

Commenced Publication in 1973

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

Editorial Board

David Hutchison

Lancaster University, UK

Takeo Kanade

Carnegie Mellon University, Pittsburgh, PA, USA

Josef Kittler

University of Surrey, Guildford, UK

Jon M. Kleinberg

Cornell University, Ithaca, NY, USA

Friedemann Mattern

ETH Zurich, Switzerland

John C. Mitchell

Stanford University, CA, USA

Moni Naor

Weizmann Institute of Science, Rehovot, Israel

Oscar Nierstrasz

University of Bern, Switzerland

C. Pandu Rangan

Indian Institute of Technology, Madras, India

Bernhard Steffen

University of Dortmund, Germany

Madhu Sudan

Massachusetts Institute of Technology, MA, USA

Demetri Terzopoulos

University of California, Los Angeles, CA, USA

Doug Tygar

University of California, Berkeley, CA, USA

Moshe Y. Vardi

Rice University, Houston, TX, USA

Gerhard Weikum

Max-Planck Institute of Computer Science, Saarbruecken, Germany

Susan M. Astley Michael Brady
Chris Rose Reyer Zwiggelaar (Eds.)

Digital Mammography

8th International Workshop, IWDM 2006
Manchester, UK, June 18-21, 2006
Proceedings



Springer

Volume Editors

Susan M. Astley

Chris Rose

University of Manchester

Imaging Science and Biomedical Engineering, Stopford Medical Building
Oxford Road, Manchester M13 9PT, UK

E-mail: sue.astley@manchester.ac.uk chris.rose@man.ac.uk

Michael Brady

Oxford University

Department of Engineering Science

Parks Road, Oxford OX1 3PJ, UK

E-mail: jmb@robots.ox.ac.uk

Reyer Zwiggelaar

University of Wales

Department of Computer Science

Aberystwyth, Ceredigion, SY23 3DB, Wales, UK

E-mail: rrz@aber.ac.uk

Library of Congress Control Number: 2006927811

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

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

ISSN 0302-9743

ISBN-10 3-540-35625-8 Springer Berlin Heidelberg New York

ISBN-13 978-3-540-35625-7 Springer Berlin Heidelberg New York

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

Springer is a part of Springer Science+Business Media

springer.com

© Springer-Verlag Berlin Heidelberg 2006

Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India

Printed on acid-free paper SPIN: 11783237 06/3142 5 4 3 2 1 0

Preface

This volume of Springer's *Lecture Notes in Computer Science* series records the proceedings of the 8th International Workshop on Digital Mammography (IWDM), which was held in Manchester, UK, June 18–21, 2006. The meetings 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 technology, not just for its own sake, but to support clinicians in the early detection and subsequent patient management of breast cancer. The conference series was initiated at a 1993 meeting of the SPIE in San Jose, with subsequent meetings hosted every two years by researchers around the world. Previous meetings were held in York, Chicago, Nijmegen, Toronto, Bremen, and North Carolina.

It is interesting to reflect on the changes that have occurred during the past 13 years. Then, the dominant technology was film-screen mammography; now it is full-field digital mammography. Then, there were few screening programmes world-wide; now there are many. Then, there was the hope that computer-aided detection (CAD) of early signs of cancer might be possible; now CAD is not only a reality but (more importantly) a commercially led clinical reality. Then, algorithms were almost entirely heuristic with little clinical support; now there is a requirement for substantial clinical support for any algorithm that is developed and published. However, upon reflection, could we have predicted with absolute certainty what would be the key questions to be addressed over the subsequent (say) six years? No! That is the nature, joy, and frustration of research. There are more blind alleys to explore than there are rich veins that bring gold (in all senses of that analogy!).

What are the current preoccupations? What are currently the ideas that we believe will bear handsome fruit over the next 20 years? These are reflected in the programme, and in the choice of invited speakers. However, it is first important to realize that what have been identified as the major challenges over the past 13 years continue to be challenges: robust, reliable, efficient algorithms for CAD, segmentation, registration, and texture analysis await definitive solution, as they do in image analysis generally (and mammography poses additional challenges). Second, the challenges of delivering the technology effectively to end-users remain unmet: what are the optimal prompts? How do you deliver CAD in large rural areas? How do you deliver mammographic image analysis over the emerging Grid? How do you integrate film-screen mammography with full-field digital? How do you fuse mammography with other imaging modalities, such as MRI, ultrasound, and PET... These observations explain about half of the sessions, as they did at previous meetings (though we all believe we have made progress)!

