PROGRESS IN BIOMEDICAL OPTICS AND IMAGING
Vol. 21 No. 56

Medical Imaging 2020

Ultrasonic Imaging and Tomography

Brett C. Byram
Nicole V. Ruiter
Editors

16–18 February 2020
Houston, Texas, United States

Sponsored by
SPIE

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

Published by
SPIE

Volume 11319

Proceedings of SPIE, 1605-7422, V. 11319

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

Medical Imaging 2020: Ultrasonic Imaging and Tomography, edited by Brett C. Byram, Nicole V. Ruiter,
Proc. of SPIE Vol. 11319, 1131901 · © 2020 SPIE · CCC code: 1605-7422/20/$21 · doi: 10.1117/12.2570236

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 2020: Ultrasonic Imaging and Tomography*, edited by Brett C. Byram, Nicole V. Ruiter, Proceedings of SPIE Vol. 11319 (SPIE, Bellingham, WA, 2020) Seven-digit Article CID Number.

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

ISBN: 9781510634053
ISBN: 9781510634060 (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 © 2020, 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 $21.00 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 1605-7422/20/$21.00.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

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

SPIE. DIGITAL LIBRARY
SPIEDigitalLibrary.org

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 *2020 Medical Imaging Award Recipients*

SESSION 1 PHOTOACOUSTIC AND FLOW IMAGING

11319 03 **Thermoacoustic combined tomography of abusive head trauma** [11319-2]

11319 04 **Wavelet-based protoacoustic signal denoising for proton range verification** [11319-3]

11319 05 **Triangulation based vector flow imaging with non-steered plane waves for transverse flows** [11319-4]

SESSION 2 ULTRASOUND SIGNAL AND IMAGE PROCESSING

11319 07 **Guided ultrasound imaging using a deep regression network** [11319-6]

11319 08 **Deep learning radiomics for non-invasive diagnosis of benign and malignant thyroid nodules using ultrasound images** [11319-7]

11319 09 **Modified Doo-Sabin modeling of the right ventricle** [11319-8]

11319 0A **The accurate non-invasive staging of liver fibrosis using deep learning radiomics based on transfer learning of shear wave elastography** [11319-38]

11319 0B **Deep attentional GAN-based high-resolution ultrasound imaging** [11319-10]

SESSION 3 USCT AND 3D ULTRASOUND

11319 0D **Quantitative Breast Density (QBD) estimation with 3D transmission ultrasound and incomplete information** [11319-11]

11319 0E **Combining statistical shape model and principal component analysis to estimate left ventricular volume and ejection fraction** [11319-12]

11319 0F **Sound speed estimation in layered media using the angular coherence of plane waves** [11319-13]

11319 0H **Clustering based quantitative breast density assessment using 3D transmission ultrasound** [11319-15]

SESSION 4 **ULTRASOUND IMAGING AND IMAGE GUIDANCE: JOINT SESSION WITH CONFERENCES 11315 AND 11319**

11319 0I **Multi-needle detection in 3D ultrasound images with sparse dictionary learning** [11319-16]

11319 0J **A complex dual-modality kidney phantom for renal biopsy studies** [11319-17]

11319 0K **Ring-arrayed forward-viewing ultrasound imaging system: a feasibility study** [11319-18]

SESSION 5 **USCT AND 3D ULTRASOUND II**

11319 0L **Comprehensive quantitative evaluations of reconstruction method using oil-gel-based phantom in ultrasound computed tomography** [11319-19]

11319 0M **Fat ray ultrasound transmission tomography: preliminary experimental results with simulated data** [11319-20]

11319 0N **Incident angle-dependent gain correction for reflection images on ultrasound computed tomography** [11319-21]

11319 0O **Variational mode decomposition for ultrasound computed tomography** [11319-22]

SESSION 6 **HIGH FREQUENCY ULTRASOUND AND ACOUSTIC MICROSCOPY**

11319 0P **Effects of radiation exposure on dermal collagen: a multi modal approach** [11319-25]

11319 0R **3D ultrasound biomicroscopy (3D-UBM) imaging of the eye for unique 3D assessment of ciliary body** [11319-27]

SESSION 7 **KEYNOTE AND NEW APPLICATIONS**

11319 0U **Mechanically-assisted 3D ultrasound scanner for Urogynecological applications: preliminary results** [11319-31]

11319 0V **Limited view reconstructions with transmission ultrasound tomography: clinical implications and quantitative accuracy** [11319-32]

11319 0W **Orthopedic and myopathic imaging with transmission ultrasound tomography: experimental verification, quantitative accuracy and clinical implications** [11319-33]

11319 0X **Quantitative ultrasound successes: past, present and future (Keynote Paper)** [11319-34]

