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Elizabeth A. Krupinski (Ed.)

# Digital Mammography

9th International Workshop, IWDM 2008  
Tucson, AZ, USA, July 20-23, 2008  
Proceedings



Springer

## Volume Editor

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Library of Congress Control Number: 2008930118

CR Subject Classification (1998): I.4, I.5-6, H.3, J.3

LNCS Sublibrary: SL 6 – Image Processing, Computer Vision, Pattern Recognition, and Graphics

ISSN	0302-9743
ISBN-10	3-540-70537-6 Springer Berlin Heidelberg New York
ISBN-13	978-3-540-70537-6 Springer Berlin Heidelberg New York

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[springer.com](http://springer.com)

© Springer-Verlag Berlin Heidelberg 2008  
Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India  
Printed on acid-free paper      SPIN: 12438426      06/3180      5 4 3 2 1 0

# Preface

This volume (5116) of Springer's *Lecture Notes in Computer Science* contains the proceedings of the 9<sup>th</sup> International Workshop on Digital Mammography (IWDM) which was held July 20 – 23, 2008 in Tucson, AZ in the USA. The IWDM meetings traditionally bring together a diverse set of researchers (physicists, mathematicians, computer scientists, engineers), clinicians (radiologists, surgeons) and representatives of industry, who are jointly committed to developing technologies to support clinicians in the early detection and subsequent patient management of breast cancer. The IWDM conference series was initiated at a 1993 meeting of the SPIE Medical Imaging Symposium in San Jose, CA, with subsequent meetings hosted every two years at sites around the world. Previous meetings were held in York, England; Chicago, IL USA; Nijmegen, Netherlands; Toronto, Canada; Bremen, Germany; Durham, NC USA and Manchester, UK.

The 9<sup>th</sup> IWDM meeting was attended by a very international group of participants, and during the two and one-half days of scientific sessions there were 70 oral presentations, 34 posters and 3 keynote addresses. The three keynote speakers discussed some of the “hot” topics in breast imaging today. Karen Lindfors spoke on “Dedicated Breast CT: Initial Clinical Experiences.” Elizabeth Rafferty asked the question is “Breast Tomosynthesis: Ready for Prime Time?” Finally, Martin Tornai discussed “3D Multi-Modality Molecular Breast Imaging.” All three talks reflected the very strong influence that imaging modalities capable of providing 3D rather than 2D information, as with traditional mammography, are having on breast imaging today. Although these keynote addresses and some of the scientific presentations hinted at the clinical promise of these new technologies, it is still unknown whether there is going to be a true impact on earlier detection and hence treatment of breast cancer. Perhaps the answer will be more clearly provided at the 10<sup>th</sup> IWDM meeting!

Full-field digital mammography (FFDM) has been an important topic at earlier IWDM meetings and it was still the focus of a number of talks this year. Perhaps this is due to the fact that although it has been around for a few years now, it is still being deployed rather slowly in many parts of the world, possibly due to cost-related issues. Even in the USA the conversion from film to digital is far less than complete and this may be a reflection of cost as it relates to declining reimbursement rates for mammography and fewer insurance companies paying for regular exams in younger women and those with no family history of breast cancer. Clearly this is a problem not only for mammography but also for women in general. Hopefully scientific evidence, such as that presented at the IWDM meeting, will prevail and women will continue to benefit from the advances in technology being made by dedicated breast cancer researchers and clinicians.

The 2008 IWDM program reflected many of the current trends, advances and efforts being made to further improve digital mammography for the early detection of breast cancer and improved management. As in previous years, a number of papers dealt with the challenges of developing tools to analyze breast density and texture in order to better predict a woman's breast cancer risk. Included this year, however, were studies that

now employed volumetric assessments using FFDM images and digital tomosynthesis images. In general, there were significantly more papers at this meeting on volumetric imaging, digital breast tomosynthesis and breast CT. Although most presentations dealt with the more technical aspects of these volumetric imaging modalities, there were a few more clinically based studies that hinted at the significant potential in diagnostic accuracy that may be gained. These new techniques will certainly raise even more questions as they continue to develop, including their impact on the clinical reading environment and reading efficiency. Will the potential diagnostic benefits of volumetric and multiple-slice imaging data be outweighed by the increased time it takes to interpret the images? We don't know the answer today, but as these images become integrated into the clinical routine on a more frequent basis it may be necessary to find the answer and concentrate research efforts on optimizing presentation modes.

As in previous years computer-aided image analysis techniques were discussed in great detail, but there were some new and interesting trends. Although computer-aided detection was still a focus, many groups have moved away from FFDM images and traditional mammography to ultrasound, MRI, CT and tomosynthesis. The focus seems to be more on an integrated approach to computer-aided decision tools that combine information from different modalities in order to improve not only lesion detection but also lesion discrimination. Temporal comparisons and registration of multi-modality images were also discussed as ways to improve computer-aided decision tools, with some very promising results.

In general, it seems that breast imaging is on the cusp of some very significant changes in the ways that images are acquired, analyzed and integrated with other types of patient information. More studies need to be done to fully evaluate how these new technologies and analysis tools actually impact both diagnostic accuracy and diagnostic efficiency. On a broader level, it may also be necessary to conduct more cost-benefit analyses in order to convince regulatory and reimbursing agencies to approve and pay for these amazing advances in imaging and patient care. The benefit to society often seems clear to those working so closely in the development and evaluation of new technologies, but convincing the rest of society that the benefits are real seems to take longer.

As with any scientific meeting, many people put in many long hours prior to the meeting to make it look effortless, and such was the case with the 9<sup>th</sup> IWDM meeting. Following the precedent set by the organizers of the 8<sup>th</sup> IWDM, presenters were required to submit a 4-page abstract for consideration by the Scientific Committee. The abstracts were reviewed by at least two members of the Scientific Committee and feedback was provided to the submitters. The rejection rate was about 20% this year, reflecting the high quality of abstracts that were accepted after diligent review by the Scientific Committee. The 104 final 8-page papers included in these proceedings represent the work of some of the finest and most dedicated researchers in breast imaging today. Many thanks and deep appreciation go to the Scientific Committee for the time taken from their busy schedules to review the abstracts and provide feedback to the authors for the final papers.