Like great music, however, for all the increasingly understood and recurrent themes there are some newer ones that press for attention! Among these

we can clearly identify tomosynthesis—subject of an invited address by Prof. Dan Kopans at UNC in 2004 and now increasingly a commercial and clinical reality—and the estimation and analysis of breast density—again, the subject of an invited address by Prof. Norman Boyd at UNC in 2004. However, with the exquisite hindsight of reflection on the past we will—six years hence—be able to identify a number of other emergent themes, although not only are we not able to see them clearly but would probably reject them as marginal! These might be fusion of mammography with other modalities and x-ray imaging techniques that currently seem *avant garde*.

A successful conference is a blend of inspired organization, financial support, scientific insight; but, ultimately, the quality of the papers that were submitted. Two of us (Sue, Mike) were charged by the IWDM Scientific Committee to organize a meeting in the UK. We invited four-page outline papers, as opposed to the paragraphs that had previously been submitted. We believe that this simultaneously increased the quality and decreased the number of submissions. Each four-page abstract was assessed independently by at least two, often three, members of the Scientific Committee, and the final eight-page submissions were assessed independently by at least two members. We believe that the final proceedings, which you have in your hand, constitute a state-of-the-art statement of mammographic image analysis, its underlying physics, and clinical pull-through. The invited addresses by Julietta Patnick—director of the UK national breast screening programme—and Profs. Andrew Maidment—digital mammography and tomosynthesis—and Etta Pisano—author *inter alia* of the influential DMIST trial—were not included in the published proceedings; but their influence on the future of the research of the community, and its pull-through into practice, cannot be over-emphasized.

Finally, in keeping with the multi-disciplinary nature of the meeting, the meeting was supported by sponsors and there was an excellent industrial exposition, pulled together by Reyer Zwiggelaar. The timely and efficient production of the reviews, final versions, arrangements, etc. depended fundamentally on Dr. Chris Rose and the remarkable CAWS website at Manchester.

Table of Contents

Breast Density

A New Step-Wedge for the Volumetric Measurement of Mammographic Density <i>Jennifer Diffey, Alan Hufton, Susan Astley</i>	1
Assessing Ground Truth of Glandular Tissue <i>Christina Olsén, Fredrik Georgsson</i>	10
Volumetric Breast Density Estimation on Mammograms Using Breast Tissue Equivalent Phantoms – An Update <i>Bindu J. Augustine, Gordon E. Mawdsley, Norman F. Boyd, Martin J. Yaffe</i>	18
An Alternative Approach to Measuring Volumetric Mammographic Breast Density <i>Christopher Tromans, Michael Brady</i>	26
Breast Density Dependent Computer Aided Detection <i>Styliani Petroudi, Michael Brady</i>	34
Evaluation of Effects of HRT on Breast Density <i>Styliani Petroudi, Kostantinos Marias, Michael Brady</i>	39

CAD

Modeling the Effect of Computer-Aided Detection on the Sensitivity of Screening Mammography <i>Robert M. Nishikawa</i>	46
Use of Prompt Magnitude in Computer Aided Detection of Masses in Mammograms <i>Nico Karssemeijer</i>	54
Current Screening Practice: Implications for the Introduction of CAD <i>Lucy Tomlinson, Nathalie Hurley, Caroline Boggis, Julie Morris, Emma Hurley, Sue Astley</i>	61
Mammographic Mass Detection Using Unsupervised Clustering in Synergy with a Parsimonious Supervised Rule-Based Classifier <i>Michel Bruynooghe</i>	68

Computerized Classification Can Reduce Unnecessary Biopsies in BI-RADS Category 4A Lesions <i>Isaac Leichter, Richard Lederman, Shalom Buchbinder, Yossi Srour, Philippe Bamberger, Fanny Sperber</i>	76
Addressing Image Variability While Learning Classifiers for Detecting Clusters of Micro-calcifications <i>Glenn Fung, Balaji Krishnapuram, Nicolas Merlet, Eli Ratner, Philippe Bamberger, Jonathan Stoeckel, R. Bharat Rao</i>	84
Computer-Aided Detection of Breast Cancer Using an Ultra High-Resolution Liquid Crystal Display: Reading Session Analysis <i>Yoshifumi Kuroki, Shigeru Nawano, Hidefumi Kobatake, Nachiko Uchiyama, Kazuo Shimura, Kouji Matano</i>	92

