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*

Alfred Kobsa
   *University of California, Irvine, CA, 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
   *TU Dortmund University, Germany*

Demetri Terzopoulos
   *University of California, Los Angeles, CA, USA*

Doug Tygar
   *University of California, Berkeley, CA, USA*

Gerhard Weikum
   *Max Planck Institute for Informatics, Saarbruecken, Germany*
Preface

This volume of Springer’s *Lecture Notes in Computer Science* series comprises the scientific proceedings of the 12th International Workshop on Breast Imaging (IWDM 2014), which was held June 29-July 2, 2014, in Gifu City, Japan. This workshop was formerly called the International Workshop on Digital Mammography, IWDM for short. Although the term “Digital Mammography” was changed to “Breast Imaging” starting from the last meeting (IWDM 2012), we still kept the familiar abbreviation “IWDM.” This new naming is to make clear the recognition of the movement in breast imaging from mammography toward more recent emerging technologies and multimodality imaging solutions. The IWDM meetings traditionally bring together a diverse set of researchers (physicists, mathematicians, computer scientists, and engineers), clinicians (radiologists, surgeons), and representatives of industry, who are jointly committed to developing technology for early detection of and subsequent patient management in breast cancer. The conference series was initiated at a 1993 meeting of the SPIE in San Jose, with subsequent meetings hosted every two years. Previous meetings have been held in York (1994), Chicago (1996), Nijmegen (1998), Toronto (2000), Bremen (2002), Durham (2006), Tucson (2008), Girona (2010), and Philadelphia (2012). This year was the first time the workshop was held in an in Asian region in the history of the workshop over the past 20 years.

A total of 122 paper submissions from around 20 countries were received for IWDM 2014. Each of the abstracts along with the maximum four-page supporting documents was reviewed in a blind process by two members of the Scientific Committee, which led to a final selection of 27 oral presentations and 76 posters during the two and a half days of sequential scientific sessions. Eleven profound talks, including a plenary lecture, eight keynotes, and two luncheon seminars, were given by invited speakers in IWDM 2014. Of these 11 talks, ten short abstracts are included in the front matter of this volume, and six full review papers by these speakers followed by 97 final peer-reviewed papers constitute a comprehensive state of the art in breast imaging today in this proceedings volume (LNCS 8539).

Invited speakers, who are working as breast surgeons, radiologists, medical physicists at hospitals, and researchers in universities or companies, were chosen discreetly. As mentioned above, this workshop was the first meeting held in an Asian area, and thus we selected the themes that are specific to issues of dense breast, screening means, and imaging modalities. Dr. Noriaki Ohuchi of Tohoku University Graduate School of Medicine, Japan, gave a lecture on the efficacy of ultrasonography screening by sharing the updated data from the randomized clinical trial for Japanese women in their 40s. Dr. Woo-Kyung Moon of Seoul National University Hospital, Republic of Korea, presented data on the current breast imaging diagnosis and screening in Korea. Dr. Ruey-Feng Chang of the
National Taiwan University, Taiwan, gave a review on computer-aided diagnosis for B-mode, elastography, and automated ultrasound, and Dr. Kwan-Hoong Ng of the University of Malaya, Malaysia, gave a review on the quantitative measurement and clinical utility of breast density. Dr. Michael K. O’Connor of the Mayo Clinic, USA, presented diagnostic and screening application of molecular breast imaging in women with dense breasts. Dr. Julian Marshall of Hologic Inc., USA, discussed the current situation in mammography CAD with the advent of tomosynthesis, while Dr. Etta D. Pisano of the Medical University of South Carolina, USA, provided a review of tomosynthesis and an overview of the Tomosynthesis Mammographic Imaging Screening Trial (TMIST) design. Dr. Andrew D. A. Maidment of the University of Pennsylvania, USA, presented his work on virtual clinical trials for the assessment of new screening modalities. Dr. Elizabeth Krupinski of the University of Arizona, USA, gave an overview of current breast cancer telemedicine services in Arizona. A special luncheon seminar was given by Dr. Tsuyoshi Shiina of Kyoto University, Japan, with the topic of real-time tissue elastography. Another luncheon seminar was presented by two invited speakers, Dr. Ch. Mueller-Leisse and Dr. Mechthild Schulze-Hagen of Maria Hilf Moenchengladbach, Germany, who talked about the clinical benefit of tomosynthesis.

Finally, a meeting as large and successful as IWDM 2014 is only possible through the tireless work of many people. First, I would like to acknowledge the excellent work of the Scientific Committee in guaranteeing scientific significance by means of providing feedback to the authors for the final papers. Second, special thanks need to go to Takeshi Hara and Chisako Muramatsu for making this meeting a reality, to Norimitsu Shinohara for working many hours to recruit the industrial partners, and to Xiangrong Zhou for making and renewing the workshop web-site daily. Third, thanks go to all the advisory board members and local Organizing Committee members listed herein. Finally, we are grateful to our academic partners, cooperating organizations, and industrial partners for their enthusiastic support for the scientific progress in breast imaging.

June 1, 2014

Hiroshi Fujita
Organization

Workshop Chair

Hiroshi Fujita  
Gifu University, Japan

Scientific Committee

Susan M. Astley  
University of Manchester, UK
Ulrich Bick  
Charité University, Germany
Hilde Bosmans  
University Hospitals of KU Leuven, Belgium
Hiroshi Fujita  
Gifu University, Japan
Maryellen L. Giger  
University of Chicago, USA
Takeshi Hara  
Gifu University, Japan
Nico Karssemeijer  
Radboud University Nijmegen Medical Centre, The Netherlands
Elizabeth A. Krupinski  
University of Arizona, USA
Andrew D.A. Maidment  
University of Pennsylvania, USA
Joan Martí  
University of Girona, Spain
Etta D. Pisano  
Medical University of South Carolina, USA
Martin J. Yaffe  
University of Toronto, Canada
Reyer Zwiggelaar  
Aberystwyth University, UK

Local Organizing Committee Chairs

Chisako Muramatsu  
Gifu University, Japan
Xiangrong Zhou  
Gifu University, Japan

Local Organizing Committee

Daisuke Fukuoka  
Gifu University, Japan
Tomoko Matsubara  
Nagoya Bunri University, Japan
Hiroko Nishide  
Gifu University of Medical Science, Japan
Norimitsu Shinohara  
Gifu University of Medical Science, Japan

Special Advisors

Kunio Doi  
University of Chicago, USA, and Gunma Prefectural College of Health Sciences, Japan
Tokiko Endo  
National Hospital Organization Higashi Nagoya National Hospital, Japan
Advisory Board

Tetsuro Katafuchi  Gifu University of Medical Science, Japan
Yoshie Kodera  Nagoya University, Japan
Woo-Kyung Moon  Seoul National University Hospital  Republic of Korea
Shigeru Nawano  International University of Health and Welfare  Mita Hospital, Japan
Shigeru Sanada  Kanazawa University, Japan
Nachiko Uchiyama  National Cancer Center, Japan
Plenary Lecture
Effectiveness of Ultrasonography Screening for Breast Cancer; Up-Dated Data from the RCT of 76,196 Women Aged 40-49 (J-START)

