Medical Imaging 2018

# Ultrasonic Imaging and Tomography

Neb Duric Brett C. Byram Editors

13–15 February 2018 Houston, Texas, United States

Sponsored by SPIE

Cosponsored by DECTRIS Ltd. (Switzerland)

Cooperating Organizations AAPM—American Association of Physicists in Medicine (United States) IFCARS—International Foundation for Computer Assisted Radiology and Surgery (Germany) MIPS—Medical Image Perception Society (United States) RSNA—Radiological Society of North America (United States) WMIS—World Molecular Imaging Society

Published by SPIE

Volume 10580

Proceedings of SPIE, 1605-7422, V. 10580

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

Medical Imaging 2018: Ultrasonic Imaging and Tomography, edited by Neb Duric, Brett C. Byram, Proc. of SPIE Vol. 10580, 1058001 · © 2018 SPIE CCC code: 1605-7422/18/\$18 · doi: 10.1117/12.2323921 The papers in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. Additional papers and presentation recordings may be available online in the SPIE Digital Library at SPIEDigitalLibrary.org.

The papers reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from these proceedings:

Author(s), "Title of Paper," in Medical Imaging 2018: Ultrasonic Imaging and Tomography, edited by Neb Duric, Brett C. Byram, Proceedings of SPIE Vol. 10580 (SPIE, Bellingham, WA, 2018) Sevendigit Article CID Number.

ISSN: 1605-7422 ISSN: 2410-9045 (electronic)

ISBN: 9781510616493 ISBN: 9781510616509 (electronic)

Published by **SPIE** P.O. Box 10, Bellingham, Washington 98227-0010 USA Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445 SPIE.org Copyright © 2018, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 1605-7422/18/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.



**Paper Numbering:** Proceedings of SPIE follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

• The first five digits correspond to the SPIE volume number.

• The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc. The CID Number appears on each page of the manuscript.

## Contents

- vii Authors
- ix Conference Committee
- xi Awards

#### **KEYNOTE AND PHOTOACOUSTICS II**

10580 05 An advanced photoacoustic tomography system based on a ring geometry design [10580-31]

#### PERFUSION AND CEUS

10580 06	Perfusion flow phantoms with	h randomly oriented microchan	nels [10580-1]

- 10580 07 Imaging biomarker development based on microbubble perfusion and oxygen saturation in a rat model of liver cancer [10580-2]
- 10580 08 Combining adaptive demodulation with singular value decomposition filtering for improved non-contrast perfusion ultrasound imaging [10580-3]
- 10580 09 Respiratory compensation in contrast enhanced ultrasound using image clustering [10580-4]
- 10580 0A In vitro high-frame-rate contrast-enhanced ultrasound particle image velocimetry in a carotid artery stent [10580-5]

#### SIGNAL PROCESSING AND B-MODE

- 10580 0B B-line detection using amplitude modulation-frequency modulation (AM-FM) features [10580-6]
- 10580 0C Wavelet shrinkage-based adaptive compounding for improvement of SNR in high volume-rate ultrasound imaging [10580-7]
- 10580 0D Synthetic recovery of the complete harmonic data set [10580-8]
- 10580 OE Real-time volumetric ultrasound imaging using free hand scanning [10580-9]

10580 OF	ADMIRE applied to fundamental and harmonic data acquired using a modern clinical platform [10580-10]
10580 0G	Suppressing off-axis scattering using deep neural networks [10580-11]
	ULTRASOUND TOMOGRAPHY I
10580 OH	Time-domain spectral-element ultrasound waveform tomography using a stochastic quasi- Newton method [10580-12]
10580 01	Optimized transducer configuration for ultrasound waveform tomography in breast cancer detection [10580-13]
10580 OJ	Solving the ultrasound inverse scattering problem of inhomogeneous media using different approaches of total least squares algorithms [10580-14]
10580 OK	Reconstruction of ultrasound tomography for cancer detection using total least squares and conjugate gradient method [10580-15]
	ULTRASOUND TOMOGRAPHY II
10580 OM	Experimental evaluation of straight ray and bent ray phase aberration correction for USCT SAFT imaging [10580-17]

