

Medical Imaging 2007

PACS and Imaging Informatics

Steven C. Horii

Katherine P. Andriole

Editors

20–22 February 2007

San Diego, California, USA

Sponsored and Published by

SPIE—The International Society for Optical Engineering

Cooperating Organizations

AAPM—American Association of Physicists in Medicine (USA)

APS—American Physiological Society (USA)

CARS—Computer Assisted Radiology and Surgery (Germany)

IS&T—The Society for Imaging Science and Technology

MIPS—Medical Image Perception Society (USA)

RSNA—Radiological Society of North America (USA)

SIIM—Society for Imaging Informatics in Medicine (USA)

SMI—The Society for Molecular Imaging

The DICOM Standards Committee (USA)

Volume 6516



The International Society
for Optical Engineering

Proceedings of SPIE—The International Society for Optical Engineering, 9780819466341, v. 6516

SPIE is an international technical society dedicated to advancing engineering and scientific applications of optical, photonic, imaging, electronic, and optoelectronic technologies.

The papers included in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. The papers published in these proceedings reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from this book:

Author(s), "Title of Paper," in *Medical Imaging 2007: PACS and Imaging Informatics*, edited by Steven C. Horii, Katherine P. Andriole, Proceedings of SPIE Vol. 6516 (SPIE, Bellingham, WA, 2007) Article CID Number.

ISSN 1605-7422
ISBN 9780819466341

Published by
SPIE—The International Society for Optical Engineering
P.O. Box 10, Bellingham, Washington 98227-0010 USA
Telephone 1 360/676-3290 (Pacific Time) · Fax 1 360/647-1445
<http://www.spie.org>

Copyright © 2007, The Society of Photo-Optical Instrumentation Engineers

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at <http://www.copyright.com>. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 1605-7422/07/\$18.00.

Printed in the United States of America.

Contents

- ix *Conference Committee*
- xi *Introduction*

SESSION 1 SURGICAL PACS

- 651602 **Specification and design of a Therapy Imaging and Model Management System (TIMMS)** [6516-01]
H. U. Lemke, Univ. of Southern California (USA); L. Berliner, New York Methodist Hospital (USA)
- 651603 **Summary of the white paper of DICOM WG24: DICOM in Surgery** [6516-02]
H. U. Lemke, Univ. of Southern California (USA)
- 651604 **Deriving DICOM surgical extensions from surgical workflows** [6516-03]
O. Burgert, T. Neumuth, M. Gessat, S. Jacobs, H. U. Lemke, Univ. Leipzig (Germany)
- 651605 **Video and LAN solutions for a digital OR: the Varese experience** [6516-04]
U. Nocco, E. Coccozza, Varese Town Hospital (Italy); M. Sivo, Infrastrutture Lombarde S.p.A. (Italy); G. Peta, Olympus Italia (Italy)
- 651606 **Virtual microscopy in medical research: Open European Nephrology Science Center (OpEN.SC)** [6516-05]
T. Schrader, Charité-Univ. Medizin Berlin (Germany); M. Beil, Lausitz Univ. of Applied Sciences (Germany); D. Schmidt, Humboldt Univ. Berlin (Germany); M. Dietel, Charité-Univ. Medizin Berlin (Germany); G. Lindemann, Humboldt Univ. Berlin (Germany)

SESSION 2 JOINT SESSION PACS/VISUALIZATION

- 651607 **Flexible high-resolution display systems for the next generation of radiology reading rooms** [6516-06]
J. J. Caban, Univ. of Maryland (USA); B. J. Wood, National Institutes of Health (USA); A. Park, Univ. of Maryland Medical Ctr. (USA)

Pagination: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first publication. Utilization of CIDs allows articles to be fully citable as soon they are published online, and connects the same identifier to all online, print, and electronic versions of the publication.

SPIE uses a six-digit CID article numbering system in which:

- The first four digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc.

The CID number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages.

