PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 10986

, "Front Matter: Volume 10986," Proc. SPIE 10986, Algorithms, Technologies, and Applications for Multispectral and Hyperspectral Imagery XXV, 1098601 (23 July 2019); doi: 10.1117/12.2537873

SPIE.

Event: SPIE Defense + Commercial Sensing, 2019, Baltimore, MD, United States

PROCEEDINGS OF SPIE

Algorithms, Technologies, and Applications for Multispectral and Hyperspectral Imagery XXV

Miguel Velez-Reyes
David W. Messinger
Editors

16–18 April 2019
Baltimore, Maryland, United States

Sponsored and Published by
SPIE

Volume 10986

Proceedings of SPIE 0277-786X, V. 10986

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

Algorithms, Technologies, and Applications for Multispectral and Hyperspectral Imagery XXV,
edited by Miguel Velez-Reyes, David W. Messinger, Proc. of SPIE Vol. 10986, 1098601
© 2019 SPIE · CCC code: 0277-786X/19/\$18 · doi: 10.1117/12.2537873

Proc. of SPIE Vol. 10986 1098601-1

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 [SPIDigitalLibrary.org](https://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 *Algorithms, Technologies, and Applications for Multispectral and Hyperspectral Imagery XXV*, edited by Miguel Velez-Reyes, David W. Messinger, Proceedings of SPIE Vol. 10986 (SPIE, Bellingham, WA, 2019) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510626379

ISBN: 9781510626386 (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](https://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. 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 by Curran Associates, Inc., under license from SPIE.

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

**SPIE. DIGITAL
LIBRARY**

[SPIDigitalLibrary.org](https://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

ix	<i>Authors</i>
xi	<i>Conference Committee</i>
xiii	<i>Introduction</i>

SESSION 1 **HYPERSPECTRAL IMAGING STANDARDS**

10986 02	IEEE P4001: progress towards a hyperspectral standard (Invited Paper) [10986-1]
----------	--

SESSION 2 **LWIR AND MWIR SPECTRAL SENSING**

10986 03	LWIR change detection using robustified temperature emissivity separation and alpha residuals [10986-2]
10986 04	Applications of spectral image quality equation for longwave infrared hyperspectral imagery [10986-3]
10986 05	Assessments of MODIS thermal emissive bands on-orbit calibration performance using Dome C observations [10986-4]
10986 06	Observations on passive polarimetric imaging across multiple infrared wavebands [10986-5]

SESSION 3 **CLASSIFICATION AND DIMENSIONALITY REDUCTION**

10986 07	Analysis of spectral data using spatial context [10986-6]
10986 08	A comparison of adaptive and template matching techniques for radio-isotope identification [10986-7]
10986 09	Semi-supervised discriminant feature selection for hyperspectral imagery classification [10986-8]
10986 0A	Unsupervised hyperspectral band selection in the compressive sensing domain [10986-9]

SESSION 4 SENSOR SYSTEMS AND CHARACTERIZATION

- 10986 OE **Simplified measurement of point spread functions of hyperspectral cameras for assessment of spatial coregistration** [10986-13]
- 10986 OF **Solar-induced fluorescence retrievals in the context of physiological, environmental, and hardware-based sources of uncertainty** [10986-14]
- 10986 OG **Stray light characterization in a high-resolution imaging spectrometer designed for solar-induced fluorescence** [10986-15]
- 10986 OH **SAGE IV Pathfinder multi-spectral imaging spectrometer telescope paves the way for semi-custom CubeSat imaging missions** [10986-16]
- 10986 OI **Extended characterization of multispectral resolving filter-on-chip snapshot-mosaic CMOS cameras** [10986-17]