Clinical Practice

Mammography Reading with Computer-Aided Detection (CAD): Performance of Different Readers <i>Susan M. Astley, Stephen W. Duffy, Caroline R.M. Boggis, Mary Wilson, Nicky B. Barr, Ursula M. Beetles, Miriam A. Griffiths, Anil Jain, Jill Johnson, Rita M. Roberts, Heather Deans, Karen Duncan, Geeta Iyengar, Olorunsola Agbaje, Pamela M. Griffiths, Magnus M. McGee, Maureen G.C. Gillan, Fiona J. Gilbert</i>	97
The Impact of Integration of Computer-Aided Detection and Human Observers <i>Nachiko Uchiyama, Noriyuki Moriyama, Takayuki Yamada, Noriaki Ohuchi</i>	105
Improving Access to Mammography in Rural Areas <i>Elizabeth A. Krupinski</i>	111
Dual Modality Surgical Guidance for Non-palpable Breast Lesions <i>Patricia Judy Goodale, Priya Raghunathan, Mark B. Williams</i>	118
Mammography Reading with Computer-Aided Detection (CAD): Single View <i>vs</i> Two Views <i>Olorunsola F. Agbaje, Susan M. Astley, Maureen G.C. Gillan, Caroline R.M. Boggis, Mary Wilson, Nicky B. Barr, Ursula M. Beetles, Miriam A. Griffiths, Anil Jain, Jill Johnson, Rita M. Roberts, Heather Deans, Karen Duncan, Geeta Iyengar, Pamela M. Griffiths, Magnus M. McGee, Stephen W. Duffy, Fiona J. Gilbert</i>	125

Automated Breast Tissue Measurement of Women at Increased Risk of Breast Cancer	
<i>H.G. Patel, S.M. Astley, A.P. Hufton, M. Harvie, K. Hagan, T.E. Marchant, V. Hillier, A. Howell, R. Warren, C.R.M. Boggis</i>	131

Tomosynthesis

Mammography Tomosynthesis System for High Performance 3D Imaging	
<i>Jeffrey W. Eberhard, Douglas Albagli, Andrea Schmitz, Bernhard E.H. Claus, Paul Carson, Mitchell Goodsitt, Heang-Ping Chan, Marilyn Roubidoux, Jerry A. Thomas, Jacqueline Osland</i>	137
Clinical Evaluation of a Photon-Counting Tomosynthesis Mammography System	
<i>Andrew D.A. Maidment, Christer Ullberg, Tom Francke, Lars Lindqvist, Skiff Sokolov, Karin Lindman, Leif Adelow, Per Sunden</i>	144
Three-Dimensional Digital Breast Tomosynthesis in the Early Diagnosis and Detection of Breast Cancer	
<i>Mari Varjonen</i>	152
Lesion Visibility in Low Dose Tomosynthesis	
<i>Andrew P. Smith, Loren Niklason, Baorui Ren, Tao Wu, Chris Ruth, Zhenxue Jing</i>	160
Generalized Filtered Back-Projection Reconstruction in Breast Tomosynthesis	
<i>Bernhard E.H. Claus, Jeffrey W. Eberhard, Andrea Schmitz, Paul Carson, Mitchell Goodsitt, Heang-Ping Chan</i>	167
Adaptation of Image Quality Using Various Filter Setups in the Filtered Backprojection Approach for Digital Breast Tomosynthesis	
<i>Jasmina Orman, Thomas Mertelmeier, Wolfgang Haerer</i>	175
Optimization of Contrast-Enhanced Digital Breast Tomosynthesis	
<i>Ann-Katherine Carton, Jingjing Li, Sara Chen, Emily Conant, Andrew D.A. Maidment</i>	183
Development of an Analytic Breast Phantom for Quantitative Comparison of Reconstruction Algorithms for Digital Breast Tomosynthesis	
<i>I. Reiser, E.Y. Sidky, R.M. Nishikawa, X. Pan</i>	190

