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Robert M. Nishikawa*
Carl J. Vyborny Translation Laboratory for Breast Imaging Research
Department of Radiology, and the Committee on Medical Physics, The University of Chicago, 5841 S. Maryland Ave. MC-2026, Chicago, IL 60637

This meeting marked the 40th year from the first SPIE Medical Imaging meeting. This paper presents a brief summary of the 40-year history of the meeting, with an emphasis on the Physics Conference. That is, when the meeting split into multiple conferences, data are presented mostly for the Physics conference only.

The first conference was held in 1972 in Chicago and it was called: Application of Optical Instrumentation in Medicine.

“We have endeavored, by way of the seminar, to provide a communication link between those with expertise in the various technologies associated with image forming devices and those in the medical field who rely on the fruits of these technologies for many of their diagnostic tools...there is a genuine interest among those in the medical field for a better understanding of the fundamental technology of imaging systems.” William C. Zarnstroff, General Chairman

For the next 40 years, with the exception of 1978 the meeting was held annually.

The first 13 conferences were entitled: Application of Optical Instrumentation in Medicine, appended with a roman numeral. The 14th meeting (1986) was modified to recognize the growing importance of PACS to the meeting: Application of Optical Instrumentation in Medicine XIV and Picture Archiving and Communication Systems (PACS IV) for Medical Applications. The following year, the conference name changed to “Medical Imaging” as it is known today, although the first 6 were denoted by roman numerals. Starting in 1993, the year was appended to the title.

The meeting started as a single track, two-day conference, and now has 8 distinct conferences covering five days plus an additional day of courses.

In 1988, the proceedings were published in two volumes, 914A and 914B. The former covering physics, image processing, and perception and the latter display and PACS. The following year (1989) each of those two split in two so that there were now four conferences:

1. Medical Imaging III: Image Formation
2. Medical Imaging III: Image Capture and Display
3. Medical Imaging III: Image Processing
4. Medical Imaging III: PACS System Design and Evaluation

These sessions were partially overlapping and, thus, for the first time, the meeting had parallel session.

This configuration of conferences remained until 1994 when Image Perception and Physiology and Function from Multidimensional Images were added. In 1997, Ultrasonic Transducer Engineering was added. In 2007, Computer-Aided Diagnosis was added.

From 1976 to 1983, the meeting was held in conjunction with or preceding the American Roentgen Ray Society. As a result, the location of the meeting changed annually. Starting in 1985, the meeting was held in Newport Beach, CA, and this was home for the next 10 years, except in 1991, the meeting was held in San Jose in conjunction with the Electronic Imaging meeting. In 1995, the meeting was then moved to San Diego, and then returned once more to Newport Beach, before moving to San Diego till 2009. Since 2009 the meeting has been alternating between San Diego and Lake Buena Vista, FL.

In the Introduction to the proceedings in 1984, Chairman Roger Schneider wrote:

This meeting, the twelfth in the series ... was intended to be a change in direction from recent meetings in the series, a reversion to the attack on fundamental problems in imaging which earlier meetings represented. We also desired to bring onto the floor a recognition that the scientific interest in imaging

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is more broad and active now than it was a decade ago and that substantial progress has been made in formulating at least the structure of an understanding of the conveyance of information to human observers through imaging channels. ... We recognized the current intense interest in development of medical systems based upon the most contemporary image communication and storage technologies, and included that topic. The design goal was to address the physics and statistics of image encoding by modality; and the processing, display, archiving, management, and psychophysical considerations independently of modality, as far as possible.

It took 2 years for this new emphasis to flourish. Beginning in 1986, the attendance and the number of papers increased rapidly (as can be seen in the plots below).

Finally, it is important to note that every year for the past 40 years, the Center for Devices and Radiological Health, FDA (formerly, the Bureau for Radiological Health) has been a cosponsor or supporting organization. Further, many members of the CDRH/BRH have helped organize the meeting, such as Robert Wagner, Robert Jennings, Roger Schneider, David Brown and several others. Their contributions to this meeting mirror the impact that the CDRH/BRH have had on the field.

![Figure 1. These plots capture some of the statistics from the meeting over time.](image)

1.1 Fun Facts

Bob Wagner dubbed 1984-1987, the Palindrome Years.

The first digital mammography paper and the first dual-energy mammography paper were presented in 1983.

The first computer-aided diagnosis (CAD) paper was presented in 1985.

The first Proceedings (Vol. 35) had a black cover and was hard bound. All subsequent Proceedings had a yellow cover and were soft bound.

The first posters were in 1988. Each poster had 3 full poster boards and wine was served at the poster session.
Although there was no “Medical Imaging” meeting in 1978, there was another medical imaging themed conferences: Recent and Future Developments in Medical Imaging I; edited by Norman A. Baily.

In 2001, the proceedings were distributed on CD for the first time.