SESSION 5 CHEMICAL AND EXPLOSIVES DETECTION

- 10986 OJ **Advances in active infrared spectroscopy for trace chemical detection** [10986-18]
- 10986 OK **Active LWIR hyperspectral imaging and algorithms for rapid standoff trace chemical identification** [10986-19]
- 10986 ON **Understanding polynomial distributed lag models: truncation lag implications for a mosquito-borne disease risk model in Brazil** [10986-101]
- 10986 OO **Algorithm development with on-board and ground-based components for hyperspectral gas detection from small satellites** [10986-22]

SESSION 6 MODELS AND MATHEMATICAL METHODOLOGIES

- 10986 OP **A universal sensing model for compressed hyperspectral image analysis** [10986-23]
- 10986 OQ **Parametric modeling of surface-distributed-scatterer ensembles for inverse analysis of diffuse-reflectance spectra** [10986-24]

SESSION 7 MACHINE LEARNING IN SPECTRAL SENSING I

- 10986 OR **Initial investigation into the effect of image degradation on the performance of a 3-category classifier using transfer learning and data augmentation** [10986-25]
- 10986 OS **Spatially regularized multiscale graph clustering for electron microscopy** [10986-26]

- 10986 OV **Analysis of long-wave infrared hyperspectral classification performance across changing scene illumination** [10986-28]
- 10986 OW **Unraveling low abundance intimate mixtures with deep learning** [10986-29]
- 10986 OX **Sheared multi-scale weight sharing for multi-spectral superresolution** [10986-30]

SESSION 8 APPLICATIONS OF SPECTRAL SENSING

- 10986 OY **Multispectral camera design and algorithms for python snake detection in the Florida Everglades** [10986-31]
- 10986 OZ **Stellar background rendering for space situational awareness algorithm development** [10986-32]
- 10986 10 **Hyperspectral nondestructive evaluation of early damage and degradation in metallic materials** [10986-33]
- 10986 11 **Hyperspectral pigment analysis of cultural heritage artifacts using the opaque form of Kubelka-Munk theory** [10986-34]
- 10986 14 **Evaluation of target detection methods and the study of accuracy improvement toward the application to MDA with hyperspectral imaging** [10986-36]

SESSION 9 TARGET AND CHANGE DETECTION

- 10986 15 **Multi-sensor anomalous change detection at scale** [10986-37]
- 10986 16 **Change detection using Landsat and Worldview images** [10986-38]
- 10986 17 **Comparison of longwave infrared hyperspectral target detection methods** [10986-39]
- 10986 18 **Coupled atmospheric surface observations with surface aerosol particle counts for daytime sky radiance quantification** [10986-40]
- 10986 19 **Object detection and classification in aerial hyperspectral imagery using a multivariate hit-or-miss transform** [10986-41]

SESSION 10 MACHINE LEARNING IN SPECTRAL SENSING II

- 10986 1A **Machine learning for better trace chemical detection** [10986-43]
- 10986 1B **Blended learning for hyperspectral data** [10986-45]

- 10986 1C **An application of CNNs to time sequenced one dimensional data in radiation detection**
[10986-46]
- 10986 1D **Optimizing deep learning model selection for angular feature extraction in satellite imagery**
[10986-47]

SESSION 11 SPECTRAL IMAGING

- 10986 1F **High speed VNIR/SWIR HSI sensor for vegetation trait mapping** [10986-49]
- 10986 1G **Frequency analysis and optimization of the diffractive plenoptic camera** [10986-50]
- 10986 1H **Assessment of residual fixed pattern noise on hyperspectral detection performance** [10986-51]
- 10986 1I **Optimized algorithm for processing hyperspectral push-broom data from multiple sources**
[10986-52]
- 10986 1J **Development of a pipeline for generating high resolution multispectral Mastcam images**
[10986-53]

