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Information Processing in Medical Imaging

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PREFACE

The thirteenth biennial International Conference on Information Processing in Medical Imaging (IPMI) was held June 14-18, 1993, on the campus of Northern Arizona University in Flagstaff, Arizona. Following the highly successful 1991 IPMI in Kent, England, this conference was the latest in a series of unique and important meetings where new developments in the acquisition, analysis and utilization of medical images are presented, discussed, dissected and extended. Over the last two decades IPMI has evolved along with the field it represents. Today it is widely recognized as a preeminent international forum for presentation of cutting-edge research in medical imaging and image analysis.

The topics discussed at IPMI are always new, often controversial and occasionally revolutionary. They are vital to virtually every medical specialty. To the radiologist analyzing an angiogram, to the cardiologist assessing myocardial viability, to the surgeon performing a needle biopsy, to the oncologist planning a course of radiation therapy, image is everything. Without the modern science of medical imaging, these specialists would be groping in the dark.

It is difficult to think of a field more dynamic, more rapidly evolving than medical imaging. Barely two decades ago, computed tomography came on the clinical scene, truly revolutionizing the practice of radiology. Yet this revolution was short-lived; a second revolution, magnetic resonance imaging, followed close on its heels. Computerized ultrasound, single-photon emission tomography, positron emission tomography, digital subtraction angiography -- the litany of vital medical techniques that did not exist a mere quarter-century ago is a long one.

All of these exciting developments were made possible by an exquisite synergy of mathematics, physics, and computer science, precisely the domain of IPMI. In a field as complex as this one, it is essential that researchers and practitioners from many disciplines and from around the world come together to share insights and ideas. Virtually any past attendee at an IPMI would attest that there is no better forum for such interchanges.

One thing that sets IPMI apart from other meetings is its free, informal spirit. A first-time IPMI attendee is certain to be amazed at one unique rule: discussion is never limited for any reason. It is not uncommon for debate to rage on for an hour or two after a presentation, to continue into the wee hours and then to be resumed the next morning. Neither preconceived schedules nor arbitrary decisions by a session chair nor even dinner can stem the flow of ideas and viewpoints at an IPMI.

Another ingredient that distinguishes IPMI from other meetings in medical imaging is its emphasis on information processing. Image is information, but extraction and effective use of this information is far from trivial. The processing of this information may be carried out by a human observer, a 3D reconstruction algorithm, a neural network for pattern recognition or a machine-vision system that distinguishes organs by analyzing their shape. All of these approaches are well represented at every IPMI.

This volume contains the text of the papers presented orally at IPMI XIII. Over 100 full manuscripts were submitted, of which only 35 could be accepted for oral presentation. Each manuscript was critically reviewed by two or more members of the scientific committee, and many excellent contributions had to be rejected or presented only as posters. The 35 papers that survived this highly competitive process represent a broad cross-section of current research in the field. In this volume they are arranged into nine categories, corresponding to the sessions at the meeting.

The first two sessions are broadly designated as shape description. Analysis of a medical image requires a compact, easily manipulable description of the major organs and other objects in the image. This description can be based on identifying landmarks in the image and fitting them to models of the objects involved, as in most of the papers in the first session. The result is both a segmentation of the image into regions representing major organs and a parameterized description of the shape of the organs. This approach has been particularly effective for the brain and heart, where realistic models are readily constructed.

The second session deals with more abstract, mathematical approaches to shape description. A prominent concept here is that of scale space, where a given image is processed at different scales or levels of resolution. Mathematical techniques from differential geometry, topology and graph theory are brought to bear in this session.

The objectives of shape description are further pursued in session 3, where the image data are supplemented with other medical knowledge for object recognition, visualization and registration. The papers in session 4 apply artificial neural networks to these same problems.

Session 5 is labelled with the catch-all phrase "novel imaging methods", though admittedly this designation could be applied to virtually any IPMI paper. Two of the papers in this session deal with new modalities (electrical impedance tomography and optical tomography) that hold considerable promise but have not yet had significant clinical impact. The other two deal with magnetic resonance imaging, a modality that has made

a dramatic transition from novel to conventional in barely over a decade. Still, the two papers on this modality here amply demonstrate that the potential for novel approaches is hardly exhausted.

Session 6 deals with tomographic image reconstruction, largely in the context of emission tomography (PET and SPECT). Two dominant themes that emerge are Bayesian estimation and accurate system modelling.

Session 7 focusses on sequences of images such as obtained in a dynamic cardiac study. The uses of Bayesian methods and image registration recapitulate concepts from earlier session, while factor analysis is introduced here for the first time in the conference.

Sessions 8 and 9 are essentially statistical in nature, 8 dealing with statistical pattern recognition and 9 with statistical approaches to the objective assessment of image quality. The essential unity of these two fields is emphasized nicely by the paper by Wagner et al., which could equally be classified as pattern recognition or image quality.

It is worth commenting on the aspects of medical imaging that are *not* represented here. First, there is virtually no mention of radiation detectors or imaging hardware. In a way, this is not surprising since the conference theme is information processing rather than data acquisition. Still, the editors cannot escape the feeling that important progress could be made by viewing data acquisition and information extraction more holistically.

Second, there is little discussion of clinical validation of the methods proposed. It could be argued that these aspects are better treated in a more clinically oriented forum such as the meeting of the Radiological Society of North America or the Society of Nuclear Medicine, but there is always a risk if our mathematically oriented enterprises are not regularly brought back to clinical reality. For many of the papers the reader is left to wonder just how the proposed mathod will impact clinical medicine and whether any objective benefit can ever be established.

Finally, there is no discussion of methods of image archiving, storage and retrieval, aspects usually lumped under the rubric PACS or the broader HIS/PACS (hospital information systems/ picture archiving, communication and storage). Though a comprehensive meeting on medical imaging would clearly include such aspects, the essential issues are rather different from the IPMI theme.

Tucson, Arizona — Harrison H. Barrett

March, 1993 — Arthur F. Gmitro

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. The winner of this prestigious award at IPMI XII in 1991 was:

Dr. H. Isil Bozma
Yale University
New Haven, Connecticut

Congratulations to Dr. Bozma for this outstanding accomplishment.

ACKNOWLEDGEMENTS

IPMI XIII would not have been possible without the dedicated efforts of many people. The organizers are particulary grateful to Jane Lockwood, Deborah Spargur and Lynn Mascarella of the University of Arizona for their assistance. Ms. Lockwood, with the able assistance of Ms. Spargur, did a spectacular job of handling the review process and assembling the manuscripts for this volume, while Ms. Mascarella and her staff at the Office of Continuing Medical Education handled the mailings and many of the budgetary matters. We also thank Marcy Biesemeyer and her staff at Northern Arizona University for capably handling the local arrangements. The conference intern at N. A. U., Stephanie Truitt, was especially helpful.

We are very appreciative of the efficient and critical reviews contributed by members of the Scientific Committee. We also thank the many researchers who submitted manuscripts for the meeting, with a special nod and request for indulgence to those whose manuscripts could not be accepted for lack of space. The IPMI rejects this year were probably equal in quality to most papers on medical imaging presented at other venues, and we are thankful that so many of these rejected authors shared their work through IPMI posters.

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