PROCEEDINGS OF SPIE

Medical Imaging 2020

Image-Guided Procedures, Robotic Interventions, and Modeling

Baowei Fei Cristian A. Linte Editors

16–19 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 11315

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: Image-Guided Procedures, Robotic Interventions, and Modeling*, edited by Baowei Fei, Cristian A. Linte, Proceedings of SPIE Vol. 11315 (SPIE, Bellingham, WA, 2020) Seven-digit Article CID Number.

ISSN: 1605-7422

ISSN: 2410-9045 (electronic)

ISBN: 9781510633971

ISBN: 9781510633988 (electronic)

Published by

SPIF

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.



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

xi	Authors
xvii	Conference Committee
xxi	Awards
SESSION 1	CALIBRATION AND TRACKING FOR IMAGE-GUIDED NAVIGATION
11315 02	Miniature C-arm simulator using wireless accelerometer based tracking [11315-1]
11315 03	Pivot calibration concept for sensor attached mobile c-arms [11315-2]
11315 04	3D catheter guidance including shape sensing for endovascular navigation [11315-3]
11315 05	Feasibility of 3D motion-compensated needle guidance for TIPS procedures [11315-4]
11315 06	Towards electromagnetic tracking of J-tip guidewire: precision assessment of sensors during bending tests [11315-5]
SESSION 2	AI METHODS FOR IMAGE-GUIDED THERAPY
11315 07	Validation of a metal artifact reduction method based on 3D conditional GANs for CT images of the ear [11315-6]
11315 08	Ultrasound image simulation with generative adversarial network [11315-7]
11315 09	Image registration with deep probabilistic classifiers: application in radiation therapy [11315-8]
11315 0A	Automatic labeling of respiratory phases and detection of abnormal respiratory signals in free-breathing thoracic dynamic MR image acquisitions based on deep learning [11315-9]
11315 OB	Image-based deformable motion compensation in cone-beam CT: translation to clinical studies in interventional body radiology [11315-10]
11315 0C	Stabilized ultrasound imaging of a moving object using 2D B-mode images and convolutional neural network [11315-11]

SESSION 3	IMAGE-GUIDED ORTHOPEDIC APPLICATIONS
11315 0D	Infrared image-guidance for intraoperative assessment of limb length discrepancy during total hip arthroplasty procedures [11315-12]
11315 OE	Three-dimensional ultrasound for monitoring knee inflammation and cartilage damage in osteoarthritis and rheumatoid arthritis [11315-13]
11315 OF	Multi-body registration for fracture reduction in orthopaedic trauma surgery (Robert F. Wagner Best Student Paper Award) [11315-14]
11315 0G	Calibration and registration of a freehand video-guided surgical drill for orthopaedic trauma [11315-15]
11315 OH	MRI-compatible needle guidance toolkit to streamline arthrography procedures: phantom accuracy study [11315-16]
SESSION 4	ULTRASOUND IMAGING AND IMAGE GUIDANCE: JOINT SESSION WITH CONFERENCES 11315 AND 11319
11315 OI	Efficient target tracking for 3D ultrasound-guided needle steering [11315-17]
11315 OJ	Automatic brain structure-guided registration of pre and intra-operative 3D ultrasound for neurosurgery [11315-18]
11315 OK	Automatic needle localization in intraoperative 3D transvaginal ultrasound images for high-dose-rate interstitial gynecologic brachytherapy [11315-19]
SESSION 5	IMAGE-GUIDED NEUROSURGICAL INTERVENTIONS
11315 OL	Comparison of head pose tracking methods for mixed-reality neuronavigation for transcranial magnetic stimulation [11315-20]
11315 OM	Localisation of the subthalamic nucleus in MRI via convolutional neural networks for deep brain stimulation planning [11315-21]
11315 0O	A guidance system for electrode placement in epilepsy cases [11315-23]
11315 OP	Brain deformation compensation for deep brain lead placement surgery: a comparison of simulations driven by surface vs deep brain sparse data [11315-24]
SESSION 7	AI-BASED METHODS FOR TISSUE CLASSIFICATION: DIAGNOSIS AND THERAPY APPLICATIONS
11315 0Q	Classification of tumor signatures from electrosurgical vapors using mass spectrometry and machine learning: a feasibility study [11315-25]