Registration and Multiple View Mammography

X-Ray Mammogram Registration: A Novel Validation Method <i>John H. Hipwell, Christine Tanner, William R. Crum, David J. Hawkes</i>	197
A Probabilistic Approach for the Simultaneous Mammogram Registration and Abnormality Detection <i>Mohamed Hachama, Agnès Desolneux, Frédéric Richard</i>	205
Mammographic Registration: Proposal and Evaluation of a New Approach <i>Robert Martí, David Raba, Arnau Oliver, Reyer Zwiggelaar</i>	213
Image Similarity and Asymmetry to Improve Computer-Aided Detection of Breast Cancer <i>Dave Tahmoush, Hanan Samet</i>	221
Potential Usefulness of Multiple-Mammographic Views in Computer-Aided Diagnosis Scheme for Identifying Histological Classification of Clustered Microcalcification <i>Ryohei Nakayama, Ryoji Watanabe, Kiyoshi Namba, Koji Yamamoto, Kan Takeda, Shigehiko Katsuragawa, Kunio Doi</i>	229
Exploitation of Correspondence Between CC and MLO Views in Computer Aided Mass Detection <i>Saskia van Engeland, Nico Karssemeijer</i>	237

Physics Models

Breast Composition Measurements Using Retrospective Standard Mammogram Form (SMF) <i>Ralph Highnam, Xia-Bo Pan, Ruth Warren, Mona Jeffreys, George Davey Smith, Michael Brady</i>	243
A Scatter Model for Use in Measuring Volumetric Mammographic Breast Density <i>Christopher Tromans, Michael Brady</i>	251
Using a Homogeneity Test as Weekly Quality Control on Digital Mammography Units <i>R.E. van Engen, M.M.J. Swinkels, L.J. Oostveen, T.D. Geertse, R. Visser</i>	259

Automated and Human Determination of Threshold Contrast for Digital Mammography Systems <i>Kenneth C. Young, James J.H. Cook, Jennifer M. Oduko</i>	266
Beam Optimization for Digital Mammography – II <i>Mark B. Williams, Priya Raghunathan, Anthony Seibert, Alex Kwan, Joseph Lo, Ehsan Samei, Laurie Fajardo, Andrew D.A. Maidment, Martin Yaffe, Aili Bloomquist</i>	273
Image Qualities of Phase-Contrast Mammography <i>Chika Honda, Hiromu Ohara, Tomonori Gido</i>	281
Application of the Multiple Image Radiography Method to Breast Imaging <i>Christopher Parham, Etta Pisano, Chad Livasy, Laura Faulconer, Miles Wernick, Jovan Brankov, Miklos Kiss, Dean Connor, Jeddy Chen, Ann Wu, Zhong Zhong, Dean Chapman</i>	289
Correlating Cone-Beam CT and Large-Section Histology Image Sets: Initial Results Using a Surgical Lumpectomy Specimen <i>James G. Mainprize, Shaista Okhai, Gina M. Clarke, Michael P. Kempston, Shawnee Eidt, Martin J. Yaffe</i>	299
Poster Session	
Calcification Descriptor and Relevance Feedback Learning Algorithms for Content-Based Mammogram Retrieval <i>Chia-Hung Wei, Chang-Tsun Li</i>	307
Clinical Optimization of Filters in Direct a-Se FFDM (Full Field Digital Mammography) System <i>Nachiko Uchiyama, Noriyuki Moriyama, Mayumi Kitagawa, Shiho Gomi, Yuichi Nagai</i>	315
Study on Cascade Classification in Abnormal Shadow Detection for Mammograms <i>Mitsutaka Nemoto, Akinobu Shimizu, Hidefumi Kobatake, Hideya Takeo, Shigeru Nawano</i>	324
Classifying Masses as Benign or Malignant Based on Co-occurrence Matrix Textures: A Comparison Study of Different Gray Level Quantizations <i>Gobert N. Lee, Takeshi Hara, Hiroshi Fujita</i>	332

