

PROCEEDINGS OF SPIE

Image and Signal Processing for Remote Sensing XXIII

Lorenzo Bruzzone
Francesca Bovolo
Editors

11–13 September 2017
Warsaw, Poland

Sponsored and Published by
SPIE

Cooperating Organisations

Innovation Centre for Sensor and Imaging Systems (United Kingdom)
ADS Scotland (United Kingdom)
The Knowledge Transfer Network (United Kingdom)
Visit Scotland (United Kingdom)
European Regional Development Fund (Belgium)
Technology Scotland (United Kingdom)
European Association of Remote Sensing Companies (Belgium)
European Association of Remote Sensing Laboratories (Germany)
The British Association of Remote Sensing Companies (United Kingdom)
Remote Sensing & Photogrammetry Society (United Kingdom)

Volume 10427

Proceedings of SPIE 0277-786X, V. 10427

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

Image and Signal Processing for Remote Sensing XXIII, edited by Lorenzo Bruzzone, Francesca Bovolo
Proc. of SPIE, Vol. 10427, 1042701 · © 2017 SPIE · CCC code: 0277-786X/17/\$18 · doi: 10.1117/12.2303933

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 *Image and Signal Processing for Remote Sensing XXIII*, edited by Lorenzo Bruzzone, Francesca Bovolo, Proceedings of SPIE Vol. 10427 (SPIE, Bellingham, WA, 2017) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510613188

ISBN: 9781510613195 (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 © 2017, 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 0277-786X/17/\$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

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

SESSION 1 IMAGE CALIBRATION, ENHANCEMENT AND RESTORATION

- 10427 02 **Bulk processing of the Landsat MSS/TM/ETM+ archive of the European Space Agency: an insight into the level 1 MSS processing** [10427-1]
- 10427 03 **Fast and accurate denoising method applied to very high resolution optical remote sensing images** [10427-2]
- 10427 04 **Sen2Cor for Sentinel-2** [10427-3]

SESSION 2 IMAGE PANSHARPENING AND SUPERRESOLUTION

- 10427 06 **Resolution enhancement of DEM using photometric stereo method in time-varying shadowed region** [10427-6]
- 10427 07 **Benefits of haze removal for modulation-based pansharpening** [10427-7]
- 10427 08 **The effect of denoising on superresolution of hyperspectral imaging** [10427-8]
- 10427 09 **New developments in super-resolution for GaoFen-4** [10427-9]

SESSION 3 IMAGE ANALYSIS AND CHANGE DETECTION

- 10427 0B **Aggregation of Sentinel-2 time series classifications as a solution for multitemporal analysis** [10427-11]
- 10427 0C **Semi-autonomous remote sensing time series generation tool** [10427-12]
- 10427 0D **A theoretical Gaussian framework for anomalous change detection in hyperspectral images** [10427-13]

SESSION 4 HYPERSPECTRAL IMAGE ANALYSIS I

- 10427 0F **Uncertainty analysis of in-flight spectral calibration for hyperspectral imaging spectrometers** [10427-16]
- 10427 0G **Evaluation of dimensionality reduction techniques in hyperspectral imagery and their application for the classification of terrestrial ecosystems** [10427-17]