Noriaki Ohuchi, Akihiko Suzuki, and Takanori Ishida

Department of Surgical Oncology, Graduate School of Medicine, Tohoku University, Sendai, Japan
{noriaki-ohuchi,takanori}@med.tohoku.ac.jp
Akihiko1622@me.com

At present, mammography (MG) is the only method for breast cancer screening that has evidence of decreasing mortality. However, MG does not achieve sufficient screening accuracy in women aged 40 to 49, as the U.S. Preventive Services Task Force (USPSTF) has recently recommended against routine screening MG in women aged 40 to 49 years. Supplemental screening ultrasonography (US) has the potential to depict early breast cancers not seen on MG. However, randomized controlled trials (RCTs), cohort studies, or case-control studies have not been completed to assess the efficacy of screening US to reduce breast cancer mortality, and the effectiveness has not been verified.

In 2007, we planned the RCT to assess the effectiveness of US screening for breast cancer in women aged 40-49, with a design to study 50,000 women with MG and US (intervention group), and 50,000 women with MG only (control group). The primary endpoints are sensitivity and specificity, and the secondary endpoint is the rate of advanced breast cancers.

The cumulative total number of participants registered is 76,196 (38,313 in the intervention group and 37,883 in the control group). The study was designed so that participants registered at their first examination underwent examinations by the same method for the subsequent two years. The second examinations were completed by end of March 2013. Among the 76,196 participants, 74.5% of women had undertaken second screening, while information including the presence of interval cancer is obtained from a further 22.6% using a questionnaire. As of end of December 2013, only 2.9% of participants are unclear for their follow-up.

This study is the first large-scale RCT carried out to clarify the effectiveness of US screening for breast cancer. It requires objective judgment regarding the advantages and disadvantages of the introduction of US screening, and it is anticipated that J-START project will make a significant contribution to establish a scientific justification for its introduction. RCT is the most appropriate way to make scientific analysis and verification of the effectiveness of new modality in cancer diagnosis and treatment, although such trials are extremely costly, take long time until the final evaluation confirmed.

We believe that J-START, a prospective and challenging trial to evaluate effectiveness of screening modality, would make an important contribution to the world, with leading to the cancer mortality reduction in future generations.
Keynote Talks
Virtual Clinical Trials for the Assessment of Novel Breast Screening Modalities

Andrew D.A. Maidment

University of Pennsylvania, Dept. of Radiology, Philadelphia, PA, USA
Andrew.Maidment@uphs.upenn.edu

Validation of any imaging system is challenging due to the huge number of system parameters that should be evaluated. The ultimate metric of system performance is a clinical trial. However, the use of clinical trials is limited by cost and duration. We are strong proponents of a preclinical alternative, in the form of Virtual Clinical Trials (VCT), which model human anatomy, image acquisition, display and processing, and image analysis and interpretation. A complete VCT pipeline was envisioned by combining the breast anatomy and image acquisition simulation pipeline developed at the University of Pennsylvania, with the MeVIC image display and observation pipeline developed by researchers at Barco. Today an integrated virtual clinical trial design program, VCTdesigner, and a virtual clinical trial management program, VCTmanager, are freely available (www.VCTworld.org). The pipeline design is flexible and extensible, making it possible to add functionality easily and rapidly. It is our hope that by freely distributing the VCTmanager software, our field can standardize on this platform for running VCT.
This review paper encapsulates the presentation of the computer-aided diagnosis (CAD) development in the session of US imaging at IWDM 2014. The development includes novel methodologies in conventional B-mode and modern ultrasound modalities such as elastography and automated breast ultrasound. For B-mode images, gray-scale invariant texture features were proposed to solve the changing of echogenicities from various ultrasound systems. Speckle patterns were analyzed to show the properties of tiny scatterers with microstructure contained in breast tissues for tissue characterization. Using quantified sonographic findings in tumor classification can achieve better diagnostic result than combining all features together. Elastography CAD systems use automatic tumor segmentation and clustering method to reduce operator-dependence. Dynamic sequence features were extracted from a sequence of elastograms to provide tumor stiffness without selecting slices. Another approach was selecting slices with quality evaluation methods. Both approaches reduced the overloads of physicians in slice selection. Automated breast ultrasound system is developed to automatically scan the whole breast and build the volumetric breast structure. Three-dimensional morphology, texture, and speckle features were proposed and combined to provide more diagnostic information than two-dimensional features. These CAD systems for B-mode, elastography, and automated breast ultrasound are good at malignancy evaluation and would be helpful in clinic use.
Breast Imaging Diagnosis and Screening in Korea

Woo Kyung Moon, M.D.

Department of Radiology, Seoul National University Hospital, Seoul, Korea

In Korea, national cancer screening program (NCSP) began in 1999 for five major cancers, including stomach, breast, uterine cervix, liver and colorectal cancers. The NCSP recommends biennial breast cancer screening for females over 40 years of age with mammogram ± clinical breast examination as the screening tool. The Korean Society of Breast Imaging (KSBI) developed guidelines and standards of quality management for mammography from 1999. On January 14, 2003, the national assembly of Korea approved the Acts including quality management for mammography. Annual inspection includes the facilities to meet minimum quality standards for personnel, equipment, and phantom image. Every three year, on site survey and evaluation of clinical image are added. Mammography accreditation program has been helping facilities improve the image quality by peer review and professional feedback.

The breast cancer screening rate increased from 33.2% in 2004 to 55.2% in 2009. According to previously published reports in Korea, there were variations in performance indicators across the institutions, but these differences were not extreme; Performance of screening mammography was associated with sensitivity of 85.0-91.5%, specificity of 95.0-99.0%, PPV₁ of 0.8-2.5%, PPV₂ of 18.0-27.7%, recall rates of 5.1-13.0%, and cancer detection rates of 0.5-2.0/1000. Compared with the ideal goal of ACR in USA, PPV₁ and cancer detection rates are lower than the goal of ACR. It is probably due to lower cancer incidence in Korea than that of USA. In the near future, results of 10 year performance and outcome measurements of NCSP in Korea will be reported.