The 9<sup>th</sup> IWDM also had the generous support from its industrial partners who both exhibited at the meeting and provided sponsorship of various conference events. Their participation in both the exhibit hall and the scientific meeting added considerably to the quality and success of the meeting. Many thanks go to June Stavem, who worked

many hours to recruit the industrial partners and help them throughout the meeting. Many thanks are also extended to Michel Rogulski, who provided significant technical advice throughout the planning phases of the meeting as well as on-site support.

July 2008

Elizabeth Krupinski

# **Scientific Meeting**

## **Preliminary Program (Subject to Change)**

**Monday July 21, 2008**

**8:00 Welcome: Elizabeth Krupinski**

**8:15 Keynote Address: Karen Lindfors, MD "Dedicated Breast CT: Initial Clinical"**

**Session 1: Breast Density, Texture & Risk I Chair: Michael Brady**

- 8:45 Serghei Malkov "Improvements to Single Energy Absorptiometry Method for Digital Mammography to Quantify Breast Tissue Density"
- 9:00 Arnau Oliver Breast Density Segmentation: a Comparison Between Clustering and Region Based Techniques"
- 9:15 Wenda He "Mammographic Segmentation Based on Texture Modeling of Tabar Mammographic Building Blocks"
- 9:30 Michael Barnathan "Analyzing Tree-Like Structures in Biomedical Images Based on Texture and Branching: an Application to Breast Imaging"
- 9:45 Keith Hartman "Volumetric Assessment of Breast Tissue Composition from FFDM Images"

**10:00 Coffee Break with Exhibitors & Poster Viewing**

**Session 2: Clinical Experiences Chair: Etta Pisano**

- 10:30 Sue Astley "Effect of Image Quality on Recall Rates"
- 10:45 Takako Morita "A Comparison Between Film-Screen Mammography and Full-Field Digital Mammography Utilizing Phase Contrast Technology in Breast Cancer Screening Programs"
- 11:00 Niamh Hambly "Impact of Digital Mammography in Breast Cancer Screening: Initial Experience in a National Breast Screening Program"
- 11:15 Andrew Smith "Clinical Performance of Breast Tomosynthesis as a Function of radiologist Experience Level"
- 11:30 Anders Tingberg "BIRADS Classification in Breast Tomosynthesis Compared to Mammography and Ultrasonography"
- 11:45 David Getty "Stereoscopic Digital Mammography: Improved Accuracy of Lesion Detection in Breast Cancer Screening"
- 12:00 Abass Alavi "Potential Role of FDG-PET Imaging in Defining Biology of Primary Breast Lesions"

## **12:15 Lunch Break**

### **Session 3: Breast Imaging Physics Chair: Martin Yaffe**

- 1:15 Katsuhiro Ichikawa "Clinical Usefulness of Super High-Resolution Liquid Crystal Displays Using Independent Sub-Pixel Driving Technology"
- 1:30 Baorui Ren "The Effect of Tomosynthesis X-Ray Pulse Width on Measured Beam Quality"
- 1:45 Mark Williams "Tomographic Dual Modality Breast Scanner"
- 2:00 Aurelie Laidevant "Dual-Energy X-Ray Absorptiometry Method Using a Full Field Digital Mammography System"
- 2:15 Ann-Katherine Carton "Optimization of a Dual-Energy Contrast-Enhanced Technique for a Photon Counting Digital Breast Tomosynthesis System"
- 2:30 Shih-Ying Huang "Simulation and Phantom Studies of Contrast-Enhanced Dual Energy Mammography (CEDEM)"
- 2:45 Satoru Matsuo "Evaluation of a Phase Contrast Imaging with Digital Mammography"

### **3:00 Coffee Break with Exhibitors & Poster Presentation Session #1 Chair: Hiroshi Fujita**

- Sue Astley "Prompting in Mammography: Reproducibility"
- Michael Berks "Synthesising Abnormal Structures in Mammograms Using Pyramid Decomposition"
- Sylvain Bernard "Computer-Aided Microcalcification Detection on Digital Breast Tomosynthesis data: a preliminary Evaluation"
- Murk Bottema "Temporal Analysis of Mammograms Based on Graph Matching"
- Ann-Katherine Carton "Temporal Subtraction versus Dual-Energy Contrast-Enhanced Digital Breast Tomosynthesis: a Pilot Study"
- Yang Gong "Texture-Based Simultaneous Registration and Segmentation of Breast DCE-MRI"
- Eduardo Guibelalde "A CDMAM Image Phantom Software Improvement for Human Observer Assessment"
- Yuji Ikeda "Computerized Classification of Whole Breast Ultrasound Images Based on Mammary Gland Patterns"
- Tetsuro Kusunoki "Comparison Between Physical Image Quality as Measured by a Newly Developed Phantom Dedicated for Digital Mammography QC and that by European Guidelines Methods"
- Anthony Maeder "Assuring Authenticity of Digital Mammograms by Image Watermarking"
- Claudia Mello-Thoms "Different Search Patterns and Similar Decision Outcomes: How Can Experts Agree in the Decisions They Make When Reading Digital Mammograms?"
- Thomas Mertelmeier "Optimization of Tomosynthesis Acquisition Parameters: Angular Range and Number of Projections"



- Takako Morita "Subtle Abnormalities in Highly Dense Breasts Detected by use of a Digital Phase Contrast Mammography System: a Report of three Invasive Cancer Cases in the Early Stage"
- Nadia Oberhofer "Image Quality Assessment and Equipment Optimisation with Automated Phantom Evaluation in Full Field Digital Mammography (FFDM)"
- Benjamin Pollard "Effect of Increased Ambient Lighting on Mass Detection in Mammograms"
- Hans Roehrig Reducing Noise of Medical Grade Liquid Crystal Displays (LCD) and its Relation to the Detection of Micro-Calcifications
- Shanghua Sun "An Ontology to Support Adaptive Training for Breast Radiologists"