POSTER SESSION

- 10986 1L **Iterative constrained energy minimization convolutional neural network for hyperspectral image classification** [10986-54]
- 10986 1M **Unsupervised iterative CEM-clustering based multiple Gaussian feature extraction for hyperspectral image classification** [10986-55]
- 10986 1N **A novel image registration method based on geometrical outlier removal** [10986-56]
- 10986 1O **An iterative SIFT based on intensity and spatial information for remote sensing image registration** [10986-57]
- 10986 1R **Case-study analysis of apparent camouflage-pattern color using segment-weighted spectra**
[10986-60]
- 10986 1S **Dried red chili peppers pungency assessment by visible and near infrared spectroscopy**
[10986-61]
- 10986 1T **Robust iterative estimation of material abundances based on spectral filters exploiting the SVD**
[10986-63]
- 10986 1U **Feature extraction and scene classification for remote sensing image based on sparse representation** [10986-64]
- 10986 1V **Hyperspectral anomaly detection algorithm based on non-negative sparsity score estimation**
[10986-66]

- 10986 1W **Tracking long-term stability of MODIS thermal emissive bands response versus scan-angle using Dome C observations** [10986-67]
- 10986 1X **Defect detection based on monogenic signal processing** [10986-68]

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.

Abera, Dawit, 09	Ford, William P., 08, 1C
Albert, Loren P., 0G	Fowl, Liam, 0X
Allen, David W., 02, 0F, 0G, 0W	Franz, Anthony L., 1G
Alonso, Luis, 0G	Furstenberg, Robert, 0K, 0Q
An, Seung Hwan, 17	Furxhi, Orges, 0Y
Anastasiadis, Johannes, 1T	Gasbarrone, Riccardo, 1S
Anthony, Keith D., 0R	Generous, Nicholas, 0N
Arvidson, Carl, 0Y	Gilchrist, John R., 02
Ash, Joshua N., 03	Goldblum, Micah, 0X
Ayhan, Bulent, 1J	Gribben, David, 1J
Bekit, Adam, 0A, 0P	Gross, Kevin C., 0V
Bichra, M., 0I	Guo, Youliang, 1U
Bonifazi, Giuseppe, 1S	Hagen, Leif, 16
Borghetti, Brett J., 0R, 0V	Hague, Emma J., 08, 1C
Breshike, Christopher J., 0K, 0Q	Halterman, Alexander Cheff, 0H
Broadwater, Joshua B., 04	Hill, Charles, 0H
Brown, Jarrod P., 06	Howells, C., 1R
Buchanan, S. Chase, 1F	Hu, Peter F., 1L, 1M
Budack, Norman, 0K	Hutyra, Lucy R., 0F
Budavari, Bence, 1J	Ibarra-Castaneda, C., 1X
Buleri, Christine, 0H	Illmann, Raik, 1I
Card, Darrell B., 06	Immel, Poppy G., 1D
Chang, Chein-I, 0A, 0P, 1L, 1M, 1O	Ito, Takaaki, 14
Chen, Shuhan, 1N, 1O	Ito, Tomonori, 14
Chou, Bryan, 16	Jansing, E. David, 04
Christiansen, Kevin P., 0W	Kamuda, Mark, 08
Churchill, Layne R., 0Z	Kapsin, Nathan, 0S
Conrad, Jessica, 0N	Kaufman, Jason R., 1H
Cordell, Christopher E., 0Z	Kavalerov, Ilya, 1B
Craig, Stephanie, 1F	Kellner, James R., 0G
Cushman, K. C., 0G	Kendziora, Christopher A., 0K, 0Q
Cusumano, Carl J., 1H	Kim, Y., 0Q
Czaja, Wojciech, 0X, 1B	Koperski, Krzysztof, 16
Damadeo, Robert, 0H	Krippner, Wolfgang, 1T
Del Valle, Sara, 0N	Kwan, Chimam, 16, 1J
Della Porta, Charles, 0A, 0P	Lambrakos, S. G., 0Q, 1R
Desai, Meera A., 1D	Lampe, Bernard, 0A, 0P
DeWitt, Kristin, 0J, 1A	Lei, L., 1X
Diaz, Carlos D., 1G	Li, Jiang, 16
Dittrich, P.-G., 0I	Li, Xiaorun, 1N, 1O
Dong, Chunhua, 09	Love, Steven P., 0O
Driggers, Ronald, 0Y	Macfarlane, Fraser, 19
Dupuis, Julia R., 1F	Maldague, X., 1X
Durell, Chris, 02	Manore, Carrie, 0N
Durkee, Nicholas, 03	Mansur, David, 1F
Fairchild, Geoffrey, 0N	Marciniak, Michael A., 1G
Feng, Zhenyuan, 1V	Marrs, Julia K., 0F
Fiorino, Steven, 18	Marshall, Stephen, 19
Fleuret, J., 1X	Martin, Jacob A., 0V