Although mammography screening is the only method presently considered appropriate for mass screening of asymptomatic women, the success in cancer detection has been limited in women with small and dense breasts, especially in Asian women. Other or new breast imaging technologies having potential role in breast screening are digital mammography, breast ultrasound including automated whole breast US, MRI, digital breast tomosynthesis. The digital mammographic imaging screening trial (DMIST) found that digital mammography performed significantly better than analog mammography in premenopausal and perimenopausal women, those aged < 50 years, and those with dense breasts. Ultrasound is an ideal supplement to mammography. The results of a multicenter trial of supplemental screening breast ultrasound for women at high risk with dense breast tissue have been promising. Several studies found that ultrasound alone caught breast tumors that mammography couldn’t see in 0.1-0.5% of patients. Previously Published Data of screening US in Korea show similar cancer detection rate, reported 0.35% - 0.5%. However, the operator dependence of...
hand held ultrasound is a major concern with respect to the widespread use of whole breast screening ultrasound. Recently developed automated whole breast ultrasound is more readily reproducible, has 3D capability through multi-planar reconstruction, and allows delayed interpretation outside of real time, optimizing the radiologist’s reading environment. Magnetic resonance imaging has been used with success in the screening of high-risk women. From 2007, the ACS issued recommendations for screening breast MRI among certain high-risk women. Recently developed digital breast tomosynthesis (DBT) allows cross-sectional visualization of breast tissue that the overlying and underlying anatomical tissue can be effectively removed when viewing individual slices. Thus overcoming the problem of super-positioning that reduces the effectiveness of mammography. It also has a potential role for breast screening. However, there are no large, peer-reviewed studies that support the routine use of other imaging techniques, these are not recommended to be widely used until a clear outcome benefit is established for breast cancer screening.
Measurement and Clinical Use of Breast Density

Kwan-Hoong Ng and Susie Lau

Department of Biomedical Imaging and University of Malaya Research Imaging Centre,
Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia
ngkh@ummc.edu.my

Breast density is loosely defined as the amount of fibroglandular tissue in the breast compared to the total amount of breast tissue. In this review paper we consider the three ways of describing breast density as seen on a mammogram: pattern-based, area-based and volumetric-based and explain the rationale for each along with detailing the various ways of estimating each of them (visual, semi-automated, and fully automated). We also consider the use of other imaging modalities of estimating breast density, including CT. Clinically, breast density has now moved from being a controversial, even derided subject to one which is widely accepted with an expanding number of clinical uses. It is proven that a woman’s breast density is a strong predictor of the failure of mammographic screening to detect breast cancer and thus can be used to indicate where alternate modalities might be considered. It is proven that breast density is a strong predictor of the risk of developing breast cancer and thus can be used to start to consider tailored screening programs. We review the current widely known clinical uses along with the lesser known uses, such as assessing the benefits of chemoprevention and generating more accurate radiation dose estimates. Breast density is becoming an increasingly important clinical tool; there is an increasing need for accurate and consistent density measures along with an understanding of how the various measures compare.
Low-Dose Molecular Breast Imaging - Diagnostic and Screening Applications in Women with Dense Breasts

Michael K. O’Connor

Department of Radiology, Mayo Clinic, Rochester, MN
mkoconnor@mayo.edu

Approaches to imaging the breast with nuclear medicine and/or molecular imaging methods have been under investigation since the early 1990s. Nuclear medicine procedures, which detect the preferential uptake of a radiotracer in breast lesions, have the potential to offer valuable functional information that complements conventional anatomical imaging techniques such as mammography and ultrasound.

Despite initial enthusiasm for scintimammography, nuclear medicine techniques in general have struggled to gain mainstream acceptance by the breast imaging community. In the last 5-10 years, older-generation scintillating gamma systems, such breast-specific gamma imaging systems, have been replaced by a new generation of dual detector cadmium zinc telluride [CZT] detectors that perform direct conversion [DC] of gamma ray energy to signal and yield improved spatial and energy resolution. Using CZT-based detectors, DC-Molecular breast Imaging [DC-MBI] has demonstrated the ability to reliably detect breast tumors in a variety of diagnostic and screening settings. Recent improvements in both the detector technology and patient preparation have enabled the associated radiation dose from DC-MBI to be reduced to less than 1.5 mSv. The most robust evidence for the clinical use of DC-MBI is in the screening of women with dense breast tissue. In two large screening studies, the addition of DC-MBI to mammography was significantly more sensitive than mammography alone in detecting cancer (91% vs. 25%, p <0.001). Supplemental screening with DC-MBI detected an additional 8.3 cancers per 1000 women, which compares very favorably to other modalities in screening women with dense breasts.
Will New Technologies Replace Mammography CAD as We Know It?

Julian Marshall, Ashwini Kshirsagar, Sibel Narin, and Nikos Gkanatsios
Hologic, Inc., Santa Clara, CA, USA

Since its commercial introduction in 1998, Mammography computer-aided detection (CAD) has been one of the few CAD technologies widely implemented in clinical practice. The original concept of CAD marks as overlays on images has been broadly accepted, although new paradigms have been proposed and successfully tested that could one day challenge that original approach. But now, as breast imaging evolves further with the advent of digital breast tomosynthesis, new image processing techniques are developing that may cause us to re-evaluate the clinical requirements for Mammography CAD as we know it. What clinical problems in breast imaging are not solved by tomosynthesis, and how can CAD help us with those problems?

Tomosynthesis: What We Know Now and Why TMIST Is Needed

Etta D. Pisano
Department of Radiology and Radiological Science,
Medical University of South Carolina,
Charleston, USA
pisanoe@musc.edu

Digital Breast Tomosynthesis provides pseudo three-dimensional viewing of breast tissue on a technological platform similar to conventional two-dimensional digital mammography. The technology is being incorporated into clinical environments across the world. This presentation provides a review of the current published literature concerning the clinical use of digital breast tomosynthesis and an overview of the design of a proposed North American Tomosynthesis Mammographic Imaging Screening Trial (TMIST).
Advanced Telecommunications in Breast Imaging—Streamlining Telemammography, Telepathology & Teleoncology Services to Improve Patient Care

Elizabeth A. Krupinski

Department of Medical Imaging, University of Arizona, Tucson, AZ USA
krupinski@radiology.arizona.edu

Teleradiology services are very common worldwide, and Full Field Digital Mammography (FFDM) systems have made it possible to include mammography. This is important because breast cancer is the most common cancer in women in many parts of the world and it is the second leading cause of cancer deaths. In rural and medically underserved areas, mammography rates are lower than in urban areas for a variety of reasons, including lack of dedicated screening facilities and/or personnel, poor compliance, and large distances between patients and clinics (making it difficult to return for follow-up care). Once possible cancers are detected, biopsies are performed but in many cases reports are very slow to get back to the patient and/or local clinician impacting treatment and follow-up. Telepathology can address this situation. Patients may also require oncology services and in rural areas they are often limited or non-existent. Real-time teleoncology services can facilitate treatment and counseling. Finally, breast care support and education can be facilitated by virtual support groups and broadcasting education lectures.
Luncheon Seminar
Real-Time Tissue Elastography: 
Theory and Usefulness for Breast Cancer 
Diagnosis

Tsuyoshi Shiina

Department of Human Health Sciences, Graduate School of Medicine, 
Kyoto University, Kyoto, Japan 
shiina@hs.med.kyoto-u.ac.jp

Disease tissues, such as breast cancer, become hard as the disease progresses. Therefore, ultrasound tissue elasticity imaging, i.e., elastography has attracted much attention as a modality that provides novel diagnostic information regarding tissue stiffness, and various techniques for elastography have been proposed in the last two decades.