#### **Session 4: Image Analysis and CAD I Chair: Maryellen Giger**

- 4:00 Dave Tahmoush "A Web Database for Computer-Aided Detection and Diagnosis of Medical Images"
- 4:15 Nico Karssemeijer "An Interactive Computer Aided Decision Support System for Detection of Masses in Mammograms"
- 4:30 Heang-Ping Chan "Detection of Masses in Digital Tomosynthesis Mammography: Effects of the Number of Projection Views and Dose"
- 4:45 Swatee Singh "Effect of Similarity Metrics and ROI Sizes in Featureless Computer Aided Detection of Breast Masses in Tomosynthesis"
- 5:00 Georgia Tourassi "Knowledge Transfer Across Breast Cancer Screening Modalities: a pilot Study Using an Information-Theoretic CADe System for Mass Detection"
- 5:15 Fengmei Zou "Gradient Vector Flow Fields and Spiculated Mass Detection in Digital Mammography Images"
- 5:30 Da Qi "The Evaluation of Effects on Breast Cancer Diagnosis Using the Mammographic Semantic Information"
- 5:45 Shinsuke Katsuhara "Computerized SCHEME for Focal Asymmetric Densities on Mammograms by use of Geometric and Texture Analysis"
- 6:00 Yading Yuan "Identifying Corresponding Lesions from CC and MLO Views via Correlative Feature Analysis"

**7:00 Dinner**

**Tuesday July 22, 2008**

#### **Session 5: Image Analysis and CAD II Chair: Nico Karssemeijer**

- 8:00 Piotr Habas "Case-Specific Reliability Assessment for Improved False Positive Reduction with an Information-Theoretic CAD System"
- 8:15 Lubomir Hadjiiski "Computerized Detection and Classification of Malignant and Benign Microcalcifications on Full Field Digital Mammograms"
- 8:30 Michiel Kallenberg "The Effect of Training Sample Size on Performance of Mass Detection"

- 8:45 Balaji Krishnapuram "Multiple-Instance Learning Improves CAD Detection of Masses in Digital Mammography"
- 9:00 Isaac Leichter "Optimizing the CAD Process for Detecting Mammographic Lesions by a New Generation Algorithm Based on linear Classifiers and a Gradient Based Method"
- 9:15 Maciej Mazurowski "Reliability Assessment of Ensemble Classifiers: Application in Mammography"
- 9:30 Berkman Sahiner "Breast Mass Classification on Full-Field Digital Mammography and Screen-Film Mammography"
- 9:45 Guido Van Schie "Detection of Microcalcifications Using a Nonuniform Noise Model"

### **10:00 Coffee Break with Exhibitors & Poster Viewing**

### **Session 6: Modeling and Simulation Chair: Ulrich Bick**

- 10:30 Vijay Rajagopal "The Biomechanical Breast Reference State for Multi-Modal Image Analysis"
- 10:45 Craig Abbey "An Ideal Observer for a Model of X-Ray Imaging in Breast Parenchymal Tissue"
- 11:00 Michael Berks "Statistical Appearance Models of Mammographic Masses"
- 11:15 Mary Yip "Validation of a Digital Mammography Image Simulation Chain with Automated Scoring of CDMAM Images"
- 11:30 Michael O'Connor "Comparison of Two Methods to Develop Breast Models for Simulation of Breast Tomosynthesis and CT"
- 11:45 Christine Tanner "Statistical Deformation Models of Breast Compressions from Biomechanical Simulations"

### **12:00 Lunch Break**

### **Session 7: Image Analysis and CAD III Chair: Sue Astley**

- 1:15 Gobert Lee "Classification of Benign and Malignant Masses in Ultrasound Breast Image Based on Geometric and Echo Features"
- 1:30 Gina Clarke "Validation of Tumor Burden Measurements Using Three-Dimensional Histopathology"
- 1:45 Akira Hasegawa "A Tool for Temporal Comparison of Mammograms: Image Toggling and Dense-Tissue-Preserving Registration"
- 2:00 Takeshi Hara "Development of Whole Breast Ultrasound Viewer and Automated Mass Detection System"
- 2:15 Mitchell Goodsitt "Automated Registration of Volumes of Interest for a Combined X-Ray and Ultrasound Breast Imaging System"

**2:30 Keynote Address: Betty Rafferty, MD "Breast Tomosynthesis: Ready for Prime Time?"**

**3:00 Coffee Break with Exhibitors & Poster Presentation Session #2 Chair: Elizabeth Krupinski**

- Jennifer Diffey "Estimating Individual Cancer Risk in the UK Screening Programme: a Feasibility study"
- Gisella Gennaro "Clinical Performance of Digital Breast Tomosynthesis versus Full-Field Digital Mammography: Preliminary Results:
- Edward Hadley "Analysis of Using Anatomical Linear Structure Information in Mammographic Risk Assessment"
- Despina Kontos "Evaluating the Effect of Tomosynthesis Acquisition Parameters on Image Texture: a Study Based on an Anthropomorphic Breast Tissue Software Model"
- Yoshifumi Kuroki "Computer Aided Detection (CAD) for Digital Mammography: What Kind of reader Group Does CAD Have an Effect in?"
- Isaac Leichter "Does a Mammography CAD Algorithm with Varying Filtering Levels of Detection Marks, Used to Reduce the False Mark Rate, Adversely Affect the Detection of Small Masses?"
- Hui Li "Performance of CADx on a Large Clinical Database of FFDM Images"
- Ana Maria Lopez "Expedited Breast Care: a New Model in Breast Health"
- Jennifer Oduko "Effect of Tungsten-Anode X-Ray Tubes on Dose and Image Quality in Full-Field Digital Mammography"
- Christina Shafer "Assessment of Low Energies and Slice Depth in the Quantification of Breast Tomosynthesis"
- Joerg Teubl "Comparison of Multiple View Strategies to Reduce False Positives in Breast Imaging"
- Meritxell Tortajada "Image Correction and Reconstruction for Breast Biopsy"
- Chris Tromans "Progress Toward a Quantitative Scale for Describing Radiodensity in Mammographic Images"
- Dominique Van de Sompel "Systematic Performance Analysis of SART as Applied to Digital Breast Tomosynthesis"
- Mari Varjonen "Optimizing the target-Filter Combination in Digital Mammography in the Sense of Image Quality and Average Glandular Dose"
- Moi Hoon Yap "Generic Infrastructure for Medical Informatics (GIMI): the Development of a Mammographic Training System"
- Cuiping Zhang "Evaluation of 3D Breast Reconstruction Accuracy Using Non-Contact Scanner Images: a Phantom Study"

