PROGRESS IN BIOMEDICAL OPTICS AND IMAGING Vol. 21 No. 50

Medical Imaging 2020

Image Processing

Ivana Išgum Bennett A. Landman Editors

17–20 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 11313

Proceedings of SPIE, 1605-7422, V. 11313

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

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 Processing*, edited by Ivana Išgum, Bennett A. Landman, Proceedings of SPIE Vol. 11313 (SPIE, Bellingham, WA, 2020) Seven-digit Article CID Number.

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

ISBN: 9781510633933 ISBN: 9781510633940 (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.



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
x∨ii	Conference Committee
xxi	2020 Medical Imaging Award Recipients
SESSION 1	IMAGE SYNTHESIS, GANS, AND NOVEL ARCHITECTURES
11313 03	Multi-modality MRI arbitrary transformation using unified generative adversarial networks [11313-1]
11313 05	Multi-modality super-resolution loss for GAN-based super-resolution of clinical CT images using micro CT image database [11313-3]
11313 07	GANet: group attention network for diabetic retinopathy image segmentation [11313-5]
11313 08	Fully automated segmentation of hyper-reflective foci in OCT images using a U-shape network [11313-6]
11313 09	Adversarial domain adaptation for multi-device retinal OCT segmentation [11313-7]
SESSION 2	IMAGE ANALYSIS IN ULTRASOUND AND OCT: JOINT SESSION WITH CONFERENCES 11313 AND 11319
11313 0A	Left ventricular and atrial segmentation of 2D echocardiography with convolutional neural networks [11313-9]
11313 OB	Multiresolution LOGISMOS graph search for automated choroidal layer segmentation of 3D macular OCT scans [11313-10]
11313 OC	Self-fusion for OCT noise reduction [11313-11]
SESSION 3	LESIONS AND PATHOLOGIES
11313 0D	Deep multi-task prediction of lung cancer and cancer-free progression from censored heterogenous clinical imaging [11313-12]

11313 OE Fine-grained tumor segmentation on computed tomography slices by leveraging bottom-up and top-down strategies [11313-13]

11313 OF Extracting 2D weak labels from volume labels using multiple instance learning in CT hemorrhage detection [11313-14]

- 11313 0G Coronary artery calcium scoring: Can we do better? (Image Processing Student Paper Award) [11313-15]
- 11313 0HFinding novelty with uncertainty [11313-16]
- 11313 01 Towards reduced-preparation spectral-CT-colonography utilizing local covariance [11313-17]

SESSION 4 MACHINE LEARNING AND DEEP LEARNING

- 11313 0J Estimation of four-dimensional CT-based imaging biomarker of liver fibrosis using finite element method [11313-18]
- 11313 0K Multilevel survival analysis with structured penalties for imaging genetics data [11313-19]
- 11313 OL Generalizing deep whole brain segmentation for pediatric and post-contrast MRI with augmented transfer learning [11313-20]
- 11313 0M Deep learning and multi-contrast-based denoising for low-SNR Arterial Spin Labeling (ASL) MRI [11313-21]
- 11313 ON Artifact reduction in brain magnetic resonance imaging (MRI) by means of a dense residual network with K-space blending (DRN-KB) [11313-22]

SESSION 5 REGISTRATION

11313 0O	Deformable alignment of longitudinal postoperative brain GBM scans using deep learning [11313-23]
11313 OP	An adversarial machine-learning-based approach and biomechanically guided validation for improving deformable image registration accuracy between a planning CT and cone-beam CT for adaptive prostate radiotherapy applications [11313-24]
11313 OQ	Deep-learning-based CT-CBCT image registration for adaptive radio therapy [11313-25]
11313 OR	Mutual information for unsupervised deep learning image registration [11313-26]

SESSION 6 FMRI AND DTI

11313 0S Deep learning estimation of multi-tissue constrained spherical deconvolution with limited single shell DW-MRI [11313-27]

11313 OT	Anatomically informed data augmentation for functional MRI with applications to deep
	learning [11313-28]

- 11313 0U Neural effect induced by exercise intervention can be categorized by altered functional connectivity in early psychotic patients [11313-29]
- 11313 0V Association between fMRI brain entropy features and behavioral measures [11313-30]
- 11313 0W Numerical DWI phantoms to optimize accuracy and precision of quantitative parametric maps for non-Gaussian diffusion [11313-31]

SESSION 7 KEYNOTE AND HIGHLIGHTS

- 11313 0Y Variational intensity cross channel encoder for unsupervised vessel segmentation on OCT angiography [11313-33]
- 11313 0Z Cardiac cine MRI left ventricle segmentation combining deep learning and graphical models [11313-34]
- 11313 10 Contrast phase classification with a generative adversarial network [11313-35]

