reconstruction of the Intracerebral Vasculature from MRA and a Pair of Projection Views
E. Bullitt, A. Liu, S. Aylward and S.M. Pizer 537

8.6 Image Quality

Two Alternative Forced- Choice Evaluation of Vessel Visibility Increases Due to Zero-filled Interpolation in MR Angiography
B.E. Chapman, K.C. Goodrich, A.L. Alexander, D.D. Blatter and D.L. Parker 543

Bayesian Detection with Amplitude, Scale, Orientation and Position Uncertainty
E. Clarkson and H. Barrett 549

Author Index 555