## **Digital Breast Tomosynthesis**

Investigation of Different PV Distributions in Digital Tomosynthesis Mammography (DTM)

*Y Zhang, HP Chan, MM Goodsitt, A Schmitz, JW Eberhard, BEH Claus*

Characterization of Projection Ordering in Iterative Reconstruction for Breast Tomosynthesis

*G Wu, J Mainprize, M Yaffe*

Effect of Scan Angle and reconstruction Algorithm on Model Observer Performance in Tomosynthesis

*I Reiser, BA Lau, RM Nishikawa*

A Novel Approach for Filtered Backprojection in Tomosynthesis Based on Filter Kernels Determined by Iterative Reconstruction Techniques

*J Ludwig, T Mertelmeier, H Kunze, W Härer*

3D Digital Breast Tomosynthesis Using Total Variation Regularization

*I Kastanis, S Arridge, A Stewart, S Gunn, C Ullberg, T Francke*

Image Artifact in Digital Breast Tomosynthesis and its Dependence on System and Reconstruction Parameters

*YH Hu, W Zhao, T Mertelmeier, J Ludwig*

Multi-Projection Correlation Imaging as a New Diagnostic Tool for Improved Breast Cancer Detection

*AS Chawla, E Samei, JY Lo, T Mertelmeier*

Sensitivity of Contrast-Enhanced Digital Breast Tomosynthesis to Changes in Iodine Concentration During Acquisition

*ML Hill, JG Mainprize, MJ Yaffe*

## **Breast Density, Texture & Risk II**

Quantifying Breast Thickness for Density Measurement

*J Diffey, A Hufon, C Beeston, J Smith, T Marchant, S Astley*

Effect of Tissue Thickness Variation in Volumetric Breast Density Estimation

*Alonzo-Proulx, Ah Tyson, J Mainprize, Ge Mawdsley, Mj Yaffe*

Breast Abnormality Detection Incorporating Breast Density Information Based on Independent Components Analysis

*S Petroudi, N Nicolaou, J Georgiou, M Brady*

Comparison of Breast Percent Density Estimated from Digital Mammograms and Central Reconstructed Tomosynthesis Slice Images

*PR Bakic, D Kontos, AB Troxel, A Maidment*

Digital Breast Tomosynthesis Parenchymal Texture Analysis for Breast Cancer Risk Estimation: a Preliminary study

*D Kontos, PR Bakic, AB Troxel, EF Conant, ADA Maidment*

Texture Based Segmentation of Breast DCE-MRI

*YC Gong, M Brady*

## Physics, Image Quality & Quality Assurance

### Image Quality Measurements in Breast Tomosynthesis

R van Engen, R Bouwman, R van der Burght, B Lazzari, DR Dance, P Heid,  
M Aslund, KC Young

### One Year of Experience with remote Quality Assurance of Digital Mammography System in the Flemish Breast Cancer Screening Program

J Jacobs, K Lemmens, J Nens, K Michielsens, G Marchal, H Bosmans

### Automatic Exposure Control in Digital Mammography: Contrast-to-Noise Ratio versus Average Glandular Dose

G Gennaro, P Golinelli, E Bellan, P Colombo, L D'Ercole, A Di Nallo, L Gallo,  
C Giordano, G Meliadó, B Morri, E Nassivera, N Oberhofer, D Origgi,  
M Paolucci, N Paruccini, M Piergentili, E Rizzi, R Rossi

### Effect of Anode Target/Filter Combination on the Dose and Image Quality of a Digital Mammography System Based on an Amorphous Selenium Detector

*P Baldelli, N Phelan, G Egan*

### Comparative Technical Study of Two Generations of CR Plates for Digital Mammography

H Bosmans, K Lemmens, J Jacobs, B Verbrugge, K Michielsens, F Zanca, J Nens,  
C Van Ongeval, G Marchal

### Comparing the Performance of Digital Mammography Systems

*KC Young, JM Oduko, O Gundogdu, A Alsager*

### Cross-Calibration of Hologic Selenia Full-Field Digital Mammography Systems for Volumetric Breast Density Measurements

J Wang, S Malkov, B Fan, J Shepherd

### Classification of artifacts in Clinical Digital Mammography

*C Van Ongeval, J Jacobs, A Van Steen, F Zanca, H Bosmans, G Marchal*

### Contrast Sensitivity in Mammographic Softcopy Reading - Determination with Psychophysical Procedures

*D Apelt, HO Peitgen*

# Table of Contents

## Breast Density, Texture and Risk I

Improvements to Single Energy Absorptiometry Method for Digital Mammography to Quantify Breast Tissue Density . . . . .	1
<i>Sergei Malkov, Jeff Wang, and John Shepherd</i>	
Breast Density Segmentation: A Comparison of Clustering and Region Based Techniques . . . . .	9
<i>A. Torrent, A. Bardera, A. Oliver, J. Freixenet, I. Boada, M. Feixes, R. Martí, X. Lladó, J. Pont, E. Pérez, S. Pedraza, and J. Martí</i>	
Mammographic Segmentation Based on Texture Modelling of Tabár Mammographic Building Blocks . . . . .	17
<i>Wenda He, Izzati Muhimmah, Erika R.E. Denton, and Reyer Zwiggelaar</i>	
Analyzing Tree-Like Structures in Biomedical Images Based on Texture and Branching: An Application to Breast Imaging . . . . .	25
<i>Michael Barnathan, Jingjing Zhang, Despina Kontos, Predrag Bakic, Andrew Maidment, and Vasileios Megalooikonomou</i>	
Volumetric Assessment of Breast Tissue Composition from FFDM Images . . . . .	33
<i>Keith Hartman, Ralph Highnam, Ruth Warren, and Valerie Jackson</i>	