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<td>Samuel J. Dwyer III</td>
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<td>Thomas G. Flohr</td>
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1.2 Summary of Each Meeting

Following is a brief summary of each meeting from 1972-2012. When there were multiple conferences at the meeting, the summary focuses mainly on the Physics Conference. I also have most of this information in an excel spreadsheet. It is available from the author to those who would like it.
Overview of the 40-Year History of the SPIE Medical Imaging Meeting

1972
Application of Optical Instrumentation in Medicine (In-depth-Seminar)
Chicago Nov 29-30
Vol. 35  29 papers  Attendance: n/a
Sponsors, Co-Sponsors & Supporting Organizations
SPIE, BRH, ASNR, SMM, UWMS, AAPM
Chairs
William C. Zamaroff, William R. Hendee, Paul L. Carson
Program Committee
Not listed
Sessions
Electro-Optical Instrumentation - William R. Hendee
Image Analysis, Enhancement and Evaluation - Paul L. Carson
Holographic and Video Images - William R. Hendee
Special Topics - William C. Zamaroff
Panel Discussion - Jock B. Krohmer

1973
Application of Optical Instrumentation in Medicine II
Chicago Nov 29-30
Vol. 43  35 papers  Attendance: n/a
Sponsors, Co-Sponsors & Supporting Organizations
SPIE, AAPM, ASNR, AAMI, BRH-EMBG, OSA, SMM, SRE, SPSE
Chairs
William R. Hendee, William C. Zamaroff, Paul L. Carson
Program Committee
Not listed
Sessions
Nuclear Medicine Imaging
Image Enhancement and Pattern Recognition
Panel Discussion: Image Enhancement for Medical Diagnosis Can It Be Effective?
Special Topics
Image Intensifier Systems
Transmission, Storage, Retrieval and Reconstruction of Images
Panel Discussion Performance Standards and Possible Field Evaluation of Image Intensifiers Performance Standards of Image Intensifiers

1974
Application of Optical Instrumentation in Medicine III
Kansas City, MO Aug 1-2
Vol. 47  45 papers  Attendance: n/a
Sponsors, Co-Sponsors & Supporting Organizations
SPIE, BRH, AAPM, ARRS, EMBG
Chairs
Paul L. Carson, Edward L. Chaney, William R. Hendee
Program Committee
Not listed
Sessions
Transmission 3-Dimensional Image Reconstruction and Computerized Axial Tomography - William R. Hendee, Joseph Gallagher
Advanced Techniques of Imaging With Ultrasound - Paul L. Carson
Acoustic Exposure Determination In Diagnostic Ultrasound - James A. Rooney
Noise, Objective, and Psychophysical Measures - Joel E. Gray
Special Topics - Jacques Ovsalia
Ray Tube Focal Spot Size and Internally Distributions: Important Practical Considerations - Bengt E. Bjelanger
Automatic Brightness Control In Image-Intensified Fluoroscopy - William R. Hendee

1975
Application of Optical Instrumentation in Medicine IV
Atlanta, GA Sept. 25-27
Vol. 70  55 papers  Attendance: n/a
Sponsors, Co-Sponsors & Supporting Organizations
SPIE, BRH, AAPM, ARRS, ACR, SRE
Chairs
Joel E. Gray, William R. Hendee
Program Committee
Not listed
Sessions
Quality Assurance, Film Handling & Film Processing - Joel E. Gray
Loading, Heat Rating, Other Characteristics of X-Ray Tubes - Edward L. Chaney
Information Extraction & Utilization From Radiologic Images - Marvin E. Harris
Quality Assurance In Diagnostic Radiology: Why Doesn't Every Department Have A Complete Program? Panel Discussion
Quality Assurance for Diagnostic Radiologic Instrumentation - James J. Vucic
Exposure Initiation/Termination Mechanisms and Automatic Exposure Timers In Diagnostic Radiology - Robert G. Waggner
Rare Earth Intensifying Screens - E. Dale Trout
Panel Discussion: Performance Specifications for Diagnostic Radiologic Equipment - Gray-Scale Ultrasound Imaging & Tissue Identification - Paul L. Carson
Physical Evaluation of Computerized Axial Tomography - Raymond P. Rossi
Special Topics - Robert Rohrer
Performance Evaluation of Mammographic Imaging Systems - Gregory L. Dubois
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<th>Year</th>
<th>Event Title</th>
<th>Location</th>
<th>Dates</th>
<th>Volume</th>
<th>Pages</th>
<th>Attendance</th>
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<td>1976</td>
<td>Application of Optical Instrumentation in Medicine V</td>
<td>Washington, DC</td>
<td>Sept. 16-19</td>
<td>Vol. 96</td>
<td>76 papers</td>
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<td>1977</td>
<td>Application of Optical Instrumentation in Medicine VI</td>
<td>Boston, MA</td>
<td>Sept. 25-27</td>
<td>Vol. 127</td>
<td>60 papers</td>
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<td>Sensitometry Update - Joel Gray</td>
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<td>Approaches to Equipment Service, Equipment Specification and Performance Evaluation - Raymond P. Rossi</td>
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<td>New Developments in Medical Imaging - William Hendee</td>
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<td>Performance Characteristics of CT Scanners - Robert K. Carak</td>
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<td>Computed Tomography: Practical Considerations - William R. Hendee</td>
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<td>X-Ray Imaging Research in Toronto - K. W. Taylor</td>
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1988
Medical Imaging II: Part A—Image Formation, Detection, Processing, and Interpretation
Newport Beach, CA Jan 31-Feb 5
Vol. 914A 168 papers (102 in Physics) Attendance: 573
Sponsors, Co-Sponsors & Supporting Organizations
SPIE, AAPM, ACR, CDRH
Chairs
Samuel J. Dwyer III, Roger H. Schneider
Program Committee
Ronald L. Arenson; Gary T. Barnes; Harrison H. Barrett; Roger A. Bauman; Arthur Burgess; Arthur E. Burgess; Gerald Cohen; Kunio Doi; Aaron Fenster; Kenneth M. Hanson; William R. Hendee; David G. Hill; Steven C. Hori; H. K. Huang; Robert J. Jennings; Robert A. Kruger; Bruce Lasinski; James L. Leh; Thomas R. Lewallen; Murray H. Lew; William C. Martinek; Laura Lee Murphy; Ohan Nalcioglu; Stephen M. Pizer; Judith M.B. Prewitt; Ronald R. Price; Stephen J. Reddick; Hans Roelandt; Roger H. Schneider; Rodney Shaw; Stephen W. Smith; Edward V. Staub; Stephen R. Thomas; Robert F. Wagner; Henry N. Wagner, Jr.; Jason S. Zielonka