Mayo, T., 1R
 Mazzotti, Frank, 0Y
 McGill, R. Andrew, 0K, 0Q
 Meola, Joseph, 03, 17, 1H
 Messinger, David W., 11
 Metcalf, Jeremy P., 07
 Moody, Daniela I., 1D
 Moore, Eric T., 08, 1C
 Murchison, Luke, 0H
 Murphy, James M., 0S
 Murray, Paul, 19
 Naghedolfeizi, Masoud, 09
 Nakaya, Daiki, 14
 Nguyen, Viet, 0K
 Notni, Gunther, 0I, 1I
 Obland, Michael, 0H
 Olsen, Richard C., 07
 Parikh, Nidhi, 0N
 Perez, Daniel, 16
 Pfützenreuter, C., 0I
 Phenis, Adam, 0H
 Prussing, Keith F., 0Z
 Puente León, Fernando, 1T
 Radtke, L., 0I
 Rameau, J. D., 1F
 Ramsey, S., 1R
 Rankin, Blake M., 04
 Ratliff, Bradley M., 1H
 Refeld, Randall, 0N
 Ren, Christopher X., 15
 Resmini, Ronald G., 0W
 Rosenberger, Maik, 0I, 1I
 Saludez, Christian L., 06
 Satori, Shin, 14
 Serranti, Silvia, 1S
 Starra, S., 1X
 Shabaev, A., 0Q, 1R
 Shang, Xiaodi, 1L, 1M
 Shen, Yuzhong, 16
 Shiwa, Mitsuharu, 14
 Shrestha, Ashish, 05, 1W
 Siraj, Amir, 0N
 Skauli, Torbjørn, 0E
 Steward, Bryan J., 0R
 Stiehler, D., 0I
 Sun, Qiupeng, 1V
 Taufique, Abu Md Niamul, 1I
 Theiler, James, 0O, 15
 Thomas, Grant, 18
 Torkildsen, Hans Erling, 0E
 Turk, Johanna, 08, 1C
 Usamentiaga, R., 1X
 Vaca-Castano, Gonzalo, 0Y
 Valenta, Christopher R., 0Z
 Wagner, Michael C., 06
 Welsh, Chad M., 06
 Wenny, Brian, 05
 Westing, Nicholas M., 0V
 White, Henry, 19
 Wolfmeyer, Scott, 18
 Wurst, Nathan P., 17
 Xiang, Dan, 10
 Xiong, Xiaoxiong, 05, 1W
 Xue, Bai, 0A, 1L, 1M, 1O
 Yacoby, Shimshone, 0H
 Yang, Han, 1N
 Yoon, Yohan, 0K
 Yum, Honam, 10
 Zacharias, Anissa, 0Z
 Zeng, Xiangyan, 09
 Zhang, Junping, 1U, 1V
 Zhao, Liaoying, 1O
 Zhong, Shengwei, 1L, 1M, 1U, 1V
 Ziemann, Amanda, 0N, 15
 Zong, Yuqin, 0G

Conference Committee

Symposium Chairs

Jay Kumler, JENOPTIK Optical Systems, LLC (United States)
Ruth Moser, Air Force Research Laboratory (United States)

Symposium Co-chair

John Pellegrino, Electro-Optical Systems Laboratory, Georgia Institute of Technology (United States)