## Clinical Experiences

Effect of Image Quality on Film Reading . . . . .	40
<i>Susan Astley, Neil Prasad, Eve Allcock, Jenny Diffey, Yit Yoong Lim, and Caroline Boggis</i>	
A Comparison between Film-Screen Mammography and Full-Field Digital Mammography Utilizing Phase Contrast Technology in Breast Cancer Screening Programs . . . . .	48
<i>Takako Morita, Maya Yamada, Akiko Kano, Sumiya Nagatsuka, Chika Honda, and Tokiko Endo</i>	
Impact of Digital Mammography in Breast Cancer Screening: Initial Experience in a National Breast Screening Program . . . . .	55
<i>N. Hambly, N. Phelan, G. Hargaden, A. O'Doherty, and F. Flanagan</i>	

Clinical Performance of Breast Tomosynthesis as a Function of Radiologist Experience Level .....	61
<i>Andrew P. Smith, Elizabeth A. Rafferty, and Loren Niklason</i>	
BIRADS Classification in Breast Tomosynthesis Compared to Mammography and Ultrasonography .....	67
<i>Anders Tingberg, Ingvar Andersson, Debra M. Ikeda, Mark Ruschin, Tony Svahn, and Pontus Timberg</i>	
Stereoscopic Digital Mammography: Improved Accuracy of Lesion Detection in Breast Cancer Screening .....	74
<i>David J. Getty, Carl J. D’Orsi, and Ronald M. Pickett</i>	
Potential Role of FDG-PET Imaging in Defining Biology of Primary Breast Lesions .....	80
<i>S. Basu, A. Mavi, T. Cermik, R. Kumar, and A. Alavi</i>	

## Breast Imaging Physics

Clinical Usefulness of Super High-Resolution Liquid Crystal Displays Using Independent Sub-pixel Driving Technology .....	84
<i>Katsuhiro Ichikawa, Hiroko Kawashima, Naohiro Kimura, and Mikio Hasegawa</i>	
The Effect of Tomosynthesis X-Ray Pulse Width on Measured Beam Quality .....	91
<i>Baorui Ren, Andrew Smith, David Aizer, Don Kennedy, Jeffrey Yorker, and Zhenxue Jing</i>	
Tomographic Dual Modality Breast Scanner .....	99
<i>Mark B. Williams, Patricia G. Judy, Mitali J. More, Jennifer A. Harvey, Stan Majewski, James Proffitt, John McKisson, Alexander Stolin, Brian Kross, Alexander Stewart, Edward Bullard, Manish Kankaria, and Roman Janer</i>	
Dual-Energy X-Ray Absorptiometry Method Using a Full Field Digital Mammography System .....	108
<i>Aurelie Laidevant, Serghei Malkov, Alfred Au, and John Shepherd</i>	
Optimization of a Dual-Energy Contrast-Enhanced Technique for a Photon Counting Digital Breast Tomosynthesis System .....	116
<i>Ann-Katherine Carton, Christer Ullberg, Karin Lindman, Tom Francke, and Andrew Maidment</i>	
Simulation and Phantom Studies of Contrast-Enhanced Dual Energy Mammography (CEDEM) .....	124
<i>Shih-Ying Huang, John M. Boone, Dandan Zheng, Kai Yang, Nathan J. Packard, and George Burkett Jr.</i>	

Preliminary Evaluation of a Phase Contrast Imaging with Digital Mammography .....	130
<i>Satoru Matsuo, Hiroshi Fujita, Junji Morishita, Tetsuro Katafuchi, Chika Honda, and Junko Sugiyama</i>	

## Poster Session I

Prompting in Mammography: Reproducibility .....	137
<i>Stephanie Tiew, Susan Astley, Bernice Dillon, Julie Morris, and Caroline Boggis</i>	
Synthesising Abnormal Structures in Mammograms Using Pyramid Decomposition .....	143
<i>Michael Berks, Chris Rose, Caroline Boggis, and Susan Astley</i>	
Computer-Aided Microcalcification Detection on Digital Breast Tomosynthesis Data: A Preliminary Evaluation .....	151
<i>Sylvain Bernard, Serge Muller, and Jon Onativia</i>	
Temporal Analysis of Mammograms Based on Graph Matching .....	158
<i>Fei Ma, Mariusz Bajger, and Murk J. Bottema</i>	
Temporal Subtraction Versus Dual-Energy Contrast-Enhanced Digital Breast Tomosynthesis: A Pilot Study .....	166
<i>Ann-Katherine Carton, Jean Anne Currivan, Emily Conant, and Andrew Maidment</i>	
Texture-Based Simultaneous Registration and Segmentation of Breast DCE-MRI .....	174
<i>Yang Can Gong and Michael Brady</i>	
A CDMAM Image Phantom Software Improvement for Human Observer Assessment .....	181
<i>Gabriel Prieto, Margarita Chevalier, and Eduardo Guibelalde</i>	
Computerized Classification of Mammary Gland Patterns in Whole Breast Ultrasound Images .....	188
<i>Yuji Ikedo, Takako Morita, Daisuke Fukuoka, Takeshi Hara, Hiroshi Fujita, Etsuo Takada, and Tokiko Endo</i>	
Comparison between Physical Image Quality as Measured by a Newly Developed Phantom Dedicated for Digital Mammography QC and That by European Guidelines Methods .....	196
<i>Tetsuro Kusunoki, Masahiro Tagi, Kenji Yosikawa, Hiroshi Arai, Nachiko Uchiyama, Chieko Nagashima, and Hiroyuki Kobayashi</i>	