- 651608 **Introducing CAVASS: a Computer-Assisted Visualization and Analysis Software System** [6516-07]
G. Grevera, St. Joseph's Univ. (USA) and Univ. of Pennsylvania (USA); J. Udupa, D. Odhner, Y. Zhuge, A. Souza, T. Iwanaga, S. Mishra, Univ. of Pennsylvania (USA)
- 651609 **PACS-CAD toolkit for integrating an independent CAD workstation to diagnostic workflow** [6516-08]
Z. Zhou, A. Le, B. Liu, H. K. Huang, Univ. of Southern California (USA)
- 65160A **The Image-Guided Surgery ToolKit IGSTK: an open source C++ software toolkit** [6516-09]
P. Cheng, Georgetown Univ. Medical Ctr. (USA); L. Ibanez, Kitware Inc. (USA); D. Gobbi, Atamai Inc. (Canada); K. Gary, Arizona State Univ. (USA); S. Aylward, J. Jomier, A. Enquobahrie, Kitware Inc. (USA); H. Zhang, Accuray Inc. (USA); H. Kim, Kyungpook National Univ. (South Korea); M. B. Blake, Georgetown Univ. (USA); K. Cleary, Georgetown Univ. Medical Ctr. (USA)
- 65160B **Whole-slide imaging in pathology: the potential impact on PACS** [6516-10]
S. C. Horii, Univ. of Pennsylvania Medical Ctr. (USA)
- 65160C **Stereo display of CT images for lung cancer screening: a pilot study** [6516-44]
X. H. Wang, J. E. Durick, D. L. Herbert, A. Lu, S. K. Golla, D. D. Shinde, S. Piracha, K. Foley, C. R. Fuhrman, B. E. Shindel, J. K. Leader, W. F. Good, Univ. of Pittsburgh (USA)
- 65160D **Medical image compression using cubic spline interpolation with bit-plane compensation** [6516-52]
T.-K. Truong, I-Shou Univ. (Taiwan); S.-H. Chen, Shu-Te Univ. (Taiwan); T.-C. Lin, I-Shou Univ. (Taiwan)

SESSION 3 DATABASES AND DATA MINING I

- 65160E **A web collaboration system for content-based image retrieval of medical images** [6516-11]
D. Tahmoush, H. Samet, Univ. of Maryland/College Park (USA)
- 65160F **Data management integration for biomedical core facilities** [6516-12]
G.-Q. Zhang, J. Szymanski, D. Wilson, Case Western Reserve Univ. (USA)
- 65160G **A new database for medical images and information** [6516-13]
D. Tahmoush, H. Samet, Univ. of Maryland/College Park (USA)
- 65160H **Content-based image retrieval from a database of fracture images** [6516-14]
H. Müller, P. A. Do Hoang, A. Depeursinge, P. Hoffmeyer, R. Stern, C. Lovis, A. Geissbuhler, Univ. Hospitals of Geneva (Switzerland)
- 65160I **Flexible patient information search and retrieval framework: pilot implementation** [6516-15]
S. Erdal, U. V. Catalyurek, J. Saltz, J. Kamal, M. N. Gurcan, The Ohio State Univ. Medical Ctr. (USA)
- 65160J **Gaps in content-based image retrieval** [6516-16]
T. M. Deserno, Aachen Univ. of Technology (Germany) and National Library of Medicine, National Institutes of Health (USA); S. Antani, R. Long, National Library of Medicine, National Institutes of Health (USA)

SESSION 4 DATABASES AND DATA MINING II

- 65160K **Finding relevant PDF medical journal articles by the content of their figures** [6516-17]
A. Christiansen, D.-J. Lee, Y. Chang, Brigham Young Univ. (USA)
- 65160L **Exploring access to scientific literature using content-based image retrieval** [6516-18]
T. M. Deserno, Aachen Univ. of Technology (Germany) and National Library of Medicine, National Institutes of Health (USA); S. Antani, R. Long, National Library of Medicine, National Institutes of Health (USA)
- 65160M **Development of an indexed integrated neuroradiology reports for teaching file creation** [6516-19]
H. Z. Tameem, C. Morioka, D. Bennett, S. El-Saden, U. Sinha, R. Taira, A. Bui, H. Kangarloo, Univ. of California/Los Angeles (USA)
- 65160N **Content-based image retrieval for pulmonary computed tomography nodule images** [6516-20]
M. Lam, James Madison Univ. (USA); T. Disney, Seattle Pacific Univ. (USA); M. Pham, Mt. Holyoke College (USA); D. Raicu, J. Furst, R. Susomboon, DePaul Univ. (USA)
- 65160O **Design and implementation of a fault-tolerant and dynamic metadata database for clinical trials** [6516-21]
J. Lee, Z. Zhou, Univ. of Southern California (USA); E. Talini, Univ. of Pisa (Italy); J. Documet, B. Liu, Univ. of Southern California (USA)
- 65160P **Integrated secure solution for electronic healthcare records sharing** [6516-45]
Y. Yao, C. Zhang, J. Sun, J. Jin, J. Zhang, Shanghai Institute of Technical Physics (China)
- 65160Q **A digital library for medical imaging activities** [6516-47]
M. dos Santos, S. S. Furuie, Heart Institute, Univ. of Sao Paulo Medical School (Brazil) and Univ. of Sao Paulo (Brazil)