A Ranklet-Based CAD for Digital Mammography <i>Enrico Angelini, Renato Campanini, Emiro Iampieri, Nico Lanconelli, Matteo Masotti, Todor Petkov, Matteo Roffilli</i>	340
Detection of Microcalcifications in Digital Mammograms Based on Dual-Threshold <i>Yuan Wu, Qian Huang, YongHong Peng, Wuchao Situ</i>	347
Feasibility and Acceptability of Stepwedge-Based Density Measurement <i>Michael Berks, Jennifer Diffey, Alan Hufton, Susan Astley</i>	355
Use of the European Protocol to Optimise a Digital Mammography System <i>Kenneth C. Young, James J.H. Cook, Jennifer M. Oduko</i>	362
Automated Detection Method for Architectural Distortion with Spiculation Based on Distribution Assessment of Mammary Gland on Mammogram <i>Takeshi Hara, Takanari Makita, Tomoko Matsubara, Hiroshi Fujita, Yoriko Inenaga, Tokiko Endo, Takuji Iwase</i>	370
Web Services for the DDSM and Digital Mammography Research <i>Chris Rose, Daniele Turi, Alan Williams, Katy Wolstencroft, Chris Taylor</i>	376
GPCALMA: An Italian Mammographic Database of Digitized Images for Research <i>Adele Lauria, Raffaella Massafra, Sabina Sonia Tangaro, Roberto Bellotti, MariaEvelina Fantacci, Pasquale Delogu, Ernesto Lopez Torres, Piergiorgio Cerello, Francesco Fauci, Rosario Magro, Ubaldo Bottigli</i>	384
Development of Breast Ultrasound CAD System for Screening <i>Daisuke Fukuoka, Yuji Ikedo, Takeshi Hara, Hiroshi Fujita, Etsuo Takada, Tokiko Endo, Takako Morita</i>	392
Linking Image Structures with Medical Ontology Information <i>Da Qi, Erika R.E. Denton, Reyer Zwiggelaar</i>	399
Comparison Between Wolfe, Boyd, BI-RADS and Tabár Based Mammographic Risk Assessment <i>Izzati Muhimmah, Arnau Oliver, Erika R.E. Denton, Josep Pont, Elsa Pérez, Reyer Zwiggelaar</i>	407

Initial Results of the Daily Quality Control of Medical Screen Devices Using a Dynamic Pattern in a Digital Mammography Environment <i>J. Jacobs, T. Deprez, G. Marchal, H. Bosmans</i>	416
A Filter-Based Approach Towards Automatic Detection of Microcalcification <i>Zhi Qing Wu, Jianmin Jiang, Yong Hong Peng, Thor Ole Gulsrud</i>	424
Texture Based Segmentation <i>Reyer Zwiggelaar, Erika R.E. Denton</i>	433
Image Quality of a Photon-Counting Mammography System Compared to Digital Mammography Based on Amorphous Silicon with CsI-Scintillator <i>Arne Fischmann, Günther Steidle</i>	441
Understanding Hessian-Based Density Scoring <i>Jakob Raundahl, Marco Loog, Mads Nielsen</i>	447
Review of the Dose and Image Quality Characteristics of 3 FFDM Systems in Clinical Practice in a Screening Programme <i>Gillian Egan, Niall Phelan</i>	453
Impact of Textured Background on Scoring of Simulated CDMAM Phantom <i>Bénédicte Grosjean, Serge Muller</i>	460
Magnetic Resonance Electrical Impedance Mammography: A Pilot Study <i>Maria Kallergi, Ernest Wollin, John J. Heine, Nataliya Kovalchuk, Anand Manohar</i>	468
Experimental Investigation of the Necessity for Extra Flat Field Corrections in Quality Control of Digital Mammography <i>Paula Pöyry, Federica Zanca, Hilde Bosmans</i>	475
Observer Evaluations of Wavelet Methods for the Enhancement and Compression of Digitized Mammograms <i>Maria Kallergi, John J. Heine, Bradley J. Lucier</i>	482
Evaluating the Effect of Dose on Reconstructed Image Quality in Digital Tomosynthesis <i>Michael P. Kempston, James G. Mainprize, Martin J. Yaffe</i>	490