Assuring Authenticity of Digital Mammograms by Image Watermarking .....	204
<i>Anthony Maeder, Jason Dowling, Anthony Nguyen, Emma Brunton, and Phuong Nguyen</i>	
Different Search Patterns and Similar Decision Outcomes: How Can Experts Agree in the Decisions They Make When Reading Digital Mammograms? .....	212
<i>Claudia Mello-Thoms, Marie Ganott, Jules Sumkin, Christiane Hakim, Cynthia Britton, Luisa Wallace, and Lara Hardesty</i>	
Optimization of Tomosynthesis Acquisition Parameters: Angular Range and Number of Projections .....	220
<i>Thomas Mertelmeier, Jasmina Ludwig, Bo Zhao, and Wei Zhao</i>	
Subtle Abnormalities in Highly Dense Breasts Detected by Use of a Digital Phase Contrast Mammography System: A Report of Three Invasive Cancer Cases in the Early Stage.....	228
<i>Takako Morita, Maya Yamada, Akiko Kano, Sumiya Nagatsuka, Chika Honda, and Tokiko Endo</i>	
Image Quality Assessment and Equipment Optimisation with Automated Phantom Evaluation in Full Field Digital Mammography (FFDM) .....	235
<i>Nadia Oberhofer, Nicoletta Paruccini, and Ehrenfried Moroder</i>	
Breast Mass Detection under Increased Ambient Lighting .....	243
<i>Benjamin J. Pollard, Amarpreet S. Chawla, Noriyuki Hashimoto, and Ehsan Samei</i>	
Reducing Noise of Medical Grade Liquid Crystal Displays (LCD) and Its Relation to the Detection of Micro-calcifications .....	249
<i>Hans Roehrig, Jiahua Fan, William J. Dallas, Elizabeth A. Krupinski, and Jeffrey Johnson</i>	
An Ontology to Support Adaptive Training for Breast Radiologists .....	257
<i>Shanghua Sun, Paul Taylor, Louise Wilkinson, and Lisanne Khoo</i>	

## Image Analysis and CAD I

A Web Database for Computer-Aided Detection and Diagnosis of Medical Images .....	265
<i>Dave Tahmouch and Hanan Samet</i>	
An Interactive Computer Aided Decision Support System for Detection of Masses in Mammograms .....	273
<i>Nico Karssemeijer, Andrea Hupse, Maurice Samulski, Michiel Kallenberg, Carla Boetes, and Gerard den Heeten</i>	

Detection of Masses in Digital Breast Tomosynthesis Mammography: Effects of the Number of Projection Views and Dose . . . . .	279
<i>Heang-Ping Chan, Jun Wei, Yiheng Zhang, Berkman Sahiner, Lubomir Hadjiiski, and Mark A. Helvie</i>	
Effect of Similarity Metrics and ROI Sizes in Featureless Computer Aided Detection of Breast Masses in Tomosynthesis . . . . .	286
<i>Swatee Singh, Georgia D. Tourassi, and Joseph Y. Lo</i>	
Knowledge Transfer across Breast Cancer Screening Modalities: A Pilot Study Using an Information-Theoretic CADe System for Mass Detection . . . . .	292
<i>Georgia D. Tourassi, Amy C. Sharma, Swatee Singh, Robert S. Saunders, Joseph Y. Lo, Ehsan Samei, and Brian P. Harrawood</i>	
Gradient Vector Flow Fields and Spiculated Mass Detection in Digital Mammography Images . . . . .	299
<i>Fengmei Zou, Yufeng Zheng, Zhengdong Zhou, and Kwabena Agyepong</i>	
The Evaluation of Effects on Breast Cancer Diagnoses When Using Mammographic Semantic Information . . . . .	307
<i>Da Qi, Erika R.E. Denton, Joanna M.E. Leason, Diaa Othman, and Reyer Zwiggelaar</i>	
Computerized Scheme for Focal Asymmetric Densities on Mammograms by Use of Geometric and Texture Analyses . . . . .	315
<i>Shinsuke Katsuhara, Hitoshi Futamura, Satoshi Kasai, Takako Morita, and Tokiko Endo</i>	
Identifying Corresponding Lesions from CC and MLO Views Via Correlative Feature Analysis . . . . .	323
<i>Yading Yuan, Maryellen Giger, Hui Li, Li Lan, and Charlene Sennett</i>	

## Image Analysis and CAD II

Case-Specific Reliability Assessment for Improved False Positive Reduction with an Information-Theoretic CAD System . . . . .	329
<i>Piotr A. Habas, Jacek M. Zurada, and Georgia D. Tourassi</i>	
Computerized Detection and Classification of Malignant and Benign Microcalcifications on Full Field Digital Mammograms . . . . .	336
<i>Lubomir Hadjiiski, Peter Filev, Heang-Ping Chan, Jun Ge, Berkman Sahiner, Mark A. Helvie, and Marilyn A. Roubidoux</i>	
The Effect of Training Sample Size on Performance of Mass Detection . . . . .	343
<i>Michiel Kallenberg and Nico Karssemeijer</i>	

Multiple-Instance Learning Improves CAD Detection of Masses in Digital Mammography .....	350
<i>Balaji Krishnapuram, Jonathan Stoeckel, Vikas Raykar, Bharat Rao, Philippe Bamberger, Eli Ratner, Nicolas Merlet, Inna Stainvas, Menahem Abramov, and Alexandra Manevitch</i>	
Optimizing the CAD Process for Detecting Mammographic Lesions by a New Generation Algorithm Using Linear Classifiers and a Gradient Based Approach .....	358
<i>Philippe Bamberger, Isaac Leichter, Nicolas Merlet, Eli Ratner, Glenn Fung, and Richard Lederman</i>	
Reliability Assessment of Ensemble Classifiers: Application in Mammography .....	366
<i>Maciej A. Mazurowski, Jacek M. Zurada, and Georgia D. Tourassi</i>	
Breast Mass Classification on Full-Field Digital Mammography and Screen-Film Mammography .....	371
<i>Jiazheng Shi, Berkman Sahiner, Heang-Ping Chan, Lubomir M. Hadjiiski, Jun Ge, and Jun Wei</i>	
Detection of Microcalcifications Using a Nonuniform Noise Model .....	378
<i>Guido van Schie and Nico Karssemeijer</i>	

## Modeling and Simulation

The Breast Biomechanics Reference State for Multi-modal Image Analysis .....	385
<i>Vijay Rajagopal, Martyn P. Nash, Ralph P. Highnam, and Poul M.F. Nielsen</i>	
An Ideal Observer for a Model of X-Ray Imaging in Breast Parenchymal Tissue .....	393
<i>Craig K. Abbey and John M. Boone</i>	
Statistical Appearance Models of Mammographic Masses .....	401
<i>Michael Berks, Steven Caulkin, Rumana Rahim, Caroline Boggis, and Susan Astley</i>	
Validation of a Digital Mammography Image Simulation Chain with Automated Scoring of CDMAM Images .....	409
<i>Mary Yip, Abdulaziz Alsager, Emma Lewis, Kevin Wells, and Kenneth C. Young</i>	
Comparison of Two Methods to Develop Breast Models for Simulation of Breast Tomosynthesis and CT .....	417
<i>J. Michael O'Connor, Mini Das, Clay Didier, Mufeed Mah'D, and Stephen J. Glick</i>	