- 10580 0N **Oil-gel-based phantom for mimicking wave refraction of breast in ultrasound computed** tomography [10580-18]
- 10580 00 Animal study of high-speed iterative refraction calibration method for ultrasound computed tomography [10580-19]
- 10580 OP In vitro and in vivo evaluations of breast ultrasound tomography imaging system in HUST [10580-20]
- 10580 0Q USCT reference data base: conclusions from the first SPIE USCT data challenge and future directions [10580-22]
- 10580 ORToward parallel optimal computation of ultrasound computed tomography using GPU<br/>[10580-21]

#### PHOTOACOUSTICS I

10580 OT	Ultrasound and photoacoustic imaging for enhanced image-guided endovenous laser ablation procedures [10580-24]
10580 0∨	Combined phased-array ultrasound and photoacoustic endoscope for gynecologic cancer imaging applications [10580-26]
10580 OW	Assessment of blood oxygen saturation using spectroscopic photoacoustic imaging as a biomarker for disease progression in a small-animal leukemia model [10580-27]

#### QUANTITATIVE ULTRASOUND AND REGISTRATION

- 10580 12 Echographic measurement method of time-varying wall-shear-stress distribution for early arteriosclerosis detection [10580-37]
- 10580 14 K-means clustering for high-resolution, realistic acoustic maps [10580-39]
- 10580 15 Comparison of two approaches for attenuation imaging using the spectral log difference method: regularized inversion versus image filtering [10580-40]
- 10580 16 Spectral analysis of ultrasound radiofrequency backscatter for the identification of five tissue types found in and around the paravertebral space [10580-41]
- 10580 17 Automated registration and stitching of multiple 3D ultrasound images for monitoring neonatal intraventricular hemorrhage [10580-42]

#### **POSTER SESSION**

- 10580 19 Investigation of priors mismatch in ultrasound tomographic reconstruction [10580-44]
- 10580 1A Ultrasound segmentation of rat hearts using convolution neural networks [10580-45]
- 10580 1B In vivo ultrasonic measures of skin layer thicknesses at various body locations and postures [10580-46]

## **Authors**

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Abdou, Ali, 0J Almekkawy, Mohamed, 0J, 0K Alshahrani, Suhail S., 05, 0V Anastasio, Mark, 05 Auerbach, Margaret A., 1B Avritscher, Ronv, 07 Avrutsky, Ivan, 05 Barlow, Jesse, OJ, OK Basij, Maryam, OV Bellan, Leon M., 06 Boehm, Christian, OH, OI Bosch, Johan G., 0A Bottenus, Nick, OD Bouchard, Richard, 07, 0W Burmeister, Jacob W., OV Byram, Brett C., 06, 08, 0F, 0G Camacho, Jorge, 0Q Cameron, Sarah E., 1B Cardona Cardenas, Diego Armando, 19 Carević, Anita, 0J, 0K Castañeda, Benjamín V., OB Castañeda, Benjamín, OB Chau, Gustavo, OB Chura, Elizabeth, OB Coila, Andres L., 15 Coolbaugh, Crystal, 08 Cummings, Kenneth, 16 Dahl, Jeremy, OB, 14 D'Angelo, Paola A., 1B de Borst, Gert J., OA de Jong, Nico, 0A de Korte, Chris L., 0E De La Cerda, Jorae, OW de Ribaupierre, S., 17 de Vries, Evelien E., 0A DeGrande, Sean, 16 Dei, Kazuyuki, OF Deng, Qian, 09 Ding, Mingyue, OP, OR Dominello, Michael, OV Dormer, James D., 1A Elsharkawy, Hesham, 16 Faley, Shannon, 06 Fedewa, Russell J., 16 Fei, Baowei, 1A Fenster, A., 17 Fichtner, Andreas, OH, OI Fredes, Gilma, OB Gardi, L., 17