Sessions
Future Potential of the Several Candidate Signals for Medical Imaging - Roger H. Schneider
Image Formation I - VI - Robert F. Wagner; Harrison H. Barrett; Kunio Doi; Robert A. Kruger; Aaron Fenster; Hans Roelandt; Gary T. Barnes
Image Processing I - Arthur Burgess
Image Processing II: Chest and Cardiovascular - Jerry Cohen
Image Processing III: Cardiological - Kenneth M. Hanson
Image Processing IV: Tomography and 3D Mapping and Interpretation - Ohan Nalcioglu
Image Processing V: Microscopy - Judith M.B. Prewitt
Digital Medical Photography - Roger A. Bauman

Other Conferences
Vol # Title Editor/Conference Chair # of papers
891B Part B-Image Data Management & Display - Samuel J. Dwyer III, Roger H. Schneider

1989
Medical Imaging III: Image Formation
Newport Beach, CA Jan 29-31
Vol. 1000 236 papers (51 in Physics) Attendance: 547
Sponsors, Co-Sponsors & Supporting Organizations
SPIE, AAPM; ACR, CDRH, IRS
Chairs
Samuel J. Dwyer III, R. Gilbert Jost M.D., Roger H. Schneider
Program Committee
Ronald L. Arenson; Harrison H. Barrett; Gary T. Barnes; Roger A. Bauman; David G. Brown; Arthur E. Burgess; Arthur Carol; Gerald Cohen; Kunio Doi; Aaron Fenster; Kenneth M. Hanson; William R. Hendee; David G. Hill; Steven C. Hori; H. K. Huang; Robert J. Jennings; Robert A. Kruger; James L. Leh; Thomas K. Lewallen; Murray H. Low; Ohan Nalcioglu; Stephen M. Pizer; Judith M. B. Prewitt; Ronald R. Price; Stephen J. Reddick; Hans Roelandt; Roger H. Schneider; Rodney Shaw; Stephen W. Smith; Edward V. Staub; Stephen R. Thomas; Robert F. Wagner

Sessions
Future Potential of the Several Candidate Signals for Medical Imaging - Roger H. Schneider
Image Formation I - Stephen J. Reddick
Image Formation II - Robert J. Jennings
Image Formation III - Arthur E. Burgess
Image Formation IV - Robert A. Kruger
Image Formation V - Kunio Doi
Image Formation VI - Ronald R. Price

Other Conferences
Vol # Title Editor/Conference Chair # of papers
1001 Image Capture and Display - Samuel J. Dwyer III, R. Gilbert Jost M.D., Roger H. Schneider
1022 Image Capture and Display - Samuel J. Dwyer III, R. Gilbert Jost M.D., Roger H. Schneider
1025 Image Processing - Murray H. Low
1048 PACS Systems Design and Evaluation - Samuel J. Dwyer III, R. Gilbert Jost M.D., Roger H. Schneider

1990
Medical Imaging IV: Image Formation
Newport Beach, CA Feb 4-6
Vol. 1321 270 papers (60 in Physics) Attendance: 668
Sponsors, Co-Sponsors & Supporting Organizations
SPIE, AAPM, ACR, CDRH, NEMA
Chairs
Roger H. Schneider
Program Committee
Ronald L. Arenson; Harrison H. Barrett; Roger A. Bauman; David G. Brown; Arthur E. Burgess; Gerald Cohen; William Dallas; Kunio Doi; Samuel J. Dwyer III; Aaron Fenster; Kenneth M. Hanson; David G. Hill; Robert Hendel; Steven C. Hori; H. K. Huang; Robert J. Jennings; R. Gilbert Jost; Yongmin Kim; Robert A. Kruger; Per-Jan Paul Lin; Murray H. Low; Richard L. Morin; Seo-ki Mun; Ohan Nalcioglu; Thomas R. Nelson; David R. Picken; Stephen M. Pizer; Judith M.S. Presti; Hans Roelandt; Roger Schneider; Roger Shannon; Rodney Shaw; Stephen W. Smith; Edward V. Staub; Stephen R. Thomas; Robert F. Wagner

Sessions
Future Potential of Biotelemetric and Ultrasonic Imaging - Roger H. Schneider
Future Potential of Ultrasound, CT, and Optical Imaging - Stephen W. Smith
Future Potential of Optical Imaging - William J. Dallas
MILS - Stephen R. Thomas
Calculated Images - Rodney Shaw
CT - Ohan Nalcioglu
Femto Screen Systems - Kunio Doi
Digital Quantum Images I - Hans Roelandt
Digital Quantum Images II - Aaron Fenster
Clinical Systems and Issues - Robert J. Jennings