Registration of Mammograms and Breast Tomosynthesis Images <i>Predrag R. Bakic, Frederic J.P. Richard, Andrew D.A. Maidment</i>	498
Complementary Role of Computer Aided Detection in Mammography <i>Keiko Sugisaki, Hiroshi Fujita, Hiro Goto, Hiroaki Hoshi</i>	504
The Refinement of Microcalcification Cluster Assessment by Joint Analysis of MLO and CC Views <i>Márta Altrichter, Gábor Horváth</i>	509
The Dependence of Tomosynthesis Imaging Performance on the Number of Scan Projections <i>Baorui Ren, Tao Wu, Andrew Smith, Chris Ruth, Loren Niklason, Zhenxue Jing, Jay Stein</i>	517
First Attempt at 3D X-Ray Visualization of DCIS (Ductal Carcinoma in Situ) Due to Refraction Contrast – In Good Relation to Pathological View <i>Masami Ando, Takao Akatsuka, Hiroko Bando, Yoshinori Chikaura, Tokiko Endo, Eiko Hashimoto, Keiichi Hirano, Kazuyuki Hyodo, Shu Ichihara, Anton Maksimenko, Chiho Ohbayashi, Hiroshi Sugiyama, Ei Ueno, Katsuhito Yamasaki, Tetsuya Yuasa</i>	525
Wavelet Methods	
Lossless Compression of Digital Mammograms <i>R. Visser, L. Oostveen, N. Karssemeijer</i>	533
Capturing Microcalcification Patterns in Dense Parenchyma with Wavelet-Based Eigenimages <i>Nikolaos Arikidis, Spyros Skiadopoulos, Filippas Sakellaropoulos, George Panayiotakis, Lena Costaridou</i>	541
Breast Component Adaptive Wavelet Enhancement for Soft-Copy Display of Mammograms <i>Spyros Skiadopoulos, Anna Karahaliou, Filippas Sakellaropoulos, George Panayiotakis, Lena Costaridou</i>	549
Using Wavelet-Based Features to Identify Masses in Dense Breast Parenchyma <i>Filippas Sakellaropoulos, Spyros Skiadopoulos, Anna Karahaliou, Lena Costaridou, George Panayiotakis</i>	557

Full-Field Digital Mammography

Leveraging the Digital Mammography Image Screening Trial (DMIST)
Data for the Evaluation of Computer-Aided Detection (CAD) Devices:
A Proposal

*Nicholas Petrick, Kyle J. Myers, Sophie Paquerault,
Frank W. Samuelson, Brandon D. Gallas, Robert F. Wagner* 565

Comparison of Computerized Image Analyses for Digitized Screen-Film
Mammograms and Full-Field Digital Mammography Images

*Hui Li, Maryellen L. Giger, Yading Yuan, Li Lan, Kenji Suzuki,
Andrew Jamieson, Laura Yarusso, Robert M. Nishikawa,
Charlene Sennett* 569

Comparison Between CRT and LCD Displays for
Full-Field-Digital-Mammography (FFDM) Interpretation

*Chiara Del Frate, Alexia Bestagno, Viviana Londero,
Raffaella Pozzi Mucelli, Valerio Salomoni, Massimo Bazzocchi* 576

A Harmonized Quality Control Program for Digital Mammography

Martin Yaffe, Gordon Mawdsley, Aili Bloomquist 585

Contrast Threshold of 4 Full Field Digital Mammography Systems
Using Different Measurement Methods

*A.-K. Carton, H. Bosmans, C. Vanongeval, G. Souverijns,
G. Marchal, J. Jacobs, D. Vandenbroucke, H. Pauwels, K. Nijs* 593

Segmentation

The Use of Multi-scale Monogenic Signal on Structure Orientation
Identification and Segmentation

*Xiao-Bo Pan, Michael Brady, Ralph Highnam,
Jérôme Declerck* 601

Breast Density Segmentation Using Texture

Styliani Petroudi, Michael Brady 609

Texture Based Mammogram Classification and Segmentation

Yang Can Gong, Michael Brady, Styliani Petroudi 616

Mammographic Risk Assessment Based on Anatomical Linear
Structures

Edward M. Hadley, Erika R.E. Denton, Reyer Zwiggelaar 626

Comparison of Methods for Classification of Breast Ductal Branching
Patterns
 Predrag R. Bakic, Despina Kontos, Vasileios Megalooikonomou,
 Mark A. Rosen, Andrew D.A. Maidment 634

Validation of Graph Theoretic Segmentation of the Pectoral Muscle
 Fei Ma, Mariusz Bajger, John P. Slavotinek, Murk J. Bottema 642

Author Index 651