SESSION 5 INFRASTRUCTURE: DEVICES, SYSTEMS, AND STANDARDS

- 65160R **A grid-based implementation of XDS-I as a part of a metropolitan EHR in Shanghai** [6516-22]
J. Zhang, C. Zhang, J. Sun, Y. Yang, J. Jin, F. Yu, Z. He, Shanghai Institute of Technical Physics (China); X. Zheng, H. Qin, Shanghai Sixth Hospital (China); J. Feng, G. Zhang, Huandong Hospital (China)
- 65160S **Design and implementation of a web-based data grid management system for enterprise PACS backup and disaster recovery** [6516-23]
Z. Zhou, Univ. of Southern California (USA); K. Ma, Univ. of Texas/Austin (USA); E. Talini, Univ. of Pisa (Italy); J. Documet, J. Lee, B. Liu, Univ. of Southern California (USA)
- 65160T **Managing healthcare information using short message service (SMS) in wireless broadband networks** [6516-24]
J. Documet, S. Tsao, Univ. of Southern California (USA); L. Documet, Saints John's Health Ctr. (USA); B. J. Liu, Z. Zhou, A. O. Joseph, Univ. of Southern California (USA)

- 65160U **A data grid for imaging-based clinical trials** [6516-25]
Z. Zhou, S. S. D. Chao, J. Lee, B. Liu, J. Documet, H. K. Huang, Univ. of Southern California (USA)
- 65160V **A PDA study management tool (SMT) utilizing wireless broadband and full DICOM viewing capability** [6516-26]
J. Documet, B. Liu, Z. Zhou, H. Huang, Univ. of Southern California (USA); L. Documet, Saint John's Health Ctr. (USA)
- 65160W **Development of a new resolution enhancement technology for medical liquid crystal displays** [6516-42]
K. Ichikawa, Y. Kodera, Nagoya Univ. (Japan); Y. Nishi, S. Hayashi, M. Hasegawa, Totoku Electric Co., Ltd. (Japan)
- 65160X **Characterization of color-related properties of displays for medical applications (Cum Laude Poster Award)** [6516-43]
J. Fan, Univ. of Arizona (USA); H. Roehrig, Univ. of Arizona (USA) and College of Optical Sciences, Univ. of Arizona (USA); E. Krupinski, Univ. of Arizona (USA)
- 65160Y **Comparison of fingerprint and facial biometric verification technologies for user access and patient identification in a clinical environment** [6516-46]
B. Guo, Univ. of Southern California (USA); Y. Zhang, Georgia Institute of Technology (USA); J. Documet, B. Liu, J. Lee, R. Shrestha, K. Wang, H. K. Huang, Univ. of Southern California (USA)
- 65160Z **Anonymization server system for DICOM images** [6516-48]
H. Suzuki, M. Amano, Graduate School of Advanced Technology and Science, Univ. of Tokushima (Japan); M. Kubo, Y. Kawata, N. Niki, H. Nishitani, Univ. of Tokushima Graduate School (Japan)

