

PROCEEDINGS OF SPIE

# ***International Forum on Medical Imaging in Asia 2019***

**Feng Lin**  
**Hiroshi Fujita**  
**Jong Hyo Kim**  
*Editors*

**7–9 January 2019**  
**Singapore, Singapore**

*Organized by*  
Multi-plAform Game Innovation Centre (MAGIC), Nanyang Technological University (Singapore)

*Sponsored by*  
EON Reality  
School of Art, Design and Media, Nanyang Technological University (Singapore)

*Technical Co-sponsor and Publisher*  
SPIE

**Volume 11050**

Proceedings of SPIE 0277-786X, V. 11050

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

International Forum on Medical Imaging in Asia 2019, edited by Feng Lin,  
Hiroshi Fujita, Jong Hyo Kim, Proc. of SPIE Vol. 11050, 1105001 · © 2019 SPIE  
CCC code: 0277-786X/19/\$18 · doi: 10.1117/12.2530960

Proc. of SPIE Vol. 11050 1105001-1

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 *International Forum on Medical Imaging in Asia 2019*, edited by Feng Lin, Hiroshi Fujita, Jong Hyo Kim, Proceedings of SPIE Vol. 11050 (SPIE, Bellingham, WA, 2019) Seven-digit Article CID Number.

ISSN: 0277-786X  
ISSN: 1996-756X (electronic)

ISBN: 9781510627758  
ISBN: 9781510627765 (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 © 2019, 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](http://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 0277-786X/19/\$18.00.

Printed in the United States of America.

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

**SPIE. DIGITAL  
LIBRARY**

[SPIEDigitalLibrary.org](http://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*  
xi *Conference Committee*

---

## IMAGE ACQUISITION AND RECONSTRUCTION

---

- 11050 02 **VR bowling for muscular rehabilitation** [11050-3]
- 11050 03 **Study on visual perception for beta motion of annular ring under peripheral vision** [11050-11]
- 11050 04 **POCS-based restoration algorithm for beam modulation CT acquisition** [11050-12]
- 11050 05 **Feasibility study of virtual monochromatic imaging for metal artifact reduction in spectral CT** [11050-15]
- 11050 06 **Extracting multi-view images from multi-focused plenoptic camera** [11050-24]
- 11050 07 **Ultrasound-based shear-wave speed measurement on a highly viscous embedded phantom** [11050-25]
- 11050 08 **Non-iterative method for metal artifact reduction by using a linearized beam-hardening correction model for polychromatic x-ray CT** [11050-28]
- 11050 09 **Improvement of optical setup for microcirculation imaging and flow analysis in septic shock rats** [11050-39]

---

## IMAGE PROCESSING AND IMAGE QUALITY

---

- 11050 0B **Comparison study of image quality between filtered back projection and iterative reconstruction algorithm for dose reduction in chest CT** [11050-19]
- 11050 0C **Noise reduction method in low-dose CT data combining neural networks and an iterative reconstruction technique** [11050-32]
- 11050 0D **How dependent are CT radiomic features on CT scan parameters?** [11050-33]
- 11050 0E **Combined low-dose simulation and deep learning for CT denoising: application in ultra-low-dose chest CT** [11050-43]
- 11050 0F **Improvement of face image super-resolution by high-precision skin color detection** [11050-503]

- 11050 OG **A hardware implementation of Craik-O'Brien effect-based contrast improvement for dichromats** [11050-47]
- 11050 OH **Artifact reduction using segmentation constrained RPCA for CT** [11050-500]
- 11050 OI **Differential phase contrast imaging using the phase retrieval of a Hilbert transform and noise filtering by low rank method** [11050-504]