Statistical Deformation Models of Breast Compressions from Biomechanical Simulations .....	426
<i>C. Tanner, J.H. Hipwell, and D.J. Hawkes</i>	

## Image Analysis and CAD III

Classification of Benign and Malignant Masses in Ultrasound Breast Image Based on Geometric and Echo Features .....	433
<i>Gobert N. Lee, Daisuke Fukuoka, Yuji Ikedo, Takeshi Hara, Hiroshi Fujita, Etsuo Takada, Tokiko Endo, and Takako Morita</i>	
Validation of Cone-Beam CT Measurements of Tumour Burden Using Three-Dimensional Histopathology: Initial Results for a Lumpectomy ...	440
<i>G.M. Clarke, J.G. Mainprize, C. Peressotti, L. Sun, D. Wang, J.T. Zubovits, C.M.B. Holloway, G.J. Czarnota, and M.J. Yaffe</i>	
A Tool for Temporal Comparison of Mammograms: Image Toggling and Dense-Tissue-Preserving Registration .....	447
<i>Akira Hasegawa, Huzefa Neemuchwala, Hiroko Tsunoda-Shimizu, Satoru Honda, Kazuo Shimura, Minoru Sato, Tomomi Koyama, Mari Kikuchi, and Sonoe Hiramatsu</i>	
Development of Whole Breast Ultrasound Viewer and Automated Mass Detection System .....	455
<i>Takeshi Hara, Daisuke Fukuoka, Yuji Ikedo, Etsuo Takada, Hiroshi Fujita, Tokiko Endo, and Takako Morita</i>	
Automated Registration of Volumes of Interest for a Combined X-Ray Tomosynthesis and Ultrasound Breast Imaging System .....	463
<i>Mitchell M. Goodsitt, Heang-Ping Chan, Lubomir Hadjiiski, Gerald L. LeCarpentier, and Paul L. Carson</i>	

## Poster Session II

Estimating Individual Cancer Risks in the UK National Breast Screening Programme: A Feasibility Study .....	469
<i>Jennifer Diffey, Alan Hufton, Susan Astley, Claire Mercer, and Anthony Maxwell</i>	
Clinical Performance of Digital Breast Tomosynthesis Versus Full-Field Digital Mammography: Preliminary Results .....	477
<i>Gisella Gennaro, Enrica Baldan, Elisabetta Bezzon, Manuela La Grassa, Luigi Pescarini, and Cosimo di Maggio</i>	
Analysis of Anatomical Linear Structure Information in Mammographic Risk Assessment .....	483
<i>Edward M. Hadley, Erika R.E. Denton, Josep Pont, Elsa Pérez, and Reyer Zwiggelaar</i>	

Evaluating the Effect of Tomosynthesis Acquisition Parameters on Image Texture: A Study Based on an Anthropomorphic Breast Tissue Software Model .....	491
<i>Despina Kontos, Cuiping Zhang, Nicole Ruiter, Predrag R. Bakic, and Andrew D.A. Maidment</i>	
Computer Aided Detection (CAD) for Digital Mammography: A Retrospective Reading Study for Consideration on Utilizing CAD Most Effectively .....	499
<i>Yoshifumi Kuroki, Shigeru Nawano, Seiko Suzuki, Hideya Takeo, and Shigeru Saotome</i>	
Does a Mammography CAD Algorithm with Varying Filtering Levels of Detection Marks, Used to Reduce the False Mark Rate, Adversely Affect the Detection of Small Masses? .....	504
<i>Isaac Leichter, Richard Lederman, Eli Ratner, Nicolas Merlet, Glenn Fung, Balaji Krishnapuram, and Philippe Bamberger</i>	
Performance of CADx on a Large Clinical Database of FFDM Images .....	510
<i>Hui Li, Maryellen L. Giger, Yading Yuan, Li Lan, and Charlene A. Sennett</i>	
Expedited Breast Care: A New Model in Breast Health .....	515
<i>A.M. Lopez, G. Barker, A. Bhattacharryya, K. Scott, M. Descour, L. Richter, J. Davenport, S. Lazarus, L. Kreykes, A. Valencia, and R. Weinstein</i>	
Effect of Using Tungsten-Anode X-Ray Tubes on Dose and Image Quality in Full-Field Digital Mammography .....	522
<i>Jennifer M. Oduko, Kenneth C. Young, Ozcan Gundogdu, and Abdulaziz Alsager</i>	
Assessment of Low Energies and Slice Depth in the Quantification of Breast Tomosynthesis .....	530
<i>Christina M. Shafer, Ehsan Samei, Thomas Mertelmeier, Robert S. Saunders, Moustafa Zerhouni, and Joseph Y. Lo</i>	
Comparison of Multiple View Strategies to Reduce False Positives in Breast Imaging .....	537
<i>Joerg Teubl and Horst Bischof</i>	
Image Correction and Reconstruction for Breast Biopsy .....	545
<i>Meritzell Tortajada, Robert Martí, Jordi Freixenet, Josep Fernández, and Melcior Sentís</i>	
Progress Toward a Quantitative Scale for Describing Radiodensity in Mammographic Images .....	553
<i>Christopher Tromans, Sir Michael Brady, Dominique Van de Sompel, Michele Lorenzon, Massimo Bazzocchi, and Chiara Zuiani</i>	

Systematic Performance Analysis of SART as Applied to Digital Breast Tomosynthesis .....	561
<i>Dominique Van de Sompel and Michael Brady</i>	
Optimizing the Target-Filter Combination in Digital Mammography in the Sense of Image Quality and Average Glandular Dose .....	570
<i>Mari Varjonen and Pekka Strömmer</i>	
Generic Infrastructure for Medical Informatics (GIMI): The Development of a Mammographic Training System .....	577
<i>Moi Hoon Yap, Alastair G. Gale, and Hazel J. Scott</i>	
Evaluation of 3D Breast Surface Reconstruction Accuracy Using Non-contact Scanner Images: A Phantom Study .....	585
<i>Cuiping Zhang, Predrag R. Bakic, Shugao Xia, Fengshan Liu, and Andrew D.A. Maidment</i>	