SESSION 8 **IMAGE ANALYSIS IN ULTRASOUND AND OCT: JOINT SESSION WITH CONFERENCES 11313 AND 11319**

11319 0Y **Deep learning-based breast tumor detection and segmentation in 3D ultrasound image** [11319-35]

11319 0Z **Unsupervised motion tracking of left ventricle in echocardiography** [11319-36]

POSTER SESSION

11319 10 **Weekly supervised convolutional long short-term memory neural networks for MR-TRUS registration** [11319-39]

11319 11 **Improvements on USCT SAFT imaging by divergence compensation** [11319-23]

11319 12 **Random field interferometry for medical ultrasound** [11319-41]

11319 14 **Weakly supervised multi-needle detection in 3D ultrasound images with bidirectional convolutional sparse coding (Cum Laude Poster Award)** [11319-37]

11319 15 **All-optical fiber ultrasound imaging system based on the photoacoustic principle** [11319-42]

11319 16 **Quantitative evaluation of skin using high-resolution ultrasound** [11319-9]

11319 17 **Multi-layered phantoms mimicking skin pathologies for high-resolution ultrasound** [11319-24]

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.

A. N., Madhavanunni, 05
Ahn, Shawn S., 0Z
Ali, Rehman, 0F
Alshara, Yasmeen, 0J
Ameri, Golafsoun, 0U
Avery, Stephen M., 04
Bamber, Jeffrey, 0P
Barker, Kevin, 0U
Bersvendsen, Jørn, 09
Boehm, Christian, 12
Bølviken, Håkon Strand, 09
Bozec, Laurent, 0P
Brekke, Pål, 09
Cardona Cardenas, Diego Armando, 11
Chan, Vincent W. S., 07
Comby, P-A., 0M
Curran, Walter J., 0B, 0I, 0Y, 10, 14
Cwikla, Martin, 0D
Dahl, Jeremy, 0F
Dangi, Shusil, 0E
Dias, Mark, 03
Ding, Mingyue, 0O
Dormer, James D., 0J
Du, Cong, 15
Duncan, James S., 0Z
Fadden, Christopher, 03
Fei, Baowei, 0J
Fenster, Aaron, 0U
Fichtner, Andreas, 12
Fu, Yabo, 10
Furuie, Sergio Shiguemi, 11
Gahan, Jeffrey, 0J
Guo, Xu, 15
Harms, Joseph, 14
Hata, Nobuhiko, 0K
He, Xiuxiu, 04, 0B, 0I, 0Y
Helms, Richard W., 0R
Hopp, T., 0M
Hopper, Colin, 0P
Hozumi, Naohiro, 17
Jani, Ashesh B., 0I, 10, 14
Jeong, Jiwoong, 0I, 10
Johnson, Brett, 0J
Judson, Blake O., 0J
Kato, Fumi, 0N
Kawabata, Ken-ichi, 0L, 0N
Kim, Alvin, 0R
Kim, Edward, 07
Klock, John, 0V, 0W
Kothapalli, Sri-Rajasekhar, 03
Kwak, Sunwoo, 0R
Le, Phuc, 0J
Lee, Sam, 0D
Lee, Sanghyeb, 0H
Lei, Yang, 0B, 0I, 0Y, 10, 14
Li, Qinmei, 0J
Li, Wei, 0Y
Linte, Cristian A., 0E
Liu, Dawei, 0E
Liu, Tian, 04, 0B, 0I, 0Y, 10, 14
Liu, Yingzi, 0B
Lu, Allen, 0Z
Maev, Roman Gr., 16, 17
Maeva, Anna, 0P, 16
Malik, Bilal, 0D, 0H, 0V, 0W
Malyarenko, Eugene, 16
Mao, Hui, 10
Maredia, Sharil, 0F
Marharjan, Jenish, 07
Minhaz, Ahmed Tahseen, 0R
Mitchell, Benjamin R., 07
Nakada, Shizuka, 17
Natesan, Rajni, 0H
Nie, Wei, 04
Nishida, Mutsumi, 0N
Oelze, Michael L., 0X
Orderud, Fredrik, 09
Orge, Faruk H., 0R
Patel, Pretesh, 0I, 10, 14
Paulmurugan, Ramasamy, 0F
Perrett, Conal, 0P
Pfefferle, Matthew, 0J
Pirshafiey, Nasser, 0V
Raveendranatha Panicker, Mahesh, 05
Ruiter, N. V., 0M
Samset, Eigil, 09
Satoh, Megumi, 0N
Schreiner, Gregory, 16
Schwarz, Karl Q., 0E
Sevgi, Duriye Damla, 0R
Seviaryn, Fedar, 16
Seviaryna, Inna, 0P, 16, 17
Shah, Rinkal, 15
Shahedi, Maysam, 0J
Shahub, Sarah, 0J
Sham, Derek, 0U
Sinusas, Albert J., 0Z
Snare, Sten Roar, 09