11315 OR	Towards democratizing AI in MR-based prostate cancer diagnosis: 3.0 to 1.5 Tesla [11315-26]
11315 OS	Automatic segmentation of brain tumor in intraoperative ultrasound images using 3D U-Net [11315-27]
SESSION 8	KEYNOTE PRESENTATION
11315 OT	Healthcare in need of innovation: exponential technology and biomedical entrepreneurship as solution providers (Keynote Paper) [11315-28]
SESSION 9	AUGMENTED REALITY FOR IMAGE-GUIDED THERAPY
11315 OU	Augmented reality visualization of hyperspectral imaging classifications for image-guided brain tumor phantom resection [11315-29]
11315 0V	Accuracy study of Smartglasses/Smartphone AR systems for percutaneous needle interventions [11315-30]
	Assessment of the state of the
11315 OW	Augmented reality-assisted biopsy of soft tissue lesions [11315-31]
11315 OW 11315 OX	Towards augmented reality-based suturing in monocular laparoscopic training [11315-32]
11315 0X	Towards augmented reality-based suturing in monocular laparoscopic training [11315-32]
11315 0X SESSION 10	Towards augmented reality-based suturing in monocular laparoscopic training [11315-32] NOVEL IMAGING TECHNOLOGIES FOR INTERVENTIONAL GUIDANCE Patient-specific deep deformation models (PsDDM) to register planning and interventional
11315 0X SESSION 10 11315 0Y	Towards augmented reality-based suturing in monocular laparoscopic training [11315-32] NOVEL IMAGING TECHNOLOGIES FOR INTERVENTIONAL GUIDANCE Patient-specific deep deformation models (PsDDM) to register planning and interventional ultrasound volumes in image fusion-guided interventions [11315-33] Image guided mitral valve replacement: registration of 3D ultrasound and 2D x-ray images
11315 0X SESSION 10 11315 0Y 11315 0Z	Towards augmented reality-based suturing in monocular laparoscopic training [11315-32] NOVEL IMAGING TECHNOLOGIES FOR INTERVENTIONAL GUIDANCE Patient-specific deep deformation models (PsDDM) to register planning and interventional ultrasound volumes in image fusion-guided interventions [11315-33] Image guided mitral valve replacement: registration of 3D ultrasound and 2D x-ray images [11315-34] Multi-view 3D echocardiography volume compounding for mitral valve procedure planning
11315 0X SESSION 10 11315 0Y 11315 0Z 11315 10	Towards augmented reality-based suturing in monocular laparoscopic training [11315-32] NOVEL IMAGING TECHNOLOGIES FOR INTERVENTIONAL GUIDANCE Patient-specific deep deformation models (PsDDM) to register planning and interventional ultrasound volumes in image fusion-guided interventions [11315-33] Image guided mitral valve replacement: registration of 3D ultrasound and 2D x-ray images [11315-34] Multi-view 3D echocardiography volume compounding for mitral valve procedure planning [11315-35] Assessment of proton beam ablation in myocardial infarct tissue using delayed contrast-
11315 0X SESSION 10 11315 0Y 11315 0Z 11315 10 11315 11	Towards augmented reality-based suturing in monocular laparoscopic training [11315-32] NOVEL IMAGING TECHNOLOGIES FOR INTERVENTIONAL GUIDANCE Patient-specific deep deformation models (PsDDM) to register planning and interventional ultrasound volumes in image fusion-guided interventions [11315-33] Image guided mitral valve replacement: registration of 3D ultrasound and 2D x-ray images [11315-34] Multi-view 3D echocardiography volume compounding for mitral valve procedure planning [11315-35] Assessment of proton beam ablation in myocardial infarct tissue using delayed contrastenhanced magnetic resonance imaging (Updated version 28 April 2020) [11315-36] Transformation optimization and image blending for 3D liver ultrasound series stitching