SESSION 6 CLINICAL APPLICATIONS AND QUALITY ASSURANCE I

- 651610 **Characterization of mobile display systems for use in medical imaging** [6516-28]
A. Saha, H. Liang, A. Badano, U.S. Food and Drug Administration (USA)
- 651611 **Image quality evaluation of color displays using a Fovean color camera** [6516-29]
H. Roehrig, W. J. Dallas, J. Fan, E. A. Krupinski, Univ. of Arizona (USA); G. R. Redford, Optic Valley Photonics (USA); T. Yoneda, EIZO Nanao Corp. (Japan)
- 651612 **Accurate color measurement methods for medical displays** [6516-30]
A. Saha, H. Liang, A. Badano, U.S. Food and Drug Administration (USA); E. F. Kelley, NIST (USA)
- 651613 **Volumetric measurements of pulmonary nodules: variability in automated analysis tools** [6516-31]
K. Juluru, VA Maryland Healthcare (USA) and Johns Hopkins Univ. School of Medicine (USA); W. Kim, W. Boonn, VA Maryland Health Care System (USA) and Hospital of the Univ. of Pennsylvania (USA); T. King, Univ. of Maryland School of Medicine (USA); K. Siddiqui, E. Siegel, VA Maryland Healthcare (USA)

- 651614 **Utilization of a global data grid repository in CAD assessment of carotid wall thickness** [6516-32]
M. A. Gutierrez, Univ. of Sao Paulo Medical School (Brazil); J. Lee, Z. Zhou, Univ. of Southern California (USA); P. E. Pilon, S. G. Lage, Univ. of Sao Paulo Medical School (Brazil)

SESSION 7 CLINICAL APPLICATIONS AND QUALITY ASSURANCE II

- 651616 **A knowledge-based imaging informatics approach to managing patients treated with proton beam therapy** [6516-34]
B. J. Liu, H. K. Huang, Univ. of Southern California (USA); M. Law, Hong Kong Polytechnic Univ. (China); A. Le, J. Documet, A. Gertych, Univ. of Southern California (USA)
- 651617 **Effect of increased ambient lighting on detectability: a psychophysical study** [6516-35]
A. S. Chawla, B. Pollard, E. Samei, Duke Univ. (USA); N. Hashimoto, Eizo Nanao Corp. (USA)
- 651618 **Bone age assessment for young children from newborn to 7-year-old using carpal bones** [6516-36]
A. Zhang, A. Gertych, B. J. Liu, H. K. Huang, Univ. of Southern California (USA)
- 651619 **A CAD system and quality assurance protocol for bone age assessment utilizing digital hand atlas** [6516-37]
A. Gertych, A. Zhang, B. Ferrara, B. J. Liu, Univ. of Southern California (USA)
- 65161A **Image migration: measured retrieval rates** [6516-38]
R. M. Witt, School of Medicine, Indiana Univ. (USA) and Richard L. Roudebush VA Medical Ctr. (USA)

SESSION 8 CLINICAL APPLICATIONS AND QUALITY ASSURANCE III

- 65161B **Observer success rates for identification of 3D surface reconstructed facial images and implications for patient privacy and security** [6516-39]
J. J. Chen, Univ. of Maryland School of Medicine (USA); K. M. Siddiqui, L. Fort, R. Moffitt, K. Juluru, W. Kim, VA Maryland Health Care System (USA); N. Safdar, Univ. of Maryland School of Medicine (USA); E. L. Siegel, Univ. of Maryland School of Medicine (USA) and VA Maryland Healthcare System (USA)
- 65161E **Computer-aided diagnosis workstation and network system for chest diagnosis based on multislice CT images** [6516-49]
H. Satoh, Tokyo Healthcare Univ. (Japan); N. Niki, Univ. of Tokushima (Japan); K. Mori, Tochigi Cancer Ctr. Hospital (Japan); K. Eguchi, Tokai Univ. School of Medicine (Japan); M. Kaneko, R. Kakinuma, N. Moriyama, National Cancer Ctr. Hospital (Japan); H. Ohmatsu, National Cancer Ctr. Hospital East (Japan); H. Masuda, S. Machida, Tochigi Public Health Service Association (Japan)
- 65161F **A method for assurance of image integrity in CAD-PACS integration** [6516-50]
Z. Zhou, Univ. of Southern California (USA)
- 65161G **A new approach of objective quality evaluation on JPEG2000 lossy-compressed lung cancer CT images (Honorable Mention Poster Award)** [6516-51]
W. Cai, Y. Tan, J. Zhang, Shanghai Institute of Technical Physics (China)