SESSION 8 LABELING AND SEGMENTATION

- 11313 11 Vessel wall segmentation of common carotid artery via multi-branch light network [11313-36]
- 11313 12 Anatomical labeling of human airway branches using novel two-step machine learning and hierarchical features [11313-37]
- 11313 13 Incorporating minimal user input into deep-learning-based image segmentation [11313-38]
- 11313 14 Weakly supervised pancreas segmentation based on class activation maps [11313-39]
- 11313 15 Detection of frame informativeness in endoscopic videos using image quality and recurrent neural networks [11313-40]

SESSION 9 DEEP LEARNING: SEGMENTATION

- 11313 16 Spatial information-embedded fully convolutional networks for multi-organ segmentation with improved data augmentation and instance normalization [11313-41]
- 11313 17 Identification of kernels in a convolutional neural network: connections between the level set equation and deep learning for image segmentation [11313-42]
- 11313 18 Influence of decoder size for binary segmentation tasks in medical imaging [11313-43]

11313 19	Unified multi-scale feature abstraction for medical image segmentation [11313-44]
11313 1A	Topology-aware activation layer for neural network image segmentation [11313-45]
11313 1B	Observer variation-aware medical image segmentation by combining deep learning and surrogate-assisted genetic algorithms [11313-46]
SESSION 10	SEGMENTATION: ANATOMY
11313 1C	Combining deep learning and model-based segmentation for labeled spine CT segmentation [11313-47]
11313 1D	Combining model- and deep-learning-based methods for the accurate and robust segmentation of the intra-cochlear anatomy in clinical head CI images [11313-48]
11313 1E	Multi-class semantic segmentation of pediatric chest radiographs [11313-49]
11313 1F	Exploiting clinically available delineations for CNN-based segmentation in radiotherapy treatment planning [11313-50]
11313 1G	Anatomy segmentation evaluation with sparse ground truth data [11313-51]
SESSION 11	DEEP LEARNING: UNCERTAINTY AND QUALITY
11313 1H	Adding uncertainty to dermatological assistance [11313-52]
11313 11	Semi-supervised multi-organ segmentation through quality assurance supervision [11313-53]
11313 1J	Visualization approach to assess the robustness of neural networks for medical image classification [11313-54]
11313 1K	An exploration of uncertainty information for segmentation quality assessment [11313-55]
11313 1L	Robust chest x-ray quality assessment using convolutional neural networks and atlas regularization [11313-56]
11313 1M	Automatic online quality control of synthetic CTs [11313-57]

Homology-based approach for prognostic prediction of lung cancer using novel topologically invariant radiomic features [11313-58] 11313 1N

11313 10	Fully convolutional network with sparse feature-maps composition for automatic lung tumor
	segmentation from PET images [11313-59]

- 11313 1P Ultra-low-dose 18F-FDG brain PET/MR denoising using deep learning and multi-contrast information [11313-60]
- 11313 1Q The improved reconstruction of fluorescence molecular tomography via regularized doubly orthogonal matching pursuit method [11313-61]
- 11313 1R Automated threshold selection on whole-body 18F-FDG PET/CT for assessing tumor metabolic response [11313-62]

POSTER SESSION

- 11313 1S Identifying the common and subject-specific functional units of speech movements via a joint sparse non-negative matrix factorization framework [11313-63]
- 11313 1U Network features of simultaneous EEG and fMRI predict working memory load [11313-65]
- 11313 1V Hybrid dictionary learning-ICA approaches built on novel instantaneous dynamic connectivity metric provide new multiscale insights into dynamic brain connectivity [11313-66]
- 11313 1W Self-adaptive 2D-3D ensemble of fully convolutional networks for medical image segmentation [11313-67]
- 11313 1X Choroidal atrophy segmentation based on deep network with deep-supervision and EDTauxiliary-loss [11313-68]
- 11313 1Y Multi-planar whole heart segmentation of 3D CT images using 2D spatial propagation CNN [11313-69]
- 11313 1Z An improved U-Net for nerve fibre segmentation in confocal corneal microscopy images [11313-70]
- 11313 20 Segmentation of choroid neovascularization in OCT images based on convolutional neural network with differential amplification blocks [11313-71]
- 11313 21 Automated retinopathy of prematurity screening using deep neural network with attention mechanism [11313-72]
- 11313 22 Estimating standard-dose PET from low-dose PET with deep learning [11313-73]
- 11313 23 Internal-transfer weighting of multi-task learning for lung cancer detection [11313-74]
- 11313 24 Reduction of motion artifacts in head CT exams using multi-scale convolutional neural network [11313-75]
- 11313 25 CAI-UNet for segmentation of liver lesion in CT image [11313-76]