11315 14	Motion induced segmentation of stone fragments in ureteroscopy video [11315-39]
11315 15	Evaluation of real-time guidewire navigation using virtual endoscopic 4D fluoroscopy [11315-40]
11315 16	Towards portable image guidance and automatic patient registration using an RGB-D camera and video projector [11315-41]
11315 17	Open-source platform for automated collection of training data to support video-based feedback in surgical simulators [11315-42]
11315 18	Improved visual SLAM for bronchoscope tracking and registration with pre-operative CT images [11315-43]
SESSION 12	ROBOT-ASSISTED IMAGE-GUIDED THERAPY
11315 19	Robotic tissue scanning with biophotonic probe [11315-44]
11315 1A	Image-guided robotic k-wire placement for orthopaedic trauma surgery [11315-45]
11315 1B	A mechatronic guidance system for positron emission mammography and ultrasound-guided breast biopsy [11315-46]
11315 1C	Fiducial-free 2D/3D registration of the proximal femur for robot-assisted femoroplasty [11315-47]
11315 1D	Feasibility of robot-assisted ultrasound imaging with force feedback for assessment of thyroid diseases [11315-48]
SESSION 13	MODELING APPLICATIONS FOR IMAGE-GUIDED THERAPEUTICS
11315 1E	Estimating tongue deformation during laryngoscopy using hybrid FEM-multibody model and intraoperative tracking: a cadaver pilot study [11315-49]
11315 1F	The image-to-physical liver registration sparse data challenge: characterizing inverse biomechanical model resolution [11315-50]
11315 1G	Image data-driven thermal dose prediction for microwave ablation therapy [11315-51]
11315 1H	Modeling the surgical exposure of anatomy in robot-assisted laparoscopic partial nephrectomy [11315-52]

SESSION 14	AI-BASED IMAGE SEGMENTATION AND FEATURE DETECTION
11315 11	CNN-based hierarchical coarse-to-fine segmentation of pelvic CT images for prostate cancer radiotherapy [11315-53]
11315 1J	CondenseUNet: a memory-efficient condensely-connected architecture for bi-ventricular blood pool and myocardium segmentation [11315-54]
11315 1K	How well do U-Net-based segmentation trained on adult cardiac magnetic resonance imaging data generalize to rare congenital heart diseases for surgical planning? [11315-55]
11315 1L	Textual fiducial detection in breast conserving surgery for a near-real time image guidance system [11315-56]
11315 1M	A deep learning approach for surgical instruments detection in Orthopaedic surgery using transfer learning [11315-57]
SESSION 15	JOURNAL OF MEDICAL IMAGING SPECIAL SECTION ON INTERVENTIONAL AND SURGICAL DATA SCIENCE
11315 10	SpineCloud: image analytics for predictive modeling of spine surgery outcomes [11315-108]
11315 1Q	A combined radiomics and cyst fluid inflammatory markers model to predict preoperative risk in pancreatic cystic lesions [11315-110]
11315 1R	Preoperative angular insertion depth prediction in case of lateral wall cochlear implant electrode arrays [11315-111]
11315 1S	Integrative radiomic analysis for pre-surgical prognostic stratification of glioblastoma patients: from advanced to basic MRI protocols [11315-112]
	POSTER SESSION
11315 1T	Multi-destination procedure planning for comprehensive lymph node staging bronchoscopy [11315-58]
11315 1U	Virtual radial-probe endobronchial ultrasound for image-guided bronchoscopy [11315-59]
11315 1V	Alignment of cortical vessels viewed through the surgical microscope with preoperative imaging to compensate for brain shift [11315-60]
11315 1W	Rigid and deformable corrections in real-time using deep learning for prostate fusion biopsy [11315-61]
11315 1X	Automated classification of brain tissue: comparison between hyperspectral imaging and diffuse reflectance spectroscopy [11315-62]