---

#### IMAGE SEGMENTATION AND REGISTRATION

---

- 11050 OJ **Effects of ginger aroma under stress conditions: a biometric perspective** [11050-6]
- 11050 OK **Deep-learning-based fast and fully automated segmentation on abdominal multiple organs from CT** [11050-59]
- 11050 OL **Defect detection using trainable segmentation** [11050-61]
- 11050 OM **Automatic segmentation of meniscus using locally weighted voting based on multi-atlas and edge classification in knee MR images** [11050-66]
- 11050 ON **Automatic segmentation of the orbital bone in 3D maxillofacial CT images with double-bone-segmentation network** [11050-67]
- 11050 OO **Ground-glass nodule classification with multiple 2.5-dimensional deep convolutional neural networks in chest CT images** [11050-68]
- 11050 OP **Automated classification of histological subtypes of NSCLC using support vector machines with radiomic features** [11050-37]
- 11050 OQ **Brain image segmentation based on improved BP-Adaboost neural network** [11050-18]
- 11050 OR **Lumen and vessel wall segmentation on intravascular ultrasound images using fully convolutional network** [11050-27]
- 11050 OS **Automated segmentation of hip and thigh muscles in metal artifact contaminated CT using CNN** [11050-31]
- 11050 OT **Reconstruction of the spine structure with bi-planar x-ray images using the generative adversarial network** [11050-49]
- 11050 OU **Multi-scale speed of sound analysis by comparing of histological image and ultrasonic microscopic images at multiple frequencies** [11050-55]
- 11050 OV **Automatic liver segmentation with CT images based on 3D U-net deep learning approach** [11050-56]
- 11050 OW **Detection of pulmonary nodules on chest x-ray images using R-CNN** [11050-58]

---

## DEEP LEARNING AND RADIOMICS

---

- 11050 0X **Initial study on the classification of amyotrophic diseases using texture analysis and deep learning in whole-body CT images** [11050-2]
- 11050 0Y **Automated segmentation framework of lung gross tumor volumes on 3D planning CT images using dense V-Net deep learning** [11050-35]
- 11050 0Z **Diagnosis of lymph node metastasis in non-small-cell lung cancer (NSCLC) patient on F-18-FDG PET/CT** [11050-36]
- 11050 10 **Segmentation of lung region from chest x-ray images using U-net** [11050-48]
- 11050 11 **Computer-aided liver cirrhosis diagnosis via automatic liver segmentation and machine learning algorithm** [11050-54]
- 11050 12 **Quantitative analysis of dopamine transporter imaging using generating MR image from low dose CT image and segmentation by deep learning** [11050-60]
- 11050 13 **VR puzzle room for cognitive rehabilitation** [11050-4]
- 11050 14 **Deep learning for breast cancer classification with mammography** [11050-5]
- 11050 15 **A tissue classification method of IVOCT images using rectangle region cropped along the circumferential direction based on deep learning** [11050-9]
- 11050 16 **Automatic hepatocellular carcinoma lesion detection with dynamic enhancement characteristic from multi-phase CT images** [11050-13]
- 11050 17 **Analysis of the effects of transfer learning on opacity classification of diffuse lung diseases using convolutional neural network** [11050-17]
- 11050 18 **Investigation of the effect of image resolution on automatic classification of mammary gland density in mammography images using deep learning** [11050-21]
- 11050 19 **Radiomics-based malignancy prediction of parotid gland tumor** [11050-26]
- 11050 1A **Automatic metastatic bone tumor classification with DCNN-based features using treatment-planning CT** [11050-30]
- 11050 1B **Convolutional neural networks-based anti-weapon detection for safe 3D printing** [11050-501]

---

## COMPUTATIONAL ANATOMY

---

- 11050 1C **Brain volume mapping for constructing volumetric statistical shape model** [11050-7]

- 11050 1D **Unsupervised and semi-supervised learning for efficient opacity annotation of diffuse lung diseases** [11050-8]
- 11050 1E **Investigation of extracting interlobular septa with Hessian analysis and radial structure tensor combined with roundness error in micro-CT volume** [11050-57]
- 11050 1F **Registration between histopathological images with different stains and an MRI Image of pancreatic cancer tumor** [11050-62]
- 11050 1G **Spatiotemporal statistical models of a human embryo** [11050-63]
- 11050 1H **Construction of multimodal 3D model of pancreatic cancer tumor** [11050-502]