Sohn, James, 04
Song, Junjie, 0O
Stendahl, John C., 0Z
Suzuki, Atsuro, 0L, 0N
Ta, Kevinminh, 0Z
Telichko, Arsenii, 0F
Terada, Takahide, 0L, 0N
Thamburaj, Krishnamoorthy, 03
Theendakara, Veena, 0W
Tian, Jie, 08, 0A
Tsubota, Yushi, 0L, 0N
Tsumura, Ryosuke, 0K
Ulrich, Ines Elisa, 12
Vang, Doua P., 0K
Vargas, Jose, 0J
Vilches-Moure, Jose, 0F
Wang, Huaijun, 0F
Wang, Kun, 08, 0A
Wang, Lijing, 0Y
Wang, Shanshan, 0O
Wang, Tonghe, 0B, 0I, 10, 14
Wang, Xingwei, 15
Wilson, David L., 0R
Wiskin, James, 0D, 0H, 0V, 0W
Wu, Hao, 0R
Wu, Wenjing, 0L, 0N
Xu, Dong, 0Y
Yamanaka, Kazuhiro, 0L, 0N
Yamashita, Hiroko, 0N
Yang, Xiaofeng, 04, 0B, 0I, 0Y, 10, 14
Yao, Jincao, 0Y
Yoshida, Sachiko, 17
Youssef, Sarah, 16
Yuchi, Ming, 0O
Zeng, Liang, 0O
Zeng, Qiulan, 0I, 10
Zhang, Haichong K., 0K
Zhang, Yupei, 0I, 14
Zhen, Tian, 0B, 0I, 10
Zhou, Hui, 08, 0A
Zhou, Jingcheng, 15
Zhou, Jun, 04
Zhou, Liang, 0O
Zuch, F., 0M

Conference Committee

Symposium Chairs

Georgia D. Tourassi, Oak Ridge National Laboratory (United States)
Metin N. Gurcan, M.D., Wake Forest Baptist Medical Center (United States)

Conference Chairs

Brett C. Byram, Vanderbilt University (United States)
Nicole V. Ruiter, Karlsruher Institut für Technologie (Germany)

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 Universiteit Rotterdam (Netherlands)
Jan D'hooge, Universiteit 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)
Peter E. Huthwaite, Imperial College London (United Kingdom)
Michael Jaeger, Universität Bern (Switzerland)
Jørgen Arendt Jensen, Technical University of Denmark (Denmark)
David H. Kim, Pohang University of Science and Technology (Korea, Republic of)
Cuiping Li, Delphinus Medical Technologies, Inc. (United States)
Roman G. Maev, University of Windsor (Canada)
Bilal H. Malik, QT Ultrasound LLC (United States)
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)
Kai E. Thomenius, Massachusetts Institute of Technology (United States)
François Varray, CREATIS (France)
James W. Wiskin, QT Ultrasound LLC (United States)

Session Chairs

1 Photoacoustic and Flow Imaging
Richard Bouchard, The University of Texas M.D. Anderson Cancer Center (United States)

2 Ultrasound Signal and Image Processing
Xiaofeng Yang, The Winship Cancer Institute of Emory University (United States)

3 USCT and 3D Ultrasound
James W. Wiskin, QT Ultrasound LLC (United States)

4 Ultrasound Imaging and Image Guidance: Joint Session with Conferences 11315 and 11319
Guy Shechter, Philips Healthcare (United States)
Haichong Kai Zhang, Worcester Polytechnic Institute (United States)

5 USCT and 3D Ultrasound II
Lluis Guasch, Imperial College London (United Kingdom)

6 High Frequency Ultrasound and Acoustic Microscopy
Torsten Hopp, Karlsruher Institut für Technologie (Germany)

7 Keynote and New Applications
Brett C. Byram, Vanderbilt University (United States)
Nicole V. Ruiter, Karlsruher Institut für Technologie (Germany)

8 Image Analysis in Ultrasound and OCT: Joint Session with Conferences 11313 and 11319
Jayaram K. Udupa, Penn Medicine (United States)
Nicole V. Ruiter, Karlsruher Institut für Technologie (Germany)

2020 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:

The Medical Image Perception Society

SPIE.

2020 Recipients:

First Place: **Multi-body registration for fracture reduction in orthopaedic trauma surgery (11315-14)**
R. Han, A. Uneri, P. Wu, R. Vijayan, P. Vagdargi, M. Ketcha, N. Sheth, Johns Hopkins University (United States), S. Vogt, G. Kleinszig, Siemens Healthineers (Germany) G. M. Osgood, John Hopkins Hospital (United States), J. H. Siewerdsen, John Hopkins University (United States)

Second Place: **Phase contrast CT enabled three-material decomposition in spectral CT imaging** (11312-47)
Xu Ji, Ran Zhang, Ke Li, Guang-Hong Chen, University of Wisconsin School of Medicine and Public Health (United States)