The most widely available commercial elastography method today is strain imaging using external tissue compression and generating images of the resulting tissue strain. The most fundamental external force is manually applying pressure with a probe on the body surface, similar to an ordinary ultrasound examination, which is referred to as strain elastography.

Advantages of ultrasonic examination, such as real-time and simple (free-hand) operation, must be preserved in the ultrasound elastography system. In a freehand compression, it is necessary to have a large dynamic range of strain for stable measurement that does not depend on a compression speed and quantity. The Combined Autocorrelation Method (CAM) was developed by our group as an image reconstruction method suited for clinical application. It produces an elasticity image with high-speed processing and accuracy, and achieves a wide dynamic range for strain estimation by combining envelope correlation and phase shift while avoiding aliasing errors. As a result of collaboration of our group and Hitachi Medical Corporation the first practical system of ultrasound elastography was released in 2003 based on the CAM.

Its efficacy was demonstrated in the diagnosis of breast-cancer tumors together with an elasticity score proposed at the same time, and it is currently being used in various fields of clinical medicine other than breast-cancer diagnosis, such as prostate-cancer, arteriosclerosis, chronic hepatitis.

Strain elastography has the advantages of being easy to use and providing elasticity images in real time and with a high spatial resolution in a manner similar to conventional ultrasonography. Many manufacturers today produce ultrasonographic equipment with a strain elastography function. Recently, another elastography approach (shear wave imaging) that provides stiffness images based upon the shear wave propagation speed has been practically applied. Features and equipment of each method, i.e., their merits and limitations, must be clarified for their appropriate use. Recently, to help users of ultrasound elastography, academic societies of medical ultrasound, such as WFUMB, EFSUMB, and JSUM, have started to prepare guidelines.
Elastography further improves the value of ultrasonography with the ability to provide new diagnostic information related to tissue characterization. On the other hand, it is still an evolving technology with much technical potential for clinical application in the future including expanding its scope of application, quantification, 3D measurement, and treatment support, etc. One might anticipate that it will further evolve in the future and attain a position as a third mode of ultrasound imaging behind B-mode and Doppler method.
Table of Contents

Invited Talks

Virtual Clinical Trials for the Assessment of Novel Breast Screening Modalities ...................................................... 1

Andrew D.A. Maidment

Computer-Aided Diagnosis for B-Mode, Elastography and Automated Breast Ultrasound ........................................... 9

Ruey-Feng Chang and Chung-Ming Lo

Measurement and Clinical Use of Breast Density ................. 16

Kwan-Hoong Ng and Susie Lau

Low-Dose Molecular Breast Imaging - Diagnostic and Screening Applications in Women with Dense Breasts ................. 24

Michael K. O’Connor

Will New Technologies Replace Mammography CAD as We Know It? ................................................................. 30

Julian Marshall, Ashwini Kshirsagar, Sibel Narin, and Nikos Gkanatsios

Advanced Telecommunications in Breast Imaging – Streamlining Telemammography, Telepathology and Teleoncology Services to Improve Patient Care ............................................ 38

Elizabeth A. Krupinski

Screening Outcomes

Predicting the Benefit of Using CADe in Screening Mammography .... 44

Robert M. Nishikawa and Andriy Bandos

Modeling Breast Cancer Screening Outcomes .......................... 50

Martin J. Yaffe, Nicole Mittman, Natasha Stout, Pablo Lee, and Anna Tosteson

The Impact of Introducing Full Field Digital Mammography into a Screening Programme ............................................. 56

Thomas Fyall, Caroline Boggis, Jamie C. Sergeant, Elaine Harkness, Sigrid Whiteside, Julie Morris, Mary Wilson, and Susan M. Astley
## Ultrasound

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully Automated Nipple Detection in 3D Breast Ultrasound Images</td>
<td>64</td>
</tr>
<tr>
<td>Lei Wang, Tobias Böhler, Fabian Zöhrer, Joachim Georgii,</td>
<td></td>
</tr>
<tr>
<td>Claudia Rauh, Peter A. Fasching, Barbara Brehm,</td>
<td></td>
</tr>
<tr>
<td>Rüdiger Schulz-Wendtland, Matthias W. Beckmann,</td>
<td></td>
</tr>
<tr>
<td>Michael Uder, and Horst K. Hahn</td>
<td></td>
</tr>
<tr>
<td>Breast Imaging with 3D Ultrasound Computer Tomography: Results of</td>
<td>72</td>
</tr>
<tr>
<td>a First In-vivo Study in Comparison to MRI Images</td>
<td></td>
</tr>
<tr>
<td>Torsten Hopp, Lukas Šroba, Michael Zapf, Robin Dapp,</td>
<td></td>
</tr>
<tr>
<td>Ernst Kretzek, Hartmut Gemmeke, and Nicole V. Ruiter</td>
<td></td>
</tr>
</tbody>
</table>

## Breast Density

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factors Affecting Agreement between Breast Density Assessment Using</td>
<td>80</td>
</tr>
<tr>
<td>Volumetric Methods and Visual Analogue Scales</td>
<td></td>
</tr>
<tr>
<td>Lucy Beattie, Elaine Harkness, Megan Bydder, Jamie C. Sergeant,</td>
<td></td>
</tr>
<tr>
<td>Anthony Maxwell, Nicky Barr, Ursula Beetles, Caroline Boggis,</td>
<td></td>
</tr>
<tr>
<td>Sara Bundred, Soujanya Gadde, Emma Hurley, Anil Jain,</td>
<td></td>
</tr>
<tr>
<td>Elizabeth Lord, Valerie Reece, Mary Wilson, Paula Stavrinos,</td>
<td></td>
</tr>
<tr>
<td>D. Gareth Evans, Tony Howell, and Susan M. Astley</td>
<td></td>
</tr>
<tr>
<td>Breast Tissue Segmentation and Mammographic Risk Scoring Using</td>
<td>88</td>
</tr>
<tr>
<td>Deep Learning</td>
<td></td>
</tr>
<tr>
<td>Kersten Petersen, Mads Nielsen, Pengfei Diao, Nico Karssemeijer,</td>
<td></td>
</tr>
<tr>
<td>and Martin Lillholm</td>
<td></td>
</tr>
</tbody>
</table>