## Digital Breast Tomosynthesis

Investigation of Different PV Distributions in Digital Breast Tomosynthesis (DBT) Mammography .....	593
<i>Yiheng Zhang, Heang-Ping Chan, Mitchell M. Goodsitt, Andrea Schmitz, Jeffrey W. Eberhard, and Bernhard E.H. Claus</i>	
Characterization of Projection Ordering in Iterative Reconstruction Methods for Breast Tomosynthesis .....	601
<i>Gang Wu, James Mainprize, and Martin Yaffe</i>	
Effect of Scan Angle and Reconstruction Algorithm on Model Observer Performance in Tomosynthesis .....	606
<i>I. Reiser, B.A. Lau, and R.M. Nishikawa</i>	
A Novel Approach for Filtered Backprojection in Tomosynthesis Based on Filter Kernels Determined by Iterative Reconstruction Techniques ...	612
<i>Jasmina Ludwig, Thomas Mertelmeier, Holger Kunze, and Wolfgang Härer</i>	
3D Digital Breast Tomosynthesis Using Total Variation Regularization .....	621
<i>Iason Kastanis, Simon Arridge, Alex Stewart, Spencer Gunn, Christer Ullberg, and Tom Francke</i>	
Image Artifact in Digital Breast Tomosynthesis and Its Dependence on System and Reconstruction Parameters .....	628
<i>Yue-Houng Hu, Wei Zhao, Thomas Mertelmeier, and Jasmina Ludwig</i>	

Multi-projection Correlation Imaging as a New Diagnostic Tool for Improved Breast Cancer Detection ..... 635  
*Amarpreet S. Chawla, Ehsan Samei, Joseph Y. Lo, and Thomas Mertelmeier*

Sensitivity of Contrast-Enhanced Digital Breast Tomosynthesis to Changes in Iodine Concentration During Acquisition ..... 643  
*Melissa L. Hill, James G. Mainprize, and Martin J. Yaffe*

**Breast Density, Texture and Risk II**

Quantifying Breast Thickness for Density Measurement ..... 651  
*Jennifer Diffey, Alan Hufton, Christine Beeston, Julia Smith, Tom Marchant, and Susan Astley*

Effect of Tissue Thickness Variation in Volumetric Breast Density Estimation ..... 659  
*Olivier Alonzo-Proulx, Albert H. Tyson, Gordon E. Mawdsley, and Martin J. Yaffe*

Breast Abnormality Detection Incorporating Breast Density Information Based on Independent Components Analysis ..... 667  
*Styliani Petroudi, Nicoletta Nicolaou, Julius Georgiou, and Michael Brady*

Comparison of Breast Percent Density Estimated from Digital Mammograms and Central Reconstructed Tomosynthesis Slice Images ..... 674  
*Predrag R. Bakic, Despina Kontos, Andrea B. Troxel, and Andrew Maidment*

Digital Breast Tomosynthesis Parenchymal Texture Analysis for Breast Cancer Risk Estimation: A Preliminary Study ..... 681  
*Despina Kontos, Predrag R. Bakic, Andrea B. Troxel, Emily F. Conant, and Andrew D.A. Maidment*

Texture Based Segmentation of Breast DCE-MRI ..... 689  
*Yang Can Gong and Michael Brady*

**Physics, Image Quality and Quality Assurance**

Image Quality Measurements in Breast Tomosynthesis ..... 696  
*Ruben van Engen, Ramona Bouwman, Roeland van der Burght, Barbara Lazzari, David R. Dance, Patrice Heid, Magnus Ashund, and Kenneth C. Young*

One Year of Experience with Remote Quality Assurance of Digital Mammography Systems in the Flemish Breast Cancer Screening Program .....	703
<i>Jurgen Jacobs, Kim Lemmens, Joris Nens, Koen Michielsens, Guy Marchal, and Hilde Bosmans</i>	
Automatic Exposure Control in Digital Mammography: Contrast-to-Noise Ratio Versus Average Glandular Dose .....	711
<i>Gisella Gennaro, Paola Golinelli, Elena Bellan, Paola Colombo, Loredana D'Ercole, Anna Di Nallo, Lara Gallo, Carlo Giordano, Gabriele Meliaddò, Barbara Morri, Elvina Nassivera, Nadia Oberhofer, Daniela Origgi, Massimiliano Paolucci, Nicoletta Paruccini, Michela Piergentili, Elisa Rizzi, and Raffaella Rossi</i>	
Effect of Anode/Filter Combination on the Dose and Image Quality of a Digital Mammography System Based on an Amorphous Selenium Detector .....	716
<i>Paola Baldelli, Niall Phelan, and Gillian Egan</i>	
Comparative Technical Study of Two Generations of CR Plates for Digital Mammography .....	724
<i>Hilde Bosmans, Kim Lemmens, Jurgen Jacobs, Beatrijs Verbrugge, Koen Michielsens, Federica Zanca, Joris Nens, Chantal Van Ongeval, and Guy Marchal</i>	
Comparing the Performance of Digital Mammography Systems .....	732
<i>Kenneth C. Young, Jennifer M. Oduko, Ozcan Gundogdu, and Abdulaziz Alsager</i>	
Cross-Calibration and Longitudinal Quality Control of Hologic Selenia Full-Field Digital Mammography Systems for Volumetric Breast Density Measurements .....	740
<i>Jeff Wang, Sergei Malkov, Bo Fan, and John Shepherd</i>	
Classification of Artifacts in Clinical Digital Mammography .....	748
<i>Chantal Van Ongeval, Jurgen Jacobs, André Van Steen, Federica Zanca, Hilde Bosmans, and Guy Marchal</i>	
Contrast Sensitivity in Mammographic Softcopy Reading – Determination with Psychophysical Procedures .....	756
<i>Dörte Apelt and Heinz-Otto Peitgen</i>	
<b>Author Index .....</b>	<b>765</b>