Conference Chairs

Miguel Velez-Reyes, The University of Texas at El Paso (United States)
David W. Messinger, Rochester Institute of Technology (United States)

Conference Program Committee

Wojciech Czaja, University of Maryland, College Park (United States)
Michael T. Eismann, Air Force Research Laboratory (United States)
Jacqueline J. Le Moigne, NASA Goddard Space Flight Center (United States)
Joseph Meola, Air Force Research Laboratory (United States)
Daniela I. Moody, Ursa Space Systems Inc. (United States)
Alan P. Schaum, U.S. Naval Research Laboratory (United States)
Torbjørn Skauli, Norwegian Defence Research Establishment (Norway)
James Theiler, Los Alamos National Laboratory (United States)
Grady Tuell, 3D Ideas, LLC (United States)
Alina Zare, University of Florida (United States)

Session Chairs

- 1 Hyperspectral Imaging Standards
 Miguel Velez-Reyes, The University of Texas at El Paso (United States)
- 2 LWIR and MWIR Spectral Sensing
 Joseph Meola, Air Force Research Laboratory (United States)
- 3 Classification and Dimensionality Reduction
 Alina Zare, University of Florida (United States)

- 4 Sensor Systems and Characterization
Torbjørn Skauli, Norwegian Defence Research Establishment
(Norway)
- 5 Chemical and Explosives Detection
James Theiler, Los Alamos National Laboratory (United States)
- 6 Models and Mathematical Methodologies
Jacqueline J. Le Moigne, NASA Goddard Space Flight Center
(United States)
- 7 Machine Learning in Spectral Sensing I
Wojciech Czaja, University of Maryland, College Park (United States)
- 8 Applications of Spectral Sensing
Michael T. Eismann, Air Force Research Laboratory (United States)
- 9 Target and Change Detection
Amanda K. Ziemann, Los Alamos National Laboratory (United States)
- 10 Machine Learning in Spectral Sensing II
Daniela I. Moody, Ursa Space Systems Inc. (United States)
- 11 Spectral Imaging
David W. Messinger, Rochester Institute of Technology (United States)

Introduction

This year marked the 25th edition of the SPIE conference Algorithms, Technologies, and Applications for Multispectral and Hyperspectral Imagery. This was a very important milestone for our community. The field of multispectral and hyperspectral imaging has grown enormously over the past 30 years and this conference has been one of its most important forums since 1994. On this 25d anniversary, we celebrated the contributions of those chairs who came before us: Dr. Sylvia S. Shen of The Aerospace Corporation (United States), Dr. Paul E. Lewis of the National Geospatial-Intelligence Agency (United States), Dr. Fred Kruse of the Naval Postgraduate Academy (United States), Dr. Michael R. Descour from The University of Arizona (United States), and Dr. A. Evan Iverson of SAIC (United States). Also, we are grateful to all of those who served on the Program Committee during those years.

The conference was established in 1994 with Dr. A. Evan Iverson as Conference Chair. He chaired until 1997. In 1997, Dr. Sylvia S. Shen became Conference Chair and led it until 2013. From 1998 to 2001, the conference was Co-chaired by Dr. Michael R. Descour, and from 2002 to 2013 by Dr. Paul E. Lewis. Under Sylvia and Paul's leadership, the conference experienced enormous growth and set the foundation for this outstanding conference. Dr. Fred Kruse co-chaired the conference with Dr. Miguel Velez-Reyes until 2015. Since 2015, Dr. Velez-Reyes and Dr. David W. Messinger have been the Co-chairs.

The conference originated in 1994 with 20 papers and over its 25 years, more than 1,400 papers have been published in the conference proceedings. This year's conference included 44 oral presentations from 11 organized sessions held 16–18 April 2019 and 14 papers in the Poster Session. A special session was held on 17 April to celebrate the 25th edition of the conference.

As we look forward to the next 25 years, it is our responsibility to continue the legacy of those who came before us and to keep this forum vibrant and relevant.

Miguel Velez-Reyes
David W. Messinger