65161H **Is a Greulich and Pyle atlas still a good reference for bone age assessment?** [6516-53]
A. Zhang, S. Tsao, Univ. of Southern California (USA); J. W. Sayre, Univ. of California/Los Angeles School of Public Health (USA); A. Gertych, B. J. Liu, H. K. Huang, Univ. of Southern California (USA)

Author Index

Conference Committee

Symposium Chairs

Elizabeth A. Krupinski, The University of Arizona (USA)
Milan Sonka, The University of Iowa (USA)
Amir A. Amini, University of Louisville (USA)

Conference Chairs

Steven C. Horii, University of Pennsylvania (USA)
Katherine P. Andriole, Harvard Medical School (USA)

Program Committee

William M. Angus, Philips Medical Systems (USA)
William W. Boonn, University of Pennsylvania (USA)
Janice C. Honeyman-Buck, University of Florida (USA)
Heinz U. Lemke, University of Southern California (USA), Universität Leipzig (Germany), Technische Universität Berlin (Germany), and Computer Assisted Radiology and Surgery (Germany)
Brent J. Liu, University of Southern California (USA)
Greg T. Mogel, University of Southern California (USA)
Khan M. Siddiqui, VA Maryland Health Care System (USA)

Session Chairs

- 1 Surgical PACS
Heinz U. Lemke, University of Southern California (USA), Universität Leipzig (Germany), Technische Universität Berlin (Germany), and Computer Assisted Radiology and Surgery (Germany)
- 2 Joint Session PACS/Visualization
Katherine P. Andriole, Harvard Medical School (USA)
- 3 Databases and Data Mining I
Brent J. Liu, University of Southern California (USA)
- 4 Databases and Data Mining II
William W. Boonn, University of Pennsylvania (USA)
- 5 Infrastructure: Devices, Systems, and Standards
Janice C. Honeyman-Buck, University of Florida (USA)
- 6 Clinical Applications and Quality Assurance I
Khan M. Siddiqui, VA Maryland Health Care System (USA)

7 Clinical Applications and Quality Assurance II
Katherine P. Andriole, Harvard Medical School (USA)

8 Clinical Applications and Quality Assurance III
Steven C. Horii, University of Pennsylvania (USA)

Special Session

Radiology for Non-Radiologists: Part II.

Steven C. Horii, University of Pennsylvania (USA)

Introduction

With the publication of these proceedings, the PACS and Imaging Informatics conference has reached its twenty-fifth year! The first of these meetings, titled "The First International Conference and Workshop on Picture Archiving and Communications Systems (PACS) for Medical Applications," was co-chaired by Samuel J. Dwyer III and Andre Duerinckx and was held in 1982. After a few years of operating as an independent SPIE conference, it was added to a larger SPIE meeting called, "Applications of Optical Instrumentation in Medicine". With the addition of other related conferences, the meeting evolved into the large Symposium of today.

It is interesting to review the current contents of this proceedings and compare them with what appeared in the first meeting proceedings. As might be expected, the Proceedings of the 1982 conference included many papers on what we would regard as the technology infrastructure of PACS. Interestingly, there were also papers on the need for standards (two years before the organization of the ACR-NEMA Committee) and a surprising number of papers on prototype PACS. These early efforts were by true pioneers as the radiology community was highly skeptical of efforts to move away from film and lightboxes. Today, functioning PACS are a given and papers in this proceedings focus on moving the PACS concept into surgery, content-based image retrieval, support for clinical trials, and clinical applications. The conference is never far from hardware and software engineering, though, and papers on data grids and color displays are also included.

Areas of common interest with the Conference on Visualization and Image-Guided Procedures (6509) led this year to a joint session covering topics in novel display systems, computer-aided visualization and analysis, integrated CAD, an image-guided surgery toolkit, and digital whole-slide imaging in pathology.

As digital imaging in medicine continues to evolve, the goal of this conference remains to present papers on the leading edge of new developments. We invite your perusal of the papers in this proceedings and hope you consider presenting your work at future meetings.

Steven C. Horii
Katherine P. Andriole