Gemmeke, Hartmut, 0M, 0Q George, Mark K., 06, 08 Ghalehnovi, Mahboobeh, OT Groot Jebbink, Erik, 0A Guo, Rongrong, 1A Haaaard, Asher, 16 Hansen, Hendrik H. G., 0E Harris, A., 17 Harutyunyan, Karine, OW He, Jiayu, OK Herraiz, Joaquín L., 0Q Hiroshima, Misaki, OC Hopp, Torsten, 0M, 0Q Hoving, Astrid M., 0A Ikeda, Teiichiro, OC lyer, Arun, 0V Jiang, Liping, 09 Jiang, Rong, 1A John, Samuel, OT Jovanović Balic, Ivana, OH, OI Kabbani, Loay, OT Kaffes, Caterina, OW Kawabata, Ken-ichi, ON, OO Kennedy, Nicole A., OT Kingsley, Charles, 07 Kishimoto, J., 17 Klingensmith, Jon D., 16 Kobayashi, Masayuki, 00 Konopleva, Marina, OW Korta Martiartu, Naiara, OH, OI Lavarello Montero, Roberto J., OB, 15 Lee, Geunseop, 0J Liu, Tingting, 09 Lobo, Viveta, OB Looby, Kevin, 14 Luchies, Adam C., 06, 0F, 0G Maldonado, Kiersten, 07 Malyarenko, Eugene, 05 Mamani, Gabriela, OB Manella, Haley, OB Mehrmohammadi, Mohammad, 05, 0T, 0V Mikhal, Julia, 0A Millward, Niki Zacharias, OW Mitcham, Trevor, 07 Munoz, Nina, 07 Naser, Mohamed A., 07 Nikolaev, Anton, OE Nishiyama, Tomohide, 12 Okada, Takashi, 12

Ozgun, Kathryn A., 06 Peña, Gilberto, OB Peng, Yang, OR Perez Liva, Mailyn, OQ Pozo Fortunić, Edmundo, OB Ramos, Dante, OB Ramsay, John W., 1B Ruiter, Nicole V., 0M, 0Q Sampaio, Diego R. T., 07 Sandino, Christopher, 14 Sasaki, Kazuaki, OO Sau, Samaresh, OV Seki, Yoshinori, 12 Serpa, Sergio, OB Seward, Shelly S., OV Shanmugavelandy, Sriram, OW Shen, Ming, 1A Shiguemi Furuie, Sergio, 19 Shimizu, Motochika, 12 Slapničar, Ivan, OJ, OK Slump, Cornelis H., 0A Song, Junjie, OP, OR Sun, Xia, OR Suzuki, Atsuro, ON, OO Taghavi, Houra, 07 Tanaka, Tomohiko, 12 Terada, Takahide, ON, OO Ticona, Eduardo, OB Tierney, Jaime E., 06, 08 Towse, Theodore, 08 Toyomura, Takashi, OC Tsubota, Yushi, ON, OO Udías, Jose M., OQ van Dongen, Koen W. A., 0Q Vasanawala, Shreyas, 14 Versluis, Michel, 0A Vinard, Nicolas, OH Vinard, Nicolas, Ol Vince, D. Geoffrey, 16 Voorneveld, Jason, 0A Wagner, Mary B., 1A Wang, Shanshan, OP, OR Wood, Cayla, 0W Wu, Kaizhi, 09 Wu, Wenjing, 0N, 0O Wu, Xiaorui, 09 Yamanaka, Kazuhiro, ON, OO Yan, Yan, 05, 0T, 0V Yu, Zirong, 09 Yuchi, Ming, OP, OR Yun, Xingzhao, OJ, OK Zapf, Michael, 0M, 0Q Zenteno, Omar, OB Zhang, Tao, 14 Zhou, Liang, OP, OR Zhu, Peifei, OC

## **Conference Committee**

Symposium Chairs

 Leonard Berliner, Weill Cornell Medical College (United States) and New York Presbyterian - Brooklyn Methodist Hospital (United States)
 Ronald M. Summers, National Institutes of Health (United States)

#### **Conference** Chairs

 Neb Duric, Delphinus Medical Technologies (United States) and Barbara Ann Karmanos Cancer Institute (United States)
 Brett C. Byram, Vanderbilt University (United States)

#### Conference Program Committee

Mark A. Anastasio, Washington University in St. Louis (United States) Jeffrey C. Bamber, The Royal Marsden NHS Foundation Trust (United Kingdom) Johan G. Bosch, Erasmus University Rotterdam (Netherlands) Jan D'hooge, University of Leuven (Belgium) Marvin M. Doyley, University of Rochester (United States) Stanislav Y. Emelianov, The University of Texas at Austin (United States) Mostafa Fatemi, Mayo Clinic College of Medicine (United States) Aaron Fenster, Robarts Research Institute (Canada) Jérémie Fromageau, The Institute of Cancer Research (United Kingdom) James F. Greenleaf, Mayo Clinic (United States) Emma J. Harris, The Institute of Cancer Research (United Kingdom) Michael Jaeger, University Bern (Switzerland) Jørgen Arendt Jensen, Technical University of Denmark (Denmark) David H. Kim, Pohang University of Science and Technology (Korea, Republic of) Roman G. Maev, University of Windsor (Canada) Stephen A. McAleavey, University of Rochester (United States) Mohammad Mehrmohammadi, Wayne State University (United States) Svetoslav I. Nikolov, BK Medical (Denmark) Olivier Roy, Barbara Ann Karmanos Cancer Institute (United States) Nicole V. Ruiter, Karlsruher Institut für Technologie (Germany) Kai E. Thomenius, Massachusetts Institute of Technology (United States) François Varray, CREATIS (France)