---

#### COMPUTER AIDED DIAGNOSIS

---

- 11050 1I **Segmentation of intervertebral disks from videofluorographic images using convolutional neural network** [11050-20]
- 11050 1J **Pilot study to generate image features by deep autoencoder for computer-aided detection systems** [11050-22]
- 11050 1K **A 3D printing-based realistic anthropomorphic dental phantom and its imaging evaluation** [11050-34]
- 11050 1L **Automated estimation of sizes of unruptured intracranial aneurysms in MRA images using localized principal component analysis** [11050-38]
- 11050 1M **Arteriovenous classification method using convolutional neural network for early detection of retinal vascular lesion** [11050-41]
- 11050 1N **Deep convolutional neural network-based automated lesion detection in wireless capsule endoscopy** [11050-64]
- 11050 1O **Detection of paroxysmal atrial fibrillation by Lorenz plot imaging of ECG R-R intervals** [11050-65]

## 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.

Ahn, Chulkyun, 0E  
Ahn, Geunhwi, 16  
Akasaka, Takashi, 15  
Arimura, Hidetaka, 0P, 0Y, 19, 1L  
Asano, E., 0X  
Atsumo, Ami, 17  
Baek, Jongduk, 0C  
Byun, So Hyun, 0O  
Chae, Seung-Hoon, 0C, 1N  
Chao, Zhen, 04, 0Q  
Chen, Chih-Chia, 0T  
Chen, Qian, 15  
Cheng, Tsu-Chi, 0T, 0V, 0Z, 11, 14  
Chiu, Nan-Tsing, 0Z  
Cho, Eunbyul, 1N  
Cho, S., 0H  
Choi, D., 0H  
Choi, Dahim, 0C  
Choi, Jang-Hwan, 0C, 0I, 1N  
Choi, Sunghoon, 0B  
Endo, Eiichi, 0J  
Fahrig, Rebecca, 0C  
Fang, Yu-Hua, 0T, 0V, 0Z, 11, 14  
Fujii, Toshiaki, 06  
Fujinaka, Ayano, 1I  
Fujita, Hiroshi, 0X, 12, 1M  
Fujita, Shu, 06  
Fukuda, Takaichi, 1C  
Furutani, Keigo, 10  
Garbout, Amin, 0L  
Goto, Tomio, 0F  
Goto, Yushi, 1F, 1H  
Haekal, Mohammad, 0Y  
Haneishi, Hideaki, 09, 0U  
Hara, Takeshi, 0X, 12  
Haseai, S., 19  
Hasegawa, Hiroshi, 0J  
Haseyama, Miki, 1A  
Hashimoto, Ryohei, 09  
Hashizume, Makoto, 1F, 1H  
Hatanaka, Yuji, 1M  
Hayano, Junichiro, 1O  
Hayashi, Naoto, 1J  
Hayashi, Yuichiro, 1E  
He, Yi-Fei, 0T, 0V, 0Z, 11, 14  
Heo, Changyong, 0E  
Hiasa, Yuta, 0S  
Hidaka, Motonobu, 0J  
Hirano, Satoshi, 0F  
Hirano, Yasushi, 0W, 10, 17, 1D  
Hong, Helen, 0M, 0N, 0O  
Hontani, Hidekata, 1F, 1G, 1H  
Hur, Jin, 08  
Ikawa, Hibiki, 1M  
Inoue, Hiroto, 03  
Itoh, Hayato, 1E  
Iwamoto, Chika, 1F, 1H  
Jeon, Pil-Hyun, 0B  
Jeon, Yejin, 1N  
Jin, Hyeongmin, 0D  
Jo, Hae Young, 1N  
Jung, Julip, 0O  
Kajiwara, Kohei, 03  
Kakeda, Shingo, 1L  
Kamezawa, H., 19  
Kamiya, Naoki, 0X, 18  
Kano, Keigo, 0F  
Kasahara, Kazuki, 1G  
Kashio, Shu, 0U  
Kasuga, Masao, 0J  
Katafuchi, Tetsuro, 12  
Katagiri, Takahiro, 1F  
Kato, H., 0X  
Kawamura, Naoki, 1F  
Kawasaki, Mami, 09  
Khiew, Jian Bin, 13  
Kido, Shoji, 0W, 10, 17, 1D  
Kim, Dohyeon, 04, 05, 0Q  
Kim, Dongjoon, 08  
Kim, Hee-Joung, 04, 05, 0B, 0Q  
Kim, Hyemi, 04, 05, 0B  
Kim, Hyeonjin, 0M  
Kim, Hyungjin, 0O  
Kim, Jieun, 0K, 16  
Kim, Jong Hyo, 0D, 0E, 1K  
Kim, Juhee, 0C  
Kim, Kyung Won, 16  
Kim, Namkug, 16  
Kim, So Yeon, 16  
Kim, SoonBeen, 0M  
Kim, Tae Oh, 1N  
Kim, Y., 0H  
Kimura, Yuichi, 1J  
Kishimoto, Masashi, 1G  
Kishimoto, R., 07  
Kisohara, Masaya, 1O  
Kitamoto, Takuma, 0J  
Ko, Jiyeon, 0R