## Imaging Physics I

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimization of X-Ray Spectra for Dual-Energy Contrast-Enhanced</td>
<td>95</td>
</tr>
<tr>
<td>Breast Imaging: Dependency on CsI Detector Scintillator Thickness</td>
<td></td>
</tr>
<tr>
<td>Pablo Milioni de Carvalho, Ann-Katherine Carton,</td>
<td></td>
</tr>
<tr>
<td>Sylvie Saab-Puong, Răzvan Iordache, and Serge Muller</td>
<td></td>
</tr>
<tr>
<td>Dose-Saving Potential of Linear- and Non-Linear Energy Weighting in</td>
<td>103</td>
</tr>
<tr>
<td>Photon-Counting Spectral Mammography</td>
<td></td>
</tr>
<tr>
<td>Udo van Stevendaal, Hanno Homann, Ewald Roessl,</td>
<td></td>
</tr>
<tr>
<td>Klaus Erhard, and Björn Cederström</td>
<td></td>
</tr>
<tr>
<td>Compositional Three-Component Breast Imaging of Fibroadenoma and</td>
<td>109</td>
</tr>
<tr>
<td>Invasive Cancer Lesions: Pilot Study</td>
<td></td>
</tr>
<tr>
<td>Serghei Malkov, Fred Duewer, Karla Kerlikowske, Karen Drukker,</td>
<td></td>
</tr>
<tr>
<td>Maryellen L. Giger, and John Shepherd</td>
<td></td>
</tr>
</tbody>
</table>
CAD

Potential Usefulness of Presentation of Histological Classifications with Computer-Aided Diagnosis (CAD) Scheme in Differential Diagnosis of Clustered Microcalcifications on Mammograms .................................................. 115
   Ryohei Nakayama, Kiyoshi Namba, Ryoji Watanabe, Hiroshi Nakahara, and Ralph Smathers

Potential Usefulness of Breast Radiographers' Reporting as a Second Opinion for Radiologists' Reading in Digital Mammography ................. 121
   Rie Tanaka, Miho Takamori, Yoshikazu Uchiyama, and Junji Shiraishi

Tomosynthesis

Effective Detective Quantum Efficiency (eDQE) Measured for a Digital Breast Tomosynthesis System .......................................................... 127
   Nicholas W. Marshall, Elena Salvagnini, and Hilde Bosmans

Comparison of SNDR, NPWE Model and Human Observer Results for Spherical Densities and Microcalcifications in Real Patient Backgrounds for 2D Digital Mammography and Breast Tomosynthesis .................. 134
   Lesley Cockmartin, Nicholas W. Marshall, and Hilde Bosmans

Assessing Radiologist Performance and Microcalcifications Visualization Using Combined 3D Rotating Mammogram (RM) and Digital Breast Tomosynthesis (DBT) .......................................................... 142
   Hitomi Tani, Nachiko Uchiyama, Minoru Machida, Mari Kikuchi, Yasuaki Arai, Kyoichi Otsuka, Anna Jerebko, Andreas Fieselmann, and Thomas Mertelmeier

Digital Breast Tomosynthesis: Image Quality and Dose Saving of the Synthesized Image ............................................................... 150
   Julia Garayoa, Irene Hernandez-Giron, Maria Castillo, Julio Valverde, and Margarita Chevalier

Patient Specific Dose Calculation Using Volumetric Breast Density for Mammography and Tomosynthesis ........................................ 158
   Christopher E. Tromans, Ralph Highnam, Oliver Morrish, Richard Black, Lorraine Tucker, Fiona Gilbert, and Sir Michael Brady

Imaging Physics II

Comparative Performance Evaluation of Contrast-Detail in Full Field Digital Mammography (FFDM) Systems Using Ideal (Hotelling) Observer versus Automated CDMAM Analysis ........................................ 166
   Ioannis Delakis, Robert Wise, Lauren Morris, and Eugenia Kulama
Mammographic Density Effect on Readers’ Performance and Visual Search Pattern ............................................................. 174
  Dana S. AL Mousa, Patrick C. Brennan, Elaine A. Ryan, and Claudia Mello-Thoms

Towards a Quantitative Measure of Radiographic Masking by Dense Tissue in Mammography ........................................... 181
  James G. Mainprize, Xinying Wang, Mei Ge, and Martin J. Yaffe

Three Dimensional Dose Distribution Comparison of Simple and Complex Acquisition Trajectories in Dedicated Breast CT – A Monte Carlo Study ................................................................. 187
  Jainil P. Shah, Steve D. Mann, Randolph L. McKinley, and Martin P. Tornai

**ICT and Image Processing**

Quantitative MRI Phenotyping of Breast Cancer across Molecular Classification Subtypes .................................................. 195
  Maryellen L. Giger, Hui Li, Li Lan, Hiroyuki Abe, and Gillian M. Newstead

A Novel Framework for Fat, Glandular Tissue, Pectoral Muscle and Nipple Segmentation in Full Field Digital Mammograms ............ 201
  Xin Chen, Emmanouil Moschidis, Chris J. Taylor, and Susan M. Astley

Texture-Based Breast Cancer Prediction in Full-Field Digital Mammograms Using the Dual-Tree Complex Wavelet Transform and Random Forest Classification ........................................... 209
  Emmanouil Moschidis, Xin Chen, Chris J. Taylor, and Susan M. Astley

**Poster Papers**

Evaluation of a New Design of Contrast-Detail Phantom for Mammography: CDMAM Model 4.0 ........................................ 217
  Celia J. Strudley and Kenneth C. Young