Other Conferences
Vol # Title Editor/Conference Chair # of papers
1222 Image Capture and Display - Samuel J. Dwyer III, R. Gilbert Jost M.D., Roger H. Schneider
1223 Image Processing - Samuel J. Dwyer III, R. Gilbert Jost M.D., Roger H. Schneider
1229 PACS Systems Design and Evaluation - Samuel J. Dwyer III, R. Gilbert Jost M.D., Roger H. Schneider

1991
Medical Imaging V: Image Physics
San Jose, CA Feb 25-26
Vol. 1443 190 papers (36 in Physics) Attendance: 500
Sponsors, Co-Sponsors & Supporting Organizations
SPIE, AAPM, ACR, CDRH, ISNEMA
Chairs
Roger H. Schneider
Program Committee
Harrison H. Barrett; David G. Brown; Arthur E. Burgess; William J. Dallas; Kunio Doi; Aaron Fenster; Robert J. Jennings; Robert A. Kruger; Pei-Jan P. Lin; Richard L. Morin; Ohan Nalcioglu; Hans Roelandt; Rodney Shaw; Stephen W. Smith; Stephen R. Thomas; Robert F. Wagner

Sessions
Magnetic Imaging - Roger H. Schneider
Acoustic Imaging - David G. Brown
Radiographic and Fluorescence Spectrometry and Systems - Hans Roelandt
Decision Makers and Display - Arthur E. Burgess
Computing Images: CR, CT, and PET - Kenneth M. Hanson
 Cone Beam CT - Aaron Fenster
 Optical Imaging - Aaron Fenster

Other Conferences
Vol # Title Editor/Conference Chair # of papers
1444 Image Capture, Formatting, and Display - Yongmin Kim
1445 Image Processing - Murray H. Low
1446 PACS Design and Evaluation - R. Gilbert Jost M.D.,
2004

Medical Imaging 2004: Physics of Medical Imaging
San Diego, CA 14 - 19 February
Vol. 5368 653 papers (152 in Physics) Attendance: 1048
Sponsors, Co-Sponsors & Supporting Organizations
SPIE; AIPM; APS; CDRH; IS&T; NEMA; RSNA; SCAR

Chairs
Martin J. Yaffe, Michael J. Flynn

Program Committee
Harrison H. Barrett; John M. Boone; Tom J. C. Bruijns; James T. Dobbins III; Paul R. Granbom; John Yorkston; Wei Zhao

Sessions
Imaging Performance - Harrison H. Barrett
Computer Tomography - Tom J. C. Bruijns
Imaging Systems Analysis I - James T. Dobbins III
Digital Radiography - John Yorkston
Optical/US/Acoustic Imaging - Harrison H. Barrett
Micro Tomography - Michael J. Flynn
Computed Tomography II - Jiang Heish
Digital Radiography II - Wei Zhao
Imaging Systems Analysis II - Michael J. Flynn
Mammography - Martin J. Yaffe

Other Conferences
Vol # Title Editor/Conference Chair # of papers
5367 Visualization, Image-Guided Procedures, and Display Robert L. Galloway, Jr 92
5369 Physiology Function, and Structure from Medical Images Amre A. Amri, Armando Manuca 90
5370 Image Processing J. Michael Fitzpatrick, Milan Sonka 232
5371 PACS and Imaging Informatics Osman M. Rathi, H. K. Huang 48
5372 Image Perception, Observer Dev P. Chakrabarty, Miguel P. Eckstein 90
Performance, and Tech Assessment Eckstein
5373 Ultrasonic Imaging and Signal Process William Walker, Stanislav Emeljanov 39

2005

Medical Imaging 2005: Physics of Medical Imaging
San Diego, CA 12-17 February
Vol. 5745 745 papers (144 in Physics) Attendance: 1180
Sponsors, Co-Sponsors & Supporting Organizations
SPIE; AIPM; APS; CDRH; IS&T; MIP; NEMA; RSNA; SCAR

Chairs
Michael J. Flynn

Program Committee
Aldo Badano; Harrison H. Barrett; James T. Dobbins III; Jiang Heish; Bruce R. Whiting; Martin J. Yaffe; John Yorkston; Wei Zhao

Sessions
Keynote Session - Michael J. Flynn
Image Data Analysis - Bruce R. Whiting
Innovative Imaging Methods - Michael J. Flynn
X-ray Computed Tomography - Jiang Heish
X-ray Imaging Detectors - Wei Zhao
Computational Simulations - Michael J. Flynn
X-ray Computed Tomography - Bruce R. Whiting
X-ray Imaging Detectors - Martin J. Yaffe
Performance Measurement - Aldo Badano
Digital Radiography - John Yorkston
Tomosynthesis and Dual Energy Imaging - James T. Dobbins III

Other Conferences
Vol # Title Editor/Conference Chair # of papers
5746 Visualization, Image-Guided Procedures, and Display Robert L. Galloway, Jr, Kevin R. Cleary
5748 Physiology Function, and Structure from Medical Images Amre A. Amri, Armando Manuca 99
5749 Image Processing Michael Fitzpatrick, Joe Rentzard 231
5748 PACS and Imaging Informatics Osman M. Rathi, H. K. Huang 93
5749 Image Perception, Observer Dev P. Chakrabarty, Miguel P. Eckstein 54
5750 Ultrasound Imaging & Signal Process. William Walker, Stanislav Emeljanov 56