Session Chairs

- Perfusion and CEUS
  Roberto Janniel Lavarello Montero, Pontificia Universidad Católica del Perú (Peru)
- 2 Signal Processing and B-Mode Olivier Roy, Barbara Ann Karmanos Cancer Institute (United States)
- 3 Ultrasound Tomography I Nicole V. Ruiter, Karlsruher Institut für Technologie (Germany)
- 4 Ultrasound Tomography II **Cuiping Li**, Delphinus Medical Technologies, Inc. (United States)
- 5 Photoacoustics I
  Mark A. Anastasio, Washington University in St. Louis (United States)
  Mohammad Mehrmohammadi, Wayne State University (United States)
- Keynote and Photoacoustics II
  Richard Bouchard, The University of Texas M.D. Anderson Cancer Center (United States)
- 7 Ultrasound Tomography III Brett C. Byram, Vanderbilt University (United States)
- 8 Quantitative Ultrasound and Registration
  Gursharan Yash Singh Sandhu, Delphinus Medical Technologies, Inc. (United States)

## 2018 Medical Imaging Award Recipients

### Robert F. Wagner Best Student Paper Award

Robert F. Wagner was an active scientist in the SPIE Medical Imaging meeting, starting with the first meeting in 1972 and continuing throughout his career. He ensured that the BRH, and subsequently the CDRH, was a sponsor for the early and subsequent Medical Imaging meetings, helping to launch and ensure the historical success of the meeting. The Robert F. Wagner All-Conference Best Student Paper Award (established 2014) is acknowledgment of his many important contributions to the Medical Imaging meeting and his many important advances to the field of medical imaging.



This award is co-sponsored by:



**IPS** The Medical Image Perception Society



2018 Recipients:

First Place: **Dynamic beam filtering for miscentered patients** (10573-29) Andrew Mao, William Shyr, Grace J. Gang, J. Webster Stayman, Johns Hopkins Univ. (United States)

Second Place: Tumor margin classification of head and neck cancer using hyperspectral imaging and convolutional neural networks (10576-4) Martin Halicek, Georgia Institute of Technology (United States) and Augusta Univ. (United States); James V. Little, Xu Wang, Emory Univ. School of Medicine (United States); Mihir Patel, Emory Univ. School of Medicine (United States) and The Winship Cancer Institute of Emory Univ. (United States); Christopher C. Griffith, Emory Univ. School of Medicine (United States); and The Winship Cancer Institute of Emory Univ. School of Emory Univ. School of Medicine (United States); Amy Y. Chen, Emory Univ. School of Medicine (United States); Baowei Fei, Georgia Institute of Technology & Emory Univ. (United States) and The Winship Cancer Institute of Emory Univ. (United States); Baowei Fei, Georgia Institute of Technology & Emory Univ. (United States) and The Winship Cancer Institute of Emory Univ. (United States) and The Winship Cancer Institute of Emory Univ. (United States); Baowei Fei, Georgia Institute of Technology & Emory Univ. (United States) and The Winship Cancer Institute of Emory Univ. (United States) and The Winship Cancer Institute of Emory Univ. (United States) and The Winship Cancer Institute of Emory Univ. (United States) and The Winship Cancer Institute of Emory Univ. (United States) and The Winship Cancer Institute of Emory Univ. (United States) and The Winship Cancer Institute of Emory Univ. (United States) and The Winship Cancer Institute of Emory Univ. (United States) and The Winship Cancer Institute of Emory Univ. (United States) and The Winship Cancer Institute of Emory Univ. (United States) and The Winship Cancer Institute of Emory Univ. (United States) and The Winship Cancer Institute of Emory Univ. (United States)