Threshold Target Thickness Calculated Using a Model Observer as a Quality Control Metric for Digital Mammography ..................... 225
  Aili K. Bloomquist, James G. Mainprize, Melissa L. Hill, and Martin J. Yaffe
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contrast-Enhanced Digital Mammography Lesion Morphology and a Phantom for Performance Evaluation</td>
<td>231</td>
</tr>
<tr>
<td>Melissa L. Hill, Aili K. Bloomquist, Sam Z. Shen, James G. Mainprize, Ann-Katherine Carton, Sylvie Saab-Puong, Serge Muller, Clarisse Dromain, and Martin J. Yaffe</td>
<td></td>
</tr>
<tr>
<td>Stability of Volumetric Tissue Composition Measured in Serial Screening Mammograms</td>
<td>239</td>
</tr>
<tr>
<td>Katharina Holland, Michiel Kallenberg, Ritse Mann, Carla van Gils, and Nico Karssemeijer</td>
<td></td>
</tr>
<tr>
<td>Breast Density Classification Based on Volumetric Glandularity Measured by Spectral Mammography</td>
<td>245</td>
</tr>
<tr>
<td>Henrik Johansson, Miriam von Tiedemann, and Björn Cederström</td>
<td></td>
</tr>
<tr>
<td>Norhasnah Zakariyah, Kwan-Hoong Ng, Susie Lau, Kartini Rahmat, Farhana Fadzli, and Nur Aishah Mohd Taib</td>
<td></td>
</tr>
<tr>
<td>Automated Volumetric Breast Density Derived by Statistical Model Approach</td>
<td>257</td>
</tr>
<tr>
<td>Serghei Malkov, Amir Pasha Mahmoudzadeh, Karla Kerlikowske, and John Shepherd</td>
<td></td>
</tr>
<tr>
<td>Volumetric Breast Density and Radiographic Parameters</td>
<td>265</td>
</tr>
<tr>
<td>Jennifer Khan-Perez, Elaine Harkness, Claire Mercer, Megan Bydder, Jamie C. Sergeant, Julie Morris, Anthony Maxwell, Catherine Rylance, and Susan M. Astley</td>
<td></td>
</tr>
<tr>
<td>The Relationship of Volumetric Breast Density to Socio-Economic Status in a Screening Population</td>
<td>273</td>
</tr>
<tr>
<td>Louisa Samuels, Elaine Harkness, Susan M. Astley, Anthony Maxwell, Jamie C. Sergeant, Julie Morris, Mary Wilson, Paula Stavrinos, D. Gareth Evans, Tony Howell, and Megan Bydder</td>
<td></td>
</tr>
<tr>
<td>Use of Volumetric Breast Density Measures for the Prediction of Weight and Body Mass Index</td>
<td>282</td>
</tr>
<tr>
<td>Elizabeth O. Donovan, Jamie C. Sergeant, Elaine Harkness, Julie Morris, Mary Wilson, Yit Lim, Paula Stavrinos, Anthony Howell, D. Gareth Evans, Caroline Boggis, and Susan M. Astley</td>
<td></td>
</tr>
<tr>
<td>Mammographic Density and Breast Cancer Characteristics</td>
<td>290</td>
</tr>
<tr>
<td>Kathy Ren, Elaine Harkness, Caroline Boggis, Soujanya Gadde, Mary Wilson, Yit Lim, Jamie C. Sergeant, Sigrid Whiteside, Julie Morris, and Susan M. Astley</td>
<td></td>
</tr>
<tr>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Managing Tiled Images in Breast Density Measurements</td>
<td>298</td>
</tr>
<tr>
<td>Jennifer Harvey, Olivier Alonzo, Gordon Mawdsley,</td>
<td></td>
</tr>
<tr>
<td>Taghreed Alshafeiy, Ralph Highnam, and Martin J. Yaffe</td>
<td></td>
</tr>
<tr>
<td>Reliability of Breast Density Estimation in Follow-Up Mammograms:</td>
<td>304</td>
</tr>
<tr>
<td>Repeatability and Reproducibility of a Fully Automated Areal Percent</td>
<td></td>
</tr>
<tr>
<td>Density Method</td>
<td></td>
</tr>
<tr>
<td>Youngwoo Kim and Jong Hyo Kim</td>
<td></td>
</tr>
<tr>
<td>Usefulness of a Combination DBT(Digital Breast Tomosynthesis) and</td>
<td>312</td>
</tr>
<tr>
<td>Automated Volume Analysis of Dynamic Contrast-Enhanced Breast (DCEB)</td>
<td></td>
</tr>
<tr>
<td>MRI in Evaluation of Response to Neoadjuvant Chemotherapy (NAC)</td>
<td></td>
</tr>
<tr>
<td>Nachiko Uchiyama, Takayuki Kinoshita, Takashi Hojo, Sota Asaga,</td>
<td></td>
</tr>
<tr>
<td>Minoru Machida, Hitomi Tani, Mari Kikuchi, Yasuaki Arai,</td>
<td></td>
</tr>
<tr>
<td>Kyoichi Otsuka</td>
<td></td>
</tr>
<tr>
<td>Clinical Efficacy of Novel Image Processing Techniques in the</td>
<td>320</td>
</tr>
<tr>
<td>Framework of Filtered Back Projection (FBP) with Digital Breast</td>
<td></td>
</tr>
<tr>
<td>Tomosynthesis (DBT)</td>
<td></td>
</tr>
<tr>
<td>Nachiko Uchiyama, Minoru Machida, Hitomi Tani, Mari Kikuchi,</td>
<td></td>
</tr>
<tr>
<td>Yasuaki Arai, Kyoichi Otsuka, Andreas Fieselmann,</td>
<td></td>
</tr>
<tr>
<td>Anna Jerebko, and Thomas Mertelmeier</td>
<td></td>
</tr>
<tr>
<td>A Revisit on Correlation between Tabár and Birads Based Risk</td>
<td>327</td>
</tr>
<tr>
<td>Assessment Schemes with Full Field Digital Mammography</td>
<td></td>
</tr>
<tr>
<td>Wenda He, Minnie Kibiro, Arne Juette, Erika R.E. Denton, and</td>
<td></td>
</tr>
<tr>
<td>Reyer Zwiggelaar</td>
<td></td>
</tr>
<tr>
<td>Predicting Triple-Negative Breast Cancer and Axillary Lymph Node</td>
<td>334</td>
</tr>
<tr>
<td>Metastasis Using Diagnostic MRI</td>
<td></td>
</tr>
<tr>
<td>Jeff Wang, Fumi Kato, Kohsuke Kudo, Hiroko Yamashita, and</td>
<td></td>
</tr>
<tr>
<td>Hiroki Shirato</td>
<td></td>
</tr>
<tr>
<td>Understanding the Role of Correct Lesion Assessment in Radiologists’</td>
<td>341</td>
</tr>
<tr>
<td>Reporting of Breast Cancer</td>
<td></td>
</tr>
<tr>
<td>Claudia Mello-Thoms, Phuong Dung Trieu,</td>
<td></td>
</tr>
<tr>
<td>Mohammed A. Rawashdeh, Kriscia Tapia,</td>
<td></td>
</tr>
<tr>
<td>Warwick B. Lee, and Patrick C. Brennan</td>
<td></td>
</tr>
<tr>
<td>Realistic Simulation of Breast Tissue Microstructure in Software</td>
<td>348</td>
</tr>
<tr>
<td>Anthropomorphic Phantoms</td>
<td></td>
</tr>
<tr>
<td>Predrag R. Bakic, David D. Pokrajac, Raffaele De Caro, and</td>
<td></td>
</tr>
<tr>
<td>Andrew D.A. Maidment</td>
<td></td>
</tr>
<tr>
<td>A Virtual Human Breast Phantom Using Surface Meshes and</td>
<td>356</td>
</tr>
<tr>
<td>Geometric Internal Structures</td>
<td></td>
</tr>
<tr>
<td>Ann-Katherine Carton, Anthony Grisey, Pablo Milioni de Carvalho,</td>
<td></td>
</tr>
<tr>
<td>Clarisse Dromain, and Serge Muller</td>
<td></td>
</tr>
</tbody>
</table>
Characterisation of Screen Detected and Simulated Calcification Clusters in Digital Mammograms ........................................... 364
Lucy M. Warren, Louise Dummott, Matthew G. Wallis, Rosalind M. Given-Wilson, Julie Cooke, David R. Dance, and Kenneth C. Young

Development of a Micro-Simulation Model for Breast Cancer to Evaluate the Impacts of Personalized Early Detection Strategies .......... 372
Rasika Rajapakshe, Cynthia Araujo, Chelsea Vandenberg, Brent Parker, Stephen Smithbower, Chris Baliski, Susan Ellard, Laurel Kovacic, Melanie Reed, Scott Tyldesley, Gillian Fyles, and Rebecca Mlikotic