2006

Medical Imaging 2006: Physics of Medical Imaging
San Diego, CA 11–16 February
Vol. 6142 760 papers (194 in Physics) Attendance: 1169
Sponsors, Co-Sponsors & Supporting Organizations
SPIE; AIPM; APS; CDRH; IS&T; MIP; NEMA; RSNA; SCAR

Chairs
Michael J. Flynn, Jiang Heish

Program Committee
Aldo Badano; Harrison H. Barrett; Jeffrey A. Fessler; Thomas Florh; Robert M. Nishikawa; Michael Overdick; John A. Rowlands; Ehsan Samei; Richard L. Van Meter; Bruce R. Whiting; Wei Zhao

Sessions
Keynote Session - Michael J. Flynn
Mammography - Robert M. Nishikawa
Tomosynthesis - Richard L. Van Meter
X-ray CT - Cardiac - Jiang Heish
Optical and MR Imaging - Harrison H. Barrett
X-ray Imaging Detectors I & II - John A. Rowlands & Wei Zhao
X-ray CT - Systems - Bruce R. Whiting
Innovative Imaging - Jiang Heish
X-ray Imaging - Michael Overdick
Dual Energy X-ray Imaging - Michael J. Flynn
Computational Simulation - Aldo Badano
CT and DR Performance Assessment - Ehsan Samei
Core Beam Reconstruction - Jeffrey A. Fessler
CT Image Reconstruction - Thomas Florh

Other Conferences
Vol # Title Editor/Conference Chair # of papers
6141 Visualization, Image-Guided Procedures, and Display Kevin Cleary, Robert Galloway 94
6143 Physiology Function, and Structure from Med Imag Amre A. Amri, Armando Manuca 117
6144 Image Processing Joseph Rentzard, Jason Plum 243
6145 PACS and Imaging Informatics Daniel C. Hest, Daniel M. Rado 43
6146 Image Perception, OI/Perform, & Tech Assess couples Yuliang Jiang, Miguel P. Eckstein 44
6147 Ultrasonic Imaging and Signal Processing Stanislav Emeljanov, William Walker 35

2007

Medical Imaging 2007: Physics of Medical Imaging
San Diego, CA 17–22 February
Vol. 6510 858 papers (201 in Physics) Attendance: 1278
Sponsors, Co-Sponsors & Supporting Organizations
SPIE; AIPM; APS; CDRH; IS&T; MIP; NEMA; RSNA; SCAR

Chairs
Jiang Heish, Michael J. Flynn

Program Committee
Aldo Badano; Jeffrey A. Fessler; Thomas Florh; Christoph Hoaschen; Robert M. Nishikawa; Michael Overdick; John A. Rowlands; Ehsan Samei; Katsuyuki Taguchi; Richard L. Van Meter; Bruce R. Whiting

Sessions
Dual Energy - Richard L. Van Meter
Performance Assessment - John A. Rowlands
Innovative Imaging I & II - Aldo Badano & Michael J. Flynn
Detector Technology - Michael Overdick
System Modeling - Christoph Hoaschen
Cardiac Imaging - Jiang Heish
Optical Imaging - Ehsan Samei
Breast Imaging - Ehsan Samei
Tomosynthesis - Robert M. Nishikawa
CT Systems - Bruce R. Whiting
Signal Corrections - Thomas Florh
Core Beam Reconstruction - Jeffrey A. Fessler
Advanced Reconstruction - Katsuyuki Taguchi

Other Conferences
Vol # Title Editor/Conference Chair # of papers
6510 Visualization, Image-Guided Procedures Kevin R. Cleary, Michael J. Miga 145
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2011

Medical Imaging 2011: Physics of Medical Imaging

Lake Buena Vista, FL 13–17 February
Vol. 7961 864 papers (204 in Physics) Attendance: 1136

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Sessions
Keynote and Imaging and Health Economics - Norbert J. Pelc; Ehsan Samei
X-ray Imaging - John A. Rowlands; Christoph Hoeschen
Metrology - Robert M. Nishikawa; John Yorkston
Iterative and Statistical Reconstruction - Jinyi Qi; Guang-Hong Chen
Detectors I & II - John Yorkston; John A. Rowlands / Karim S. Karim; Mats Danielsson
Breast Imaging - Anders Tingberg; Stephen J. Glick
Tomosynthesis I: Reconstruction - John M. Sabol; Michael Grass
Tomosynthesis II - Despina Kontos; Anders Tingberg
X-ray Imaging: Phase Contrast Diffraction - Jeffrey H. Siewerdsen; Taly Gilat Schmidt
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Novel Systems - Mats Danielsson; Taly Gilat Schmidt
CT IV: Cone Beam - Maria Drangova; Marc Kachelriess
Dose - Iacovos S. Kyprianou; Hee-Joung Kim
Two Special Sessions on Dose with a Panel Discussion - Ehsan Samei; Dianna D. Cody / Christoph Hoeschen; Michael F. McNitt-Gray / Ehsan Samei
2012

Medical Imaging 2012: Physics of Medical Imaging

San Diego, CA  Feb 5-9
Vol. 8313  909 papers (233 in Physics)  Attendance: ?