11315 1Y	[11315-63]
11315 1Z	Error analysis for a navigation system using 3D abdominal ultrasound [11315-64]
11315 20	Flexible piezoelectric sensor for real-time image-guided colonoscopies: a solution to endoscopic looping challenges in clinic [11315-65]
11315 21	Feasibility study of catheter segmentation in 3D Frustum ultrasounds by DCNN [11315-66]
11315 22	Blood flow anomaly detection via generative adversarial networks: a preliminary study [11315-67]
11315 23	Exploiting confident information for weakly supervised prostate segmentation based on image-level labels [11315-68]
11315 24	Workflow for creation and evaluation of virtual nephrolithotomy training models [11315-69]
11315 25	Value based decision support to prioritize development of innovative technologies for image-guided vascular surgery in the hybrid operating theater [11315-70]
11315 26	Open source software platform for interstitial ablation treatment planning [11315-71]
11315 27	Automatic segmentation of spinal ultrasound landmarks with U-net using multiple consecutive images for input [11315-72]
11315 28	Applications of VR medical image visualization to chordal length measurements for cardiac procedures [11315-73]
11315 29	Stereovision-updated image guidance in multi-level open spine surgery: short vs. long exposure [11315-74]
11315 2A	Assessment of skill translation of intrathecal needle insertion using real-time needle tracking with an augmented reality display [11315-75]
11315 2B	Multi-slot extended view imaging on the O-Arm: image quality and application to intraoperative assessment of spinal morphology [11315-76]
11315 2C	Computer vision-guided bronchoscopic navigation using dual CNN-generated depth images and ICP registration [11315-77]
11315 2E	Patient-specific, dynamic models of hypoplastic left heart syndrome tricuspid valves for simulation and planning [11315-79]
11315 2F	A Windows GUI application for real-time image guidance during motion-managed proton beam therapy [11315-80]
11315 2G	Automated segmentation of computed tomography colonography images using a 3D U-Net [11315-81]

11315 2H	Spherical harmonics for modeling shape transformations of breasts following breast surgery [11315-82]
11315 21	Deep learning-based automatic prostate segmentation in 3D transrectal ultrasound images from multiple acquisition geometries and systems [11315-83]
11315 2K	Assessment of therapy applicator targeting with a mechanically assisted 3D ultrasound system for minimally invasive focal liver tumor therapy [11315-85]
11315 2L	Video-based automatic and objective endoscopic sinus surgery skill assessment [11315-86]
11315 2M	Multi-slot intraoperative imaging and 3D-2D registration for evaluation of long surgical constructs in spine surgery [11315-88]
11315 20	Development of ultrasonography assistance robot for prenatal care [11315-90]
11315 2P	Data-driven detection and registration of spine surgery instrumentation in intraoperative images (Cum Laude Poster Award) [11315-91]
11315 2Q	Force and torque feedback in endoscopic vessel harvesting [11315-92]
11315 2R	Multi-step segmentation for prostate MR image based on reinforcement learning [11315-93]
11315 2S	Image-based extraction of breathing signal from cone-beam CT projections [11315-94]
11315 2T	A standardized method for accuracy study of MRI-compatible robots: case study: a body-mounted robot [11315-95]
11315 2U	Preoperative prediction of insertion depth of lateral wall cochlear implant electrode arrays [11315-96]
11315 2V	Cochlear implant electrode sequence optimization using patient specific neural stimulation models [11315-97]
11315 2W	Renal biopsy under augmented reality guidance (Image-Guided Procedures, Robotic Interventions, and Modeling Student Paper Award) [11315-98]
11315 2X	Development of a novel tumor phantom model for head and neck squamous cell carcinoma and its applications [11315-99]
11315 2Y	Automated segmentation of cardiac chambers from cine cardiac MRI using an adversarial network architecture [11315-100]
11315 2Z	Optical imaging of dental plaque pH [11315-101]
11315 30	Texture kinetic features from pre-treatment DCE MRI for predicting pathologic tumor stage regression after neoadjuvant chemoradiation in rectal cancers [11315-102]
11315 31	A comprehensive workflow and framework for immersive virtual endoscopy of dissected aortae from CTA data [11315-104]

11315 32	A personalized approach for microwave ablation treatment planning fusing radiomics and bioheat transfer modeling [11315-105]
11315 33	Obtaining the potential number of object models/atlases needed in medical image analysis [11315-106]