PROCEEDINGS OF SPIE

# *Algorithms and Technologies for Multispectral, Hyperspectral, and Ultraspectral Imagery XVIII*

**Sylvia S. Shen**
**Paul E. Lewis**
*Editors*

**23–27 April 2012**
**Baltimore, Maryland, United States**

*Sponsored and Published by*
SPIE

**Volume 8390**

Proceedings of SPIE, 0277-786X, v. 8390



Algorithms and Technologies for Multispectral, Hyperspectral, and Ultraspectral Imagery XVIII,
edited by Sylvia S. Shen, Paul E. Lewis, Proc. of SPIE Vol. 8390, 839001 · © 2012 SPIE
CCC code: 0277-786X/12/$18 · doi: 10.1117/12.979120

The papers included 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. The papers published in these proceedings 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 this book:
Author(s), "Title of Paper," in *Algorithms and Technologies for Multispectral, Hyperspectral, and Ultraspectral Imagery XVIII*, edited by Sylvia S. Shen, Paul E. Lewis, Proceedings of SPIE Vol. 8390 (SPIE, Bellingham, WA, 2012) Article CID Number.

ISSN 0277-786X
ISBN 9780819490681

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



Printed in the United States of America.

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


SPIEDigitalLibrary.org

---

**Paper Numbering:** Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first 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, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four 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. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

# Contents

## Part One

**POSTER SESSION**

# Conference Committee

*Symposium Chair*

**Kevin P. Meiners,** Office of the Secretary of Defense (United States)

*Symposium Cochair*

**Kenneth R. Israel,** Lockheed Martin Corporation (United States)

*Conference Chairs*

**Sylvia S. Shen,** The Aerospace Corporation (United States)
**Paul E. Lewis,** National Geospatial-Intelligence Agency (United States)

*Program Committee*

**Gail P. Anderson,** Air Force Research Laboratory (United States)
**Hsiao-hua K. Burke,** MIT Lincoln Laboratory (United States)
**Chein-I Chang,** University of Maryland, Baltimore County (United States)
**Eustace L. Dereniak,** College of Optical Sciences, The University of Arizona (United States)
**Michael T. Eismann,** Air Force Research Laboratory (United States)
**Glenn E. Healey,** University of California, Irvine (United States)
**James R. Irons,** NASA Goddard Space Flight Center (United States)
**Fred A. Kruse,** Naval Postgraduate School (United States)
**Giovanni B. Marchisio,** DigitalGlobe, Inc (United States)
**David W. Messinger,** Rochester Institute of Technology (United States)
**Alan P. Schaum,** U.S. Naval Research Laboratory (United States)
**James Theiler,** Los Alamos National Laboratory (United States)
**Grady H. Tuell,** Georgia Tech Research Institute (United States)
**Miguel Velez-Reyes,** Universidad de Puerto Rico Mayagüez (United States)

*Session Chairs*

1 Detection, Identification, and Quantification I
**Sylvia S. Shen,** The Aerospace Corporation (United States)

2 Multisensor Data Fusion I
**Grady H. Tuell,** Georgia Tech Research Institute (United States)

# Introduction

This Proceedings of SPIE volume constitutes the 18th Annual Conference on Algorithms and Technologies for Multispectral, Hyperspectral, and Ultraspectral Imagery. The continuing objectives of this conference are to demonstrate the utility and to advance the capabilities of algorithms, sensors, and applications for multispectral, hyperspectral, and ultraspectral imagery by providing a forum for comprehensive insight into the field of spectral remote sensing. This conference endeavors to facilitate the exchange of information and new ideas amongst the community of spectral sensor system developers, automated processing system and algorithm developers, atmospheric phenomenology researchers, spectral data analysts, geo-spatial information researchers, and developers of specific commercial, civil, homeland security, environmental, and defense applications using remotely sensed spectral data.

The availability of high quality spectral data replete with sufficient and relevant "ground truth and metadata" information to be useful to the community mentioned above has always been a challenge. Informing this community on the availability of quality spectral data has always been a goal of this conference. During this year's conference, two papers were given depicting high quality data sets of which our conference attendees and readers of this Proceedings volume should be aware.

The first paper:

> IMAGESEER: images for science, education, experimentation and research: a NASA database of benchmark images for image processing teaching and research [8390-80]
> Jacqueline J. Le Moigne, Thomas G. Grubb, Barbara C. Milner, NASA Goddard Space Flight Center (United States)
>
> IMAGESEER is a new web portal that brings easy access to NASA image data for non-NASA researchers, educators, and students. It provides representative NASA image datasets, available in two easily readable formats, with associated reference benchmark data that enable teaching Image Processing (IP) techniques on NASA data, as well as provide reference benchmark data to validate new IP algorithms.
>
> Compared to