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Sessions
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3D Breast Imaging - Hilde Bosmans; Joseph Y. Lo
Breast Multi-Energy/Photon Counting - Mats E. Danielsson; Stephen J. Glick
Mammography - Anders Tingberg; Despina Kontos
X-Ray Imaging - Hee-Joung Kim; Karim S. Karim
Small Animal Imaging - John Yorkston; Maria Drangova
Photon Counting Systems and Techniques - Taly G. Schmidt; Jeffrey H. Siewerdsen
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CT - Dianna D. Cody; Marc Kachelriess
CT Detection Performance - Jinyi Qi; Bruce R. Whiting
Dose - Christoph Hoeschen; Dianna D. Cody
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### Abbreviations

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<tr>
<th>Abbreviation</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>AAMI</td>
<td>Association for the Advancement of Medical Instrumentation</td>
</tr>
<tr>
<td>AAPM</td>
<td>American Association of Physicists in Medicine</td>
</tr>
<tr>
<td>ACR</td>
<td>American College of Radiology</td>
</tr>
<tr>
<td>APS</td>
<td>American Physiological Society</td>
</tr>
<tr>
<td>ARRS</td>
<td>American Roentgen Ray Society</td>
</tr>
<tr>
<td>ASNR</td>
<td>American Society of Neuroradiology</td>
</tr>
<tr>
<td>BIOS</td>
<td>Biomedical Optics Society</td>
</tr>
<tr>
<td>BRH</td>
<td>Bureau of Radiological Health, Department of Health, Education And Welfare</td>
</tr>
<tr>
<td>CARS</td>
<td>Computer Assisted Radiology and Surgery</td>
</tr>
<tr>
<td>CDRH</td>
<td>Center for Devices and Radiological Health, FDA</td>
</tr>
<tr>
<td>DICOM</td>
<td>The DICOM Standards Committee</td>
</tr>
<tr>
<td>EFOMP</td>
<td>European Federation of Organizations for Medical Physics</td>
</tr>
<tr>
<td>EMBG</td>
<td>IEEE Engineering in Medicine and Biology Group</td>
</tr>
<tr>
<td>EMBS</td>
<td>IEEE—The Institute of Electrical and Electronics Engineers/Engineering in Medicine and Biology Society</td>
</tr>
<tr>
<td>IEEE-CS</td>
<td>IEEE Computer Society, Technical Committee on Computational Medicine</td>
</tr>
<tr>
<td>IRS</td>
<td>Institute for Regulatory Science</td>
</tr>
<tr>
<td>IS&amp;T</td>
<td>The Society for Imaging Science and Technology</td>
</tr>
<tr>
<td>JPL</td>
<td>Jet Propulsion Laboratory</td>
</tr>
<tr>
<td>MIPS</td>
<td>Medical Image Perception Society</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Electrical Manufacturers Association/Diagnostic Imaging and Therapy, Systems Division</td>
</tr>
<tr>
<td>OSA</td>
<td>The Optical Society of America</td>
</tr>
<tr>
<td>RISC</td>
<td>Radiology Information System Consortium</td>
</tr>
<tr>
<td>RSNA</td>
<td>Radiological Society of North America</td>
</tr>
<tr>
<td>SCAR</td>
<td>Society for Computer Applications in Radiology</td>
</tr>
<tr>
<td>SIIM</td>
<td>Society for Imaging Informatics in Medicine</td>
</tr>
<tr>
<td>SMI</td>
<td>The Society for Molecular Imaging</td>
</tr>
<tr>
<td>SNM</td>
<td>The Society of Nuclear Medicine</td>
</tr>
<tr>
<td>SPIE</td>
<td>The Society of Photo-Optical Instrumentation Engineers</td>
</tr>
<tr>
<td>SPSE</td>
<td>The Society of Photographic Scientists and Engineers</td>
</tr>
<tr>
<td>SRE</td>
<td>Society for Radiological Engineering</td>
</tr>
<tr>
<td>UWMS</td>
<td>University of Wisconsin Medical School</td>
</tr>
<tr>
<td>WMIS</td>
<td>World Molecular Imaging Society</td>
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</tbody>
</table>
The Image Perception & Performance Conference has not been a track in the SPIE Medical Imaging Meeting for 40 years, but has been an integral part of the meeting since its inception in 1994 in a variety of ways. Everything discussed at the SPIE Medical Imaging meeting, whether overtly discussed or implied, relates back to one fundamental idea – developing better tools for radiologists and other clinicians to render more effective and efficient diagnostic decisions. Thus image perception and observer performance issues are fundamental to the medical imaging field. This poster highlights some of the trends observed since 1994 years at the SPIE Medical Imaging meeting as they relate specifically to the Image Perception & Performance Conference. The Image Perception track has covered a wide variety of areas, including Methods for Assessing Performance, Mathematical Observer Modeling, Human-Computer Interface & Ergonomics, Eye-Tracking & Visual Search, and Clinical Decision Making. Investigation of the perceptual and cognitive factors underlying medical image interpretation is an important and valuable endeavor that contributes significantly to our continuing efforts to improve the detection, diagnosis and treatment of diseases to improve patient care and well-being. Collaborations between medical physicists, workstation design engineers, image processing and image analysis scientists, and vision and cognitive psychologists should be encouraged to facilitate and promote further research in medical image perception so that patient care can be improved.