11313 28 An end-to-end deep learning approach for landmark detection and matching in medical images [11313-79] 11313 29 Non-rigid MRI-CT image registration with unsupervised deep-learning-based deformation prediction [11313-80] 11313 2A A target-oriented and multi-patch-based framework for image quality assessment on carotid artery MRI [11313-81] 11313 2B Convolutional neural-network-based ordinal regression for brain age prediction from MRI scans [11313-82] 11313 2C Segmentation of stem cell colonies in fluorescence microscopy images with transfer learning (Cum Laude Poster Award) [11313-83] 11313 2D Automatic epicardial fat segmentation in cardiac CT imaging using 3D deep attention U-Net [11313-84] 11313 2E New loss functions for medical image registration based on VoxelMorph [11313-85] 11313 2F A GICA-TVGL framework to study sex differences in resting state fMRI dynamic connectivity [11313-86] 11313 2G A generalized method for computation of n-dimensional Radon transforms [11313-87] 11313 2H Enhanced low-rank plus group sparse decomposition for speckle reduction in OCT images [11313-88] 11313 2I Metal artifacts reduction in computed tomography by Fourier coefficient correction using convolutional neural network [11313-89] 11313 2J Super-resolution magnetic resonance imaging reconstruction using deep attention networks [11313-90] 11313 2K Simultaneously spatial and temporal higher-order total variations for noise suppression and motion reduction in DCE and IVIM [11313-91] Liver synthetic CT generation based on a dense-CycleGAN for MRI-only treatment planning 11313 2L [11313-92] 11313 2M FunSyn-Net: enhanced residual variational auto-encoder and image-to-image translation network for fundus image synthesis [11313-93] Deep similarity learning using a Siamese ResNet trained on similarity labels from disparity maps 11313 2N of cerebral MRA MIP pairs [11313-94]

Enhancing infarct segmentation performance using domain-specific attention in acute

A grid-line suppression technique based on deep convolutional neural networks [11313-78]

11313 26

11313 27

ischemic stroke [11313-77]

11313 2O	Validation and optimization of multi-organ segmentation on clinical imaging archives [11313-95]
11313 2P	A quasi-conformal mapping-based data augmentation technique for brain tumor segmentation [11313-96]
11313 2Q	MRI correlates of chronic symptoms in mild traumatic brain injury [11313-97]
11313 2R	Development of a 3D carotid atlas for quantification of local volume change [11313-98]
11313 2S	Integrating deep transfer learning and radiomics features in glioblastoma multiforme patient survival prediction [11313-99]
11313 2T	An unsupervised deep learning approach for 4DCT lung deformable image registration [11313-100]
11313 2U	Cone-beam Computed Tomography (CBCT) and CT image registration aided by CBCT-based synthetic CT [11313-101]
11313 2V	Imposing implicit feasibility constraints on deformable image registration using a statistical generative model [11313-102]
11313 2W	Local structure orientation: a new method for histology and MRI coregistration [11313-103]
11313 2X	Unsupervised learning-based deformable registration of temporal chest radiographs to detect interval change [11313-104]
11313 2Y	Weakly non-rigid MR-TRUS prostate registration using fully convolutional and recurrent neural networks [11313-105]
11313 2Z	Feature-based retinal image registration for longitudinal analysis of patients with age-related macular degeneration [11313-106]
11313 31	Multi-label segmentation of bone, muscle, and fat in CT volumes via convex relaxation [11313-108]
11313 32	Group-wise attention fusion network for choroid segmentation in OCT images [11313-109]
11313 33	Automatic lung segmentation in low-dose CT image with contrastive attention module [11313-110]
11313 34	Attention-guided channel to pixel convolution network for retinal layer segmentation with choroidal neovascularization [11313-111]
11313 35	Attention multi-scale network for pigment epithelial detachment segmentation in OCT images [11313-112]
11313 36	Outlier guided optimization of abdominal segmentation [11313-113]
11313 37	Reflection-equivariant convolutional neural networks improve segmentation over reflection augmentation [11313-114]

- 11313 38 Synthetic MRI-aided pelvic multi-organ segmentation in cone-beam computed tomography [11313-115]
- 11313 39 Comparison of training strategies for the segmentation of retina layers in optical coherence tomography images of rodent eyes using convolutional neural networks [11313-116]
- 11313 3A Multi-organ segmentation in head and neck MRI using U-Faster-RCNN [11313-117]
- 11313 3B Improved automated segmentation of human kidney organoids using deep convolutional neural networks [11313-118]
- 11313 3C Segmenting retinal OCT images with inter-B-scan and longitudinal information [11313-119]
- 11313 3D Multi-atlas-based tissue identification in the lower leg using pQCT [11313-120]
- 11313 3E Unsupervised local feature learning for sensitive three-dimensional ultrasound assessment of carotid atherosclerosis [11313-121]