Kobayashi, Hirokazu, 1F  
 Korogi, Yukunori, 1L  
 Kosuge, Takahiro, 0J  
 Kubo, Takashi, 15  
 Kubota, Ryosuke, 0G  
 Kudo, Hiroyuki, 1I  
 Kudo, Kohsuke, 1A  
 Kugler, Mauricio, 1F, 1H  
 Kurazume, Ryo, 1C  
 Kuremoto, Takashi, 17, 1D  
 Kwack, Myung-Joon, 0I  
 Kwon, Ki-Ryong, 1B  
 Lee, Do Il, 1K  
 Lee, Donghoon, 04, 05, 0B  
 Lee, Gaeun, 16  
 Lee, June-Goo, 0K, 0R, 16  
 Lee, Min Jin, 0N  
 Lee, Minjae, 04, 05  
 Lee, Sangchul, 08  
 Lee, Seung Soo, 16  
 Lee, Soo-yeul, 0I  
 Lee, Soyoung, 0N  
 Lee, Suk-Hwan, 1B  
 Lim, S., 0H  
 Lin, Cheng-Li, 0T  
 Lin, Feng, 02, 13  
 Ma, Zhuangfei, 1L  
 Mabui, Shingo, 0W, 17, 1D  
 Maier, Andreas, 0C  
 Malcolm, Andrew A., 0L  
 Masuda, Yuto, 1O  
 Matsuo, M., 0X  
 Matsusako, Masaki, 12  
 Matsuzoe, Hiroshi, 1G  
 Mekata, Kojiro, 1I  
 Mikawa, Sho, 06  
 Miyagawa, Kazuya, 0J  
 Miyagi, Yasushi, 1C  
 Miyauchi, Shoko, 1C  
 Miyoshi, T., 0X  
 Moon, Chang Mo, 1N  
 Moon, Sehwa, 1N  
 Mori, Kensaku, 1E  
 Morooka, Ken'ichi, 1C  
 Muramatsu, Chisako, 0X, 1M  
 Mutiargo, Bisma, 0L  
 Nakamura, Shota, 1E  
 Nakano, Kazuya, 09  
 Nakano, Risa, 0Y  
 Nemoto, Mitsutaka, 1J  
 Ninomiya, Kenta, 0P, 19  
 Obata, T., 07  
 Oda, Hirohisa, 1E  
 Oda, Masahiro, 1E  
 Oda, Shigeto, 09  
 Ogawa, Takahiro, 1A  
 Ogawa, Takuya, 0U  
 Ogohara, Kazunori, 1M  
 Ohba, Teruko, 0J  
 Ohga, Saiji, 0Y  
 Ohnishi, Takashi, 09, 0U  
 Ohuchida, Kenoki, 1F, 1H  
 Ono, Tomohiro, 0G  
 Oshima, Ami, 0X, 18  
 Otake, Yoshito, 0S  
 Panahpourtehrani, Mehrdad, 06  
 Park, Chang Min, 0O  
 Park, Hyun-Seok, 0C  
 Park, Seong Ho, 16  
 Park, Seongeun, 0N  
 Pham, Giao N., 1B  
 Phung, Son Lam, 0F  
 Ren, Xinbo, 15  
 Saito, Atsushi, 1G  
 Saito, Yuki, 1I  
 Sakamoto, Mitsuki, 0S  
 Sato, Yoshinobu, 0S  
 Seah, Hock Soon, 02, 13  
 Sei, Tomonari, 1F  
 Sekine, Masashi, 09  
 Shibata, Hikaru, 03  
 Shim, Kyu Won, 0N  
 Shimizu, Akinobu, 1F, 1G  
 Shimomura, Tomoshige, 1F  
 Shin, Yeong-gil, 08  
 Shinohara, Norimitsu, 18  
 Shirato, Hiroki, 1A  
 Son, Junyoung, 05, 0B  
 Song, Yong Sub, 0O  
 Soufi, Mazen, 0P  
 Su, Ting-Yu, 0T, 0V, 0Z, 11, 14  
 Suetake, Noriaki, 0G  
 Suga, M., 07  
 Sugano, Nobuhiko, 0S  
 Sui, Yiliang, 02  
 Sunayama, Wataru, 1M  
 Suzuki, Yuka, 0J  
 Suzuki, Yuki, 0S  
 Takahashi, Keita, 06  
 Takakuwa, Tetsuya, 1G  
 Takao, Masaki, 0S  
 Takemiya, R., 0W  
 Takizawa, Hotaka, 1I  
 Tamukoh, Hakaru, 0G  
 Tamura, Yuki, 1F  
 Tan, Peng Hian, 13  
 Tanaka, Atsuko, 1J  
 Tetsutani, Nobuji, 03  
 Tha, Khin Khin, 1A  
 Togo, Ren, 1A  
 Tsujikawa, Masaki, 1G  
 Ushifusa, Kazuyuki, 1J  
 Usumura, M., 07  
 Wang, Joon Ho, 0M  
 Watanabe, Eizo, 09  
 Watanabe, Haruna, 1A  
 Wu, Haiyuan, 15  
 Yamada, M., 0X  
 Yamada, Masahiro, 0P  
 Yamada, Shigehito, 1G