Modelling Vascularity in Breast Cancer and Surrounding Stromata Using Diffusion MRI and Intravoxel Incoherent Motion ....................... 380
Colleen Bailey, Sarah Vinnicombe, Eleftheria Panagiotaki, Shelley A. Waugh, John H. Hipwell, Daniel C. Alexander, Kathryn Kitching, Patsy Whelehan, Sarah E. Pinder, Andrew Evans, and David J. Hawkes

Monte Carlo Modeling of the DQE of a-Se X-Ray Detectors for Breast Imaging ................................................................. 387
Yuan Fang, Andreu Badal, Karim S. Karim, and Aldo Badano

kVp Tool for Digital Mammography Using Commercial Metallic Foils ... 394
Héctor A. Galván and Yolanda Villaseñor

Possibility of Exposure Dose Reduction in Contrast Enhanced Spectral Mammography Using Dual Energy Subtraction Technique: A Phantom Study ................................................................. 399
Noriko Nishikawa, Kaori Yanagisawa, Kuniji Naoi, Yutaka Ohnuma, and Yoshihisa Muramatsu

Jennifer Oduko, Peter Homolka, Vivienne Jones, and David Whitwam

Trends in Mammogram Image Quality, Dose and Screen-Detected Cancer Rates in an Organized Screening Mammography Program .... 415
Brent Parker, Rasika Rajapakshe, Ashley Yip, Teresa Wight, Nancy Aldoff, Janette Sam, and Christine Wilson

Power Spectrum Analysis of an Anthropomorphic Breast Phantom Compared to Patient Data in 2D Digital Mammography and Breast Tomosynthesis ................................................................. 423
Lesley Cockmartin, Predrag R. Bakic, Hilde Bosmans, Andrew D.A. Maidment, Hunter Gall, Moustafa Zerhouni, and Nicholas W. Marshall
Contrast-Enhanced Digital Mammography Image Quality Evaluation in the Clinic .................................................... 430

Melissa L. Hill, Aili K. Bloomquist, Sam Z. Shen, James G. Mainprize, Ann-Katherine Carton, Sylvie Saab-Puong, Serge Muller, and Martin J. Yaffe

BREAST: A Novel Strategy to Improve the Detection of Breast Cancer ........................................................ 438

Patrick C. Brennan, Phuong Dung Trieu, Kriscia Tapia, John Ryan, Claudia Mello-Thoms, and Warwick B. Lee

A Regional Web-Based Automated Quality Control Platform .......... 444

Stephen Smithbower, Rasika Rajapakshe, Janette Sam, Nancy Aldoff, and Teresa Wight

A European Protocol for Technical Quality Control of Breast Tomosynthesis Systems ........................................... 452

Ruben E. van Engen, Hilde Bosmans, Ramona W. Bouwman, David R. Dance, Patrice Heid, Barbara Lazzari, Nicholas W. Marshall, Stephan Schopphoven, Celia J. Strudley, Martin Thijsse, and Kenneth C. Young

Conventional Mammographic Image Generation Method with Increased Calcification Sensitivity Based on Dual-Energy .......... 460

Xi Chen and Xuanqin Mou

Development of Mammography System Using CdTe Photon Counting Detector for Exposure Dose Reduction - Study of Effectiveness of the Spectrum by Simulation ........................................ 468

Naoko Niwa, Misaki Yamazaki, Sho Maruyama, and Yoshie Kodera

Development of Mammography System Using CdTe Photon-Counting Detector for Exposure Dose Reduction - Evaluation of Image Quality in the Prototype System- ........................................ 475

Misaki Yamazaki, Niwa Naoko, Sho Maruyama, and Yoshie Kodera

Investigation of Dependence on the Object Orientation in Visibility-Contrast Imaging with the X-Ray Talbot-Lau Interferometer ............................................................ 482

Takayuki Shibata, Shohei Okubo, Daiki Iwai, Junko Kiyohara, Sumiya Nagatsuka, and Yoshie Kodera

Development of New Imaging System Based on Grating Interferometry: Preclinical Study in Breast Imaging ....................... 488

Tokiko Endo, Shu Ichihara, Suzuko Moritani, Mikinao Ooiwa, Misaki Shiraiwa, Takako Morita, Yasuyuki Sato, Junko Kiyohara, and Sumiya Nagatsuka
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Study on the Development of a High-Resolution Breast CT</td>
<td>494</td>
</tr>
<tr>
<td>Atsushi Teramoto, Tomoyuki Ohno, Fumio Hashimoto, Chika Murata, Keiko Takahashi, Ruriha Yoshikawa, Shoichi Suzuki, and Hiroshi Fujita</td>
<td></td>
</tr>
<tr>
<td>Analysis of Dependence of Detector Position on Detected Scatter</td>
<td>501</td>
</tr>
<tr>
<td>Steve D. Mann, Jainil P. Shah, and Martin P. Tornai</td>
<td></td>
</tr>
<tr>
<td>Evaluation of Physical and Psychological Burden of Subjects in</td>
<td>508</td>
</tr>
<tr>
<td>Mammography</td>
<td></td>
</tr>
<tr>
<td>Yongbum Lee and Mieko Uchiyama</td>
<td></td>
</tr>
<tr>
<td>Mammographic Image Database (MIDB) and Associated Web-Enabled Software for Research</td>
<td>514</td>
</tr>
<tr>
<td>Mark D. Halling-Brown, Pádraig T. Looney, Mishal N. Patela, Lucy M. Warren, Alistair Mackenzie, and Kenneth C. Young</td>
<td></td>
</tr>
<tr>
<td>Optimizing High Resolution Reconstruction in Digital Breast</td>
<td>520</td>
</tr>
<tr>
<td>Tomosynthesis Using Filtered Back Projection</td>
<td></td>
</tr>
<tr>
<td>Shiras Abdurahman, Frank Dennerlein, Anna Jerebko, Andreas Fieselmann, and Thomas Mertelmeier</td>
<td></td>
</tr>
<tr>
<td>The Investigation of Different Factors to Optimize the Simulation of 3D Mass Models in Breast Tomosynthesis</td>
<td>528</td>
</tr>
<tr>
<td>Eman Shaheen, Frédéric Bemelmans, Chantal Van Ongeval, Frederik De Keyzer, Nausikaã Geeraert, and Hilde Bosmans</td>
<td></td>
</tr>
<tr>
<td>Clinical Evaluation of Dual Mode Tomosynthesis</td>
<td>536</td>
</tr>
<tr>
<td>Tokiko Endo, Mikinao Ooiwa, Takako Morita, Namiko Suda, Kazuki Yoshikawa, Misaki Shiraiwa, Yukie Hayashi, Takao Horiba, Yasuyuki Sato, Shu Ichihara, Tomonari Sendai, Tetsuro Kusunoki, and Takahisa Arai</td>
<td></td>
</tr>
<tr>
<td>Image Quality of Thick Average Intensity Pixel Slabs Using Statistical Artifact Reduction in Breast Tomosynthesis</td>
<td>544</td>
</tr>
<tr>
<td>Magnus Dustler, Pontus Timberg, Anders Tingberg, and Sophia Zackrisson</td>
<td></td>
</tr>
<tr>
<td>Detection of Spiculated Lesions in Digital Mammograms Using a Novel Image Analysis Technique</td>
<td>550</td>
</tr>
<tr>
<td>Ashley Seepujak, Tomas Adomavicius, Sergey Dolgobrodov, Emmanouil Moschidis, Xin Chen, Anthony Maxwell, Susan M. Astley, and Alan M. Roseman</td>
<td></td>
</tr>
<tr>
<td>Spatial Correlation Analysis of Mammograms for Detection of Asymmetric Findings</td>
<td>558</td>
</tr>
<tr>
<td>Paola Casti, Arianna Mencattini, Marcello Salmeri, and Rangaraj M. Rangayyan</td>
<td></td>
</tr>
</tbody>
</table>
Temporal Breast Cancer Risk Assessment Based on Higher-Order Textons .......................................................... 565
   Xi-Zhao Li, Simon Williams, Peter Downey, and Murk J. Bottema