Keywords: image perception, 40th anniversary

INTRODUCTION

The Image Perception & Performance Conference has not been a track in the SPIE Medical Imaging Meeting for all 40 years, but it has been an integral part of the meeting since its inception in 1994. Initially it was called the “Image Perception” conference. In 1999 the name was changed to “Image Perception and Performance”, and in 2002 it was changed to “Image Perception, Observer Performance, and Technology Assessment” which is its current title. These changes in the title since 1994 reflect not only the growth of the conference and its participants, but also the recognition that perception goes far beyond simply trying to understand the role of the visual system and visual processing in medical image interpretation. In order to fully appreciate and comprehend the interpretation process, observer performance (what decisions are rendered, the accuracy of those decisions, the efficiency with which they are made etc.) must also be taken into account. Additionally, the technology involved in the acquisition and display of the image data as well as the task to be undertaken by the user with those images (e.g., detection, diagnosis, measurement, treatment recommendation, etc.) is critical to the outcome of the interpretation process.

WHY AN IMAGE PERCEPTION CONFERENCE?

The Image Perception Conference was established by Harold L. Kundel, MD (Department of Radiology, University of Pennsylvania) in 1994. He was the Chair of the conference from 1994 – 1998 and from 1999 – 2000 Elizabeth Krupinski, PhD (University of Arizona) was the Chair. Starting in 2001, the conference had grown enough to warrant two chairs and Dev Chakraborty, PhD (University of Pittsburgh) joined Dr. Krupinski until 2003. Since 2004 the Chairs have rotated on and off and have included: Miguel Eckstein, PhD (University of California Santa Barbara), Yulei Jiang, PhD (University of Chicago), Berkman Sahiner, PhD (FDA), David Manning, PhD (the first international Chair; Lancaster University), Craig Abbey, PhD (University of California Santa Barbara), and Claudia Mello-Thoms, PhD (University of Pittsburgh).
Since an independent Perception conference was not part of the Medical Imaging meeting in the early years, the question is why was one established? Dr. Kundel describes the rationale for establishing this conference track and some of his observations from attending over the years.

“Until 1964, papers about image perception submitted to the SPIE Medical Imaging Meeting were assigned mainly to the Physics and Image Processing Conferences. At the 1963 meeting Sam Dwyer suggested that the perception papers should be grouped together and he asked me to organize a Perception Conference for the 1994 meeting. I relied on submitted papers and a little recruitment to put together the first conference. The participants, whom I will not name for fear of either intimidating or omitting someone, included investigators from Canada, France, the Netherlands, Russia, the United Kingdom, and the United States. They represented universities, industry and government. The papers were grouped into five sections by topics that I believe are still relevant today.

1. Performance on Noise Limited Imaging Tasks;
2. Visual Search and Object Recognition;
3. Factors Determining Image Acceptance;
4. Measuring Observer Performance on Imaging Tasks;
5. Modeling the Human Observer.

Since its inception the simple title “Image Perception” has evolved into “Image Perception, Observer Performance, and Technology Assessment” perhaps to better reflect the subject matter. Imaging has also advanced from plain, projection images to computed tomography (CT), three dimensional imaging and, amazingly, stereoscopy, which was almost completely abandoned in the 1960s. Technological advances have not eliminated the need for humans to interpret images. Indeed, the problems of misinterpretation have not gone away. Computer aided diagnosis is still in its infancy and has a long way to go despite the arrival of the IBM Watson Supercomputer. Meanwhile it is both challenging and productive to try to understand the working of that exquisite pattern recognition apparatus - the human brain.”

Harold L. Kundel, M.D.
Professor Emeritus of Radiology
University of Pennsylvania
Philadelphia, PA
December 20, 2011

SOME FACTS & FIGURES

Everything discussed at the SPIE Medical Imaging meeting, whether overtly or implied, relates back to one fundamental idea – developing better tools/images for radiologists and other clinicians to render more effective and efficient diagnostic decisions to improve patient care. Thus image perception and observer performance issues are fundamental to the medical imaging field. The Image Perception track has covered a wide variety of areas over the years, including Methods for Assessing Performance, Mathematical Observer Modeling, Human-Computer Interface & Ergonomics, Eye-Tracking & Visual Search, and Clinical Decision Making.

The SPIE Medical Imaging Conference itself brings together a wide variety of people, but it is perhaps in the area of image perception that we have seen the greatest variety and change. The Image Perception track generally includes those investigating the process of extracting diagnostic information from medical images and rendering diagnostic decisions, and this therefore includes radiologists, psychologists, statisticians, physicists, engineers, and others in this growing research community. The investigators have come from universities, hospitals, private companies, and government agencies (e.g., NIH, FDA, military).
It is interesting and revealing to examine some of the facts and figures associated with the Image Perception Conference. The first conference in 1994 was chaired by Hal Kundel and the Program Committee included David Beard, Larry Cook, David Gur and Elizabeth Krupinski. There were 5 sessions at that meeting, and although the conference has expanded and the titles changed, these core sessions clearly served as the foundation for future meetings with the themes still present in today’s 2012 conference. The sessions as noted above were: “Performance on Noise-Limited Tasks”, “Observer Performance – Visual Search & Object Recognition”, “Factors Determining image Acceptance”, “Image System Evaluation – Performance Indices”, and “Modeling the Human Observer”. There were 24 talks across these 5 sessions. Participation in the poster session did not start until 1995.

For the 2012 conference there are two chairs and the Program Committee has 14 members, 6 of whom are international! There are now 8 sessions with 41 presentations plus 29 presentations in the poster session. As can be seen, the session topics, although broader, are still focused on the same key issues: “Technology Assessment”, “Image Display”, “ROC Analysis” “Image Perception”, “Digital Pathology I & II”, “Model Observers”, and “Observer Performance”. The notable addition in 2012 is the Digital Pathology sessions organized jointly with the Image Processing and Computer-Aided Diagnosis Conferences. The focus on Digital Pathology brings to the forefront the growth not only of the Perception Conference but the entire meeting as a whole, as it recognizes the importance of imaging in other clinical specialties and emphasizes the benefits derived from cross-fertilization of fields and sharing of ideas, tools, methods and results.