Yamada, Takahiro, 1J  
Yamaguchi, Tadashi, 0U  
Yang, Ching-Juei, 11  
Yang, Jae-suk, 0I  
Yang, Wei-Tse, 0T, 0V, 0Z, 11, 14  
Yang, Zepa, 1K  
Yasuda, Koichi, 1A  
Yasumatsu, R., 19  
Yokoi, Shogo, 12  
Yokota, Tatsuya, 1F, 1H  
Yoshida, Kenji, 0U  
Yuda, Emi, 1O  
Zhao, Xiaofan, 1E  
Zhou, Xiangrong, 0X, 12



# Conference Committee

## *Conference Chairs*

**Jong Hyo Kim**, *General Chair*, Seoul National University (Korea, Republic of)

**Feng Lin**, *Program Committee Chair*, Nanyang Technological University (Singapore)

## *Program Committee*

**Feng Lin**, Nanyang Technological University (Singapore)

**Ruey-Feng Chang**, National Taiwan University (Taiwan, China)

**Kuo-Sheng Chen**, National Cheng Kung University (Taiwan, China)

**Seungryong Cho**, Korea Advanced Institute of Science and Technology (Korea, Republic of)

**Ryo Haraguchi**, University of Hyogo (Japan)

**Helen Hong**, Seoul Women's University (Korea, Republic of)

**Hyoungseop Kim**, Kyushu University (Japan)

**Jzau-Sheng Lin**, National Chin-Yi University of Technology (Taiwan, China)

**Jinah Park**, Korea Advanced Institute of Science and Technology (Korea, Republic of)