Invariant Features for Discriminating Cysts from Solid Lesions in Mammography ............................................ 573
   Thijs Kooi and Nico Karssemeijer

Breast Masses Identification through Pixel-Based Texture Classification ............................................................. 581
   Jordina Torrents-Barrena, Domenec Puig, Maria Ferre, Jaime Melendez, Lorena Diez-Presa, Meritxell Arenas, and Joan Martí

Automated Labeling of Screening Mammograms with Arterial Calcifications ..................................................... 589
   Jan-Jurre Mordang, Jakob Hauth, Gerard J. den Heeten, and Nico Karssemeijer

False Positive Reduction in CADe Using Diffusing Scale Space ............................. 597
   Faraz Janan, Sir Michael Brady, and Ralph Highnam

Automated Detection of Architectural Distortion Using Improved Adaptive Gabor Filter .................................... 606
   Rurika Yoshikawa, Atsushi Teramoto, Tomoko Matusbara, and Hiroshi Fujita

Detecting Abnormal Mammographic Cases in Temporal Studies Using Image Registration Features .................... 612
   Robert Martí, Yago Díez, Arnau Oliver, Meritxell Tortajada, Reyer Zwiggelaar, and Xavier Lladó

Analysis of Mammographic Microcalcification Clusters Using Topological Features ........................................ 620
   Zhili Chen, Harry Strange, Erika R.E. Denton, and Reyer Zwiggelaar

Differentiation of Malignant and Benign Masses on Mammograms Using Radial Local Ternary Pattern .................. 628
   Chisako Muramatsu, Min Zhang, Takeshi Hara, Tokiko Endo, and Hiroshi Fujita

Statistical Temporal Changes for Breast Cancer Detection: A Preliminary Study ........................................... 635
   Gobert N. Lee and Mariusz Bajger

Comparison of Calcification Cluster Detection by CAD and Human Observers at Different Image Quality Levels .................. 643
   Pádraig T. Looney, Lucy M. Warren, Susan M. Astley, and Kenneth C. Young
A Novel Image Enhancement Methodology for Full Field Digital Mammography .................................................. 650
   Wenda He, Minnie Kibiro, Arne Juette, Erika R.E. Denton, Peter Hogg, and Reyer Zwiggelaar

Correlation between Topological Descriptors of the Breast Ductal Network from Clinical Galactograms and Texture Features of Corresponding Mammograms ............................................................ 658
   Predrag R. Bakic, David D. Pokrajac, Mathew Thomas, Angeliki Skoura, Tatyana Nuzhnaya, Vasileios Megalooikonomou, Brad Keller, Yuanjie Zheng, Despina Kontos, James C. Gee, Gilda Cardenosa, and Andrew D.A. Maidment

Breast Volume Measurement Using a Games Console Input Device .... 666
   Stefanie T.L. Pöhlmann, Jeremy Hewes, Andrew I. Williamson, Jamie C. Sergeant, Alan Hufton, Ashu Gandhi, Christopher J. Taylor, and Susan M. Astley

Towards Spatial Correspondence between Specimen and In-vivo Breast Imaging .......................................................... 674
   Thomy Mertzanidou, John Hipwell, Mehmet Dalmis, Bram Platel, Jeroen van der Laak, Ritse Mann, Nico Karssemeijer, Peter Bult, and David Hawkes

SIFT Texture Description for Understanding Breast Ultrasound Images .............................................................. 681
   Joan Massich, Fabrice Meriaudeau, Melcior Sentís, Sergi Ganau, Elsa Pérez, Domenec Puig, Robert Martí, Arnau Oliver, and Joan Martí

Comparison of Methods for Current-to-Prior Registration of Breast DCE-MRI .............................................................. 689
   Yago Díez, Albert Gubern-Mérida, Lei Wang, Susanne Diekmann, Joan Martí, Bram Platel, Johanna Kramme, and Robert Martí

A Study on Mammographic Image Modelling and Classification Using Multiple Databases ............................................. 696
   Wenda He, Erika R.E. Denton, and Reyer Zwiggelaar

Quasi-3D Display of Lesion Locations Simulated by Two Views of Digital Mammography ............................................ 702
   Yu Narita, Noritaka Higashi, Yoshikazu Uchiyama, and Junji Shiraishi

A Shearlet-Based Filter for Low-Dose Mammography .............. 707
   Huiqin Jiang, Yunyi Zhang, Ling Ma, Xiaopeng Yang, and Yumin Liu
Evaluation of Human Contrast Sensitivity Functions Used in the Nonprewhitening Model Observer with Eye Filter ............................ 715
   Ramona W. Bouwman, Ruben E. van Engen, David R. Dance,
   Kenneth C. Young, and Wouter J.H. Veldkamp

It Is Hard to See a Needle in a Haystack: Modeling Contrast Masking
Effect in a Numerical Observer ........................................... 723
   Ali R.N. Avanaki, Kathryn S. Espig, Albert Xthona,
   Tom R.L. Kimpe, Predrag R. Bakic, and
   Andrew D.A. Maidment

Mammography: Radiologist and Image Characteristics That Determine the Accuracy of Breast Cancer Diagnosis .......................... 731
   Mohammad A. Rawashdeh, Claudia Mello-Thoms,
   Roger Bourne, and Patrick C. Brennan

Preliminary Study on Sub-Pixel Rendering for Mammography Medical Grade Color Displays .............................. 737
   Katsuhiro Ichikawa and Hiroko Kawashima

Impact of Color Calibration on Breast Biopsy Whole Slide Image Interpretation Accuracy and Efficiency ......................... 744
   Elizabeth A. Krupinski, Louis D. Silverstein, Syed F. Hashmi,
   Anna R. Graham, Ronald S. Weinstein, and Hans Roehrig

Author Index ............................................................ 749