The first Keynote Address occurred at the 1998 meeting and was give by Art Burgess, PhD. The title of his talk was “From Light to Optic Nerve: Optimization of the Front End Visual Systems”. Since then the Keynotes have spanned a range of topics from pure perception to performance measurement to clinical applications and implications of image perception research. To pay tribute to the Conference founder and his significant contributions to medical image perception over the years, the Keynote lecture was named the “Harold Kundel Honorary Lecture” in 2007 and Hal gave the first keynote with the new title called “How to Minimize Perceptual Error and Maximize Expertise in Medical Imaging”. The Keynote Address for 2012 illustrates again the expanding scope of medical image perception, with Michael Becich, MD presenting “Pathology: Why the Future of Medicine’s Gold Standard is to go Digital”.

Workshops were not a part of the conference at the beginning, but have evolved into an integral part of the meeting for those interested in medical image perception. The focus of the workshops has varied over the years, but some of the more exciting ones have involved researchers bringing their “tools of the trade” to the meeting for others to view and interact with. For example, one year participants brought eye-position recording systems to the meeting, allowing many researchers to see first-hand for the first time the equipment used in many of the core visual search studies that had been presented at the SPIE Medical Imaging meeting in previous years. It is impossible to say definitively that this workshop and others that have highlighted eye-position recording tools caused researchers to get involved in eye-tracking, but there has been a steady growth in the use of these tools since these workshops were held with a significant amount of new and exciting research results produced.

The number of papers published in the SPIE Proceedings has naturally fluctuated over the years, but as Figure 1 shows there has been a steady increase in the Perception conference papers with 2012 reaching an all time high of 70! To some extent the number of papers presented in the Perception conference today is a function of the number of slots available and the time allotted to the conference during the meeting. Today the oral presentations span two full days of the meeting, with the workshop starting things off the night before Session I and the poster session taking place on the night of the first full day. In contrast, the first conference had no workshop, no keynote speakers and essentially took place in a single day. It has grown considerably over the years and we look forward to expanding even further in future years.
The SPIE Medical Imaging meeting and the Image Perception Conference in particular has fostering the growth of the medical image perception field in a number of key ways. The first “Far West Image Perception Conference” actually preceded the establishment of the SPIE Perception Conference as it was first held in 1985. Today it is called the “Medical Image Perception Meeting” and is hosted by the Medical Image Perception Society (MIPS). However, the two meetings over the years have complimented each other and brought together an array of researchers whose goal is to improve our understanding of the medical image interpretation process. The value of the SPIE Perception Conference is that it allows those researchers from other diverse fields (physics, ultrasound, robotics, CAD, image processing, PACS, etc.) to get a better idea of what medical image perception is all about by providing the ready opportunity to attend talks and view posters within the context of the greater Medical Imaging meeting. The 2012 meeting with the joint Digital Pathology sessions highlights the way that the various tracks, although independent, are also quite integrated and together foster new directions and improved understanding of medical imaging in general.

Another way that the SPIE meeting has fostered growth in medical image perception is through its efforts to foster and promote student participation. It is safe to say that nearly all of the subsequent Conference Chairs and Program Committee members since Dr. Kundel were at one time student presenters at the SPIE Medical Imaging Meeting in the Perception Conference! The value of the meeting in terms of providing opportunities for students to not only present their research, but also to interact with the experienced experts in the field is immeasurable. The Perception Conference provides a unique opportunity for students to attend a variety of sessions that cover everything from basic perception to vision modeling to technology evaluation and evaluation methods to clinical applications of perception research. The poster sessions in particular have provided burgeoning perception students with a valuable opportunity to present their research findings in an extended (and hopefully non-threatening!) environment where they can receive one-on-one feedback from experienced investigators. It also provides them

Investigation of the perceptual and cognitive factors underlying medical image interpretation is an important and valuable endeavor that contributes significantly to our continuing efforts to improve the detection, diagnosis and treatment of diseases to improve patient care and well-being. Collaborations between medical physicists, workstation
design engineers, image processing and image analysis scientists, and vision and cognitive psychologists should be encouraged to facilitate and promote further research in medical image perception so that patient care can be improved.

Radiology services, especially high-technology modalities, second opinion and teleradiology have increased significantly in recent years. Fewer radiologists now read more studies, each containing more images, in less time. The same is true in many of the other image-based clinical specialties, especially with the increase in telemedicine services being provided nationally and internationally. The visual tasks faced by radiologists and other imaging clinicians have continuously changed as new imaging techniques have arrived. As new technologies continue to evolve so will the demands placed on the diagnostic image interpretation process and thus on the interpreting clinicians. The effort required to process and manipulate images at the point of interpretation will continue to be at the forefront of medical imaging research. The need to understand how the clinician interacts with the images presented to them, how to enhance the development of expertise in interpretation, and how to optimize the images as well as the interpretation environment continues to grow. Image perception researchers will continue to lead the way in these efforts and will hopefully continue to have a home at the SPIE Medical Imaging Meeting to present their research findings, interact with the peers, and foster and find the mentorship and inspiration needed to take the field of medical image perception into the future.