10427 OH **Classification of hyperspectral images using unsupervised support vector machine** [10427-18]

10427 OI **Nearest neighbor-density-based clustering methods for large hyperspectral images** [10427-19]

SESSION 5 HYPERSPECTRAL IMAGE AND ANALYSIS II

10427 OK **Hyperspectral image classification using non-subsampled shearlet transform** [10427-21]

10427 OL **Blind estimation of blur in hyperspectral images** [10427-22]

10427 OM **Hyperspectral image denoising and anomaly detection based on low-rank and sparse representations** [10427-23]

10427 OO **Target detection with compressive sensing hyperspectral images** [10427-52]

SESSION 6 ESTIMATION AND MODELLING TECHNIQUES

10427 OP **Convolutional neural networks for estimating spatially-distributed evapotranspiration** [10427-26]

10427 OQ **An approach to conifer stem localization and modeling in high density airborne LiDAR data** [10427-27]

10427 OR **Comparative study of building footprint estimation methods from LiDAR point clouds** [10427-28]

SESSION 7 OBJECT-BASED IMAGE ANALYSIS AND CLASSIFICATION

10427 OU **Increasing the UAV data value by an OBIA methodology** [10427-32]

10427 OV **Object-based image analysis for cadastral mapping using satellite images** [10427-33]

10427 OW **Integrating support vector machines and random forests to classify crops in time series of Worldview-2 images** [10427-34]

10427 OX **On the interest of the spectral bands in the automatic selection of high quality MODIS data through spatial pattern identification** [10427-35]

SESSION 8 IMAGE COMPRESSION, DETECTION AND RETRIEVAL

10427 OY **Analysis of signal-dependent sensor noise on JPEG 2000-compressed Sentinel-2 multi-spectral images** [10427-36]

10427 OZ **Using the time shift in single pushbroom datatakes to detect ships and their heading** [10427-37]

- 10427 10 **Comparison of different detection methods for persistent multiple hypothesis tracking in wide area motion imagery** [10427-38]
- 10427 11 **Ship detection leveraging deep neural networks in WorldView-2 images** [10427-39]
- 10427 12 **A novel class sensitive hashing technique for large-scale content-based remote sensing image retrieval** [10427-40]

SESSION 9 SAR IMAGE ANALYSIS

- 10427 13 **A filtering framework for SAR data based on non-Gaussian statistics and pixel clustering** [10427-41]
- 10427 14 **Computational efficient unsupervised coastline detection from single-polarization 1-look SAR images of complex coastal environments** [10427-42]

JOINT SESSION: SAR DATA PROCESSING I

- 10427 16 **Time domain SAR raw data simulation using CST and image focusing of 3D objects** [10427-46]
- 10427 17 **L₁ regularization recovered SAR images based interferometric SAR imaging via complex approximated message passing** [10427-47]
- 10427 18 **Automatic detection of subglacial lakes in radar sounder data acquired in Antarctica** [10427-48]

JOINT SESSION: SAR DATA PROCESSING II

- 10427 1A **Automatic identification of non-reflective subsurface targets in radar sounder data based on morphological profile** [10427-51]

POSTER SESSION

- 10427 1C **Application of asymmetric mapping and selective filtering (AM&SF) method to Cosmo/SkyMed images by implementation of a selective blocks approach for ship detection optimization in SEASAFE framework** [10427-43]
- 10427 1E **Implementing and validating of pan-sharpening algorithms in open-source software** [10427-54]
- 10427 1G **Verification of the test stand for microbolometer camera in accredited laboratory** [10427-56]
- 10427 1H **A high resolution imaging algorithm for synthetic aperture interferometric radiometers in near-field** [10427-57]

- 10427 1I **The laboratory demonstration and signal processing of the inverse synthetic aperture lidar** [10427-59]
- 10427 1J **Ground based automated radiometric calibration system in Baotou site, China** [10427-60]
- 10427 1K **Supervised classification of remotely sensed images using Bayesian network models and Kruskal algorithm** [10427-62]
- 10427 1L **Progressive sample processing of band selection for hyperspectral imagery** [10427-64]
- 10427 1M **Feature extraction and descriptor calculation methods for automatic georeferencing of Philippines' first microsatellite imagery** [10427-65]
- 10427 1N **Subaperture analysis to measure directivity and isotropy in pol-CSAR** [10427-66]
- 10427 1O **Small real time detection satellites for MDA using hyperspectral imaging** [10427-67]
- 10427 1S **Analysis of the SNR and sensing ability of different sensor types in a LIDAR system** [10427-72]
- 10427 1T **Estimating the number of endmembers in hyperspectral imagery using accumulated convex hull vertex and similarity measure** [10427-73]
- 10427 1U **Research of generalized wavelet transformations of Haar correctness in remote sensing of the Earth** [10427-74]
- 10427 1V **Multisource data fusion for documenting archaeological sites** [10427-76]
- 10427 1W **Multispectral image enhancement processing for microsat-borne imager** [10427-78]
- 10427 1Y **High efficient optical remote sensing images acquisition for nano-satellite: reconstruction algorithms** [10427-81]
- 10427 2I **Output MSE and PSNR prediction in DCT-based lossy compression of remote sensing images** [10427-84]

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.

- Abramov, Sergey K., 0L, 21
Acito, Nicola, 0D
Adibi, Sayyed Ashkan, 0H
Alonso-Sarría, Francisco, 1E
Alparone, Luciano, 07
Aranas, R. K. D., 1M
Artigues, Stéphanie, 03
August, Isaac, 0O
Babu, Dinesh Kumar, 0C
Baillarin, Simon, 03
Barela, Jaroslaw, 1G
Belhadj-Aissa, Aichouche, 1K
Bennett, R., 0V
Bi, Hui, 17
Biamino, W., 1C
Biasutti, Roberto, 02
Binet, Renaud, 03
Bioucas-Dias, José M., 0M
Blanchet, Gwendoline, 03
Blumberg, Dan G., 0O
Borisova, Denitsa, 1U
Boudissa, Youcef, 1K
Bovalo, F., 0Q
Bruzzone, Lorenzo, 0Q, 12, 18, 1A
Cabaleiro, J. C., 0R
Cánovas-García, Fulgencio, 1E
Cariou, Claude, 0I
Chehdi, Kacem, 0I, 0L, 0Y, 21
Chen, Shih-Yu, 1L
Chibunichev, Alexander, 1V
Chien, Hung-Chang, 1L
Chmielewski, Krzysztof, 1G
Choi, Gyudong, 1S
Choi, Han-Lim, 06
Conrad, Christopher, 0C
Corsini, Giovanni, 0D
Cristea, Anca, 13
Crommelinck, S., 0V
Dalsasso, Emanuele, 18
Dasallas, J. A., 1M
Debaecker, Vincent, 04
Demir, Begüm, 12
Dhams, Thorsten, 0C
Diani, Marco, 0D
Di Matteo, L., 1C
Domingo-Marimon, Cristina, 0X
Doulgeris, Anthony P., 13
Eltoft, Torbjørn, 13
Eskandari, Armin, 08
Ferrara, Riccardo, 02
Fu, Jie, 09, 1Y
Galli, Luca, 02
Gao, Lianru, 0M
Gao, Si, 11
García-Pedrero, Angel M., 0P, 0U
Garzelli, Andrea, 07, 14
Gascon, Ferran, 02, 04
Gedalin, Daniel, 0O
Geng, Ruonan, 0F
Gómez-Carbojo, Natalia, 0X
Gonzalo-Martín, Consuelo, 0G, 0P, 0U
Goryl, Philippe, 02
Han, Munhyun, 1S
Harikumar, A., 0Q
Hartung, Christine, 10
Hassani, Mohammad, 0H
He, Feng, 1H
Hellwich, Olaf, 16
Hong, Wen, 17, 1N
Hu, Fei, 1H
Hu, Hao, 1H
Huang, Puming, 1Y
Ibarrola-Ulzurrun, Edurne, 0G
Ilisei, Ana-Maria, 18, 1A
Ito, Tomonori, 1O
Ivanova, Iva, 1U
Izquierdo-Verdiguier, E., 0W
Jia, Guorui, 0F
Jiao, B. J. D., 1M
Jiménez-Díaz, María Teresa, 0X
Karami, Azam, 08, 0H, 0K
Kastek, Mariusz, 1G
Kaufmann, Christof, 0C
Kazama, Y., 11
Kazaryan, Maretta, 1U
Kheddam, Radja, 1K
Khodadadzadeh, Mahdi, 18, 1A
Knyaz, Vladimir, 1V
Koeva, M., 0V
Kohli, D., 0V
Kozhemiakin, Ruslan A., 21
Krupiński, Michał, 0B, 1G
Kukawska, Ewa, 0B
Lassalle, Pierre, 03
Lavender, Samantha, 02
Lefèvre, Sébastien, 03
Lemmen, C., 0V
Lewiński, Stanisław, 0B

- Li, Chuanrong, 1J
 Li, Feng, 09, 1Y
 Li, Wei, 1J
 Lillo-Saavedra, Mario F., 0P, 0U
 Lin, Yun, 17, 1N
 Liu, Keng-Hao, 1L
 Liu, Yang, 1Y
 Liu, Yaokai, 1J
 Liu, Yuhong, 09
 Liu, Zhijia, 09
 Lolli, Simone, 07
 Loreggia, D., 1C
 Louis, Jerome, 04
 Lukin, Vladimir V., 0L, 0Y, 21
 Lv, Qunbo, 1W
 Ma, Lingling, 1J
 Magallon, B. J. P., 1M
 Main-Korn, Magdalena, 04
 Malinowski, Radek, 0B
 Marcello, Javier, 0G
 Masse, Antoine, 03
 Meloni, Marco, 02
 Menasalvas, Ernestina, 0P
 Meng, Fanrong, 1J
 Mheen, Bongki, 1S
 Mica, Stefano, 02
 Moon, SungHyun, 06
 Müller-Wilm, Uwe, 04
 Nakaya, Daiki, 1O
 Nedkov, Roumen, 1U
 Northrop, Amy, 02
 Nowakowski, Artur, 0B
 Oiknine, Yaniv, 0O
 Pang, Bo, 1J
 Pei, Linlin, 1W
 Pena, T. F., 0R
 Peng, Xiaohui, 1H
 Pesántez-Cobos, Paúl, 1E
 Pesquer, Lluís, 0X
 Pflug, Bringfried, 04
 Pinelli, Gianpaolo, 14
 Pons, Xavier, 0X
 Qian, Yonggang, 1J
 Ramos, M. K. F., 1M
 Reato, Thomas, 12
 Richter, Andrey, 1U
 Rivera, F. F., 0R
 Rodríguez-Esparragón, Dionisio, 0P, 0U
 Rodriguez-Gonzalez, Alejandro, 0U
 Rotman, Stanley R., 0O
 Rozas, E., 0R
 Rybicki, Marcin, 0B
 Saeed, Adnan, 16
 Saunier, Sébastien, 02
 Schmidt, Marco, 0C
 Schuchert, Tobias, 10
 Schwenk, Kurt, 0Z
 Sempio, J. N. H., 1M
 Seo, Hongseok, 1S
 Shakhramanyan, Mihail, 1U
 Shen, Wenjie, 1N
 Shin, Satori, 1O
 Soleimanzadeh, Mohamad Reza, 0K
 Spraul, Raphael, 10
 Stankova, Nataliya, 1U
 Stern, Adrian, 0O
 Sun, Jianying, 1W
 Takeuchi, Yusuke, 1O
 Tamondong, A. M., 1M
 Tan, Zheng, 1W
 Tang, Lingli, 1J
 Tataranni, F., 1C
 Teng, Hong-Chao, 1T
 Trivero, P., 1C
 Tupas, M. E. A., 1M
 Uss, Mykhail, 0L, 0Y
 Vilariño, D. L., 0R
 Vivone, Gemine, 07
 Vozel, Benoit, 0L, 0Y, 21
 Wang, Daming, 0F
 Wang, Dongjin, 1J
 Wang, Ning, 1J
 Willburger, Katharina A. M., 0Z
 Wu, Chenyang, 17
 Wu, Jee-Cheng, 1T
 Wu, Kang-Pei, 1T
 Xin, Lei, 09, 1Y
 Xu, XianWen, 1I
 Xue, Fei-teng, 1N
 Yamamoto, T., 11
 Yanagida, Hiroki, 1O
 Yu, WenXian, 1I
 Zafari, A., 0W
 Zaharinova, Mariana, 1U
 Zhang, Bing, 0M
 Zhang, Bingchen, 17, 1N
 Zhang, Mo, 0L
 Zhang, Zenghui, 1I
 Zhao, Huijie, 0F
 Zhao, Yongguang, 1J
 Zhao, Yue, 1N
 Zheng, Tao, 1H
 Zhuang, Lina, 0M
 Zhuravlev, Denis, 1V
 Zoppetti, Claudia, 14
 Zurita-Milla, R., 0W

Conference Committee

Symposium Chair

Klaus Schäfer, (Retired) Karlsruhe Institute of Technology, Institute of Meteorology and Climate Research (Germany)

Symposium Co-chair

Christopher M. U. Neale, University of Nebraska-Lincoln (United States), Daugherty Water for Food Institute (United States)

Conference Chair

Lorenzo Bruzzone, Università degli Studi di Trento (Italy)

Conference Co-chairs

Francesca Bovolo, Fondazione Bruno Kessler (Italy)

Jon Álfur Benediktsson, University of Iceland (Iceland)

Conference Programme Committee

Selim Aksoy, Bilkent University (Turkey)

Luciano Alparone, Università degli Studi di Firenze (Italy)

José M. Bioucas-Dias, Universidade Técnica de Lisboa (Portugal)

Gustavo Camps-Valls, Universidad de València (Spain)

Jocelyn Chanussot, Laboratoire des Images et des Signaux (France)

Chi-Hau Chen, University of Massachusetts Dartmouth (United States)

Fabio Dell'Acqua, Università degli Studi di Pavia (Italy)

Begüm Demir, Università degli Studi di Trento (Italy)

Peijun Du, Nanjing University (China)

Giles M. Foody, The University of Nottingham (United Kingdom)

Andrea Garzelli, Università degli Studi di Siena (Italy)

Jordi Inglada, Centre d'Etudes Spatiales de la Biosphère (France)

Gabriele Moser, Università degli Studi di Genova (Italy)

Allan A. Nielsen, Technical University of Denmark (Denmark)

Ryuei Nishii, Kyushu University (Japan)

Antonio J. Plaza Miguel, Universidad de Extremadura (Spain)

John A. Richards, The Australian National University (Australia)

Josiane B. Zerubia, INRIA Sophia Antipolis - Méditerranée (France)

Session Chairs

- 1 Image Calibration, Enhancement and Restoration

Antoine Masse, Institut Géographique National (France)

- 2 Image Pansharpening and Superresolution
Lorenzo Bruzzone, Universitá degli Studi di Trento (Italy)
 - 3 Image Analysis and Change Detection
Francesca Bovolo, Fondazione Bruno Kessler (Italy)
 - 4 Hyperspectral Image Analysis I
Allan A. Nielsen, Technical University of Denmark (Denmark)
 - 5 Hyperspectral Image and Analysis II
Benoit Vozel, Université de Rennes 1 (France)
 - 6 Estimation and Modelling Techniques
Lorenzo Bruzzone, Universitá degli Studi di Trento (Italy)
 - 7 Object-based Image Analysis and Classification
Lorenzo Bruzzone, Universitá degli Studi di Trento (Italy)
 - 8 Image Compression, Detection and Retrieval
Begüm Demir, Universitá degli Studi di Trento (Italy)
 - 9 SAR Image Analysis
Andrea Garzelli, Universitá degli Studi di Siena (Italy)
- Joint Session: SAR Data Processing I
Lorenzo Bruzzone, Universitá degli Studi di Trento (Italy)
- Joint Session: SAR Data Processing II
Claudia Notarnicola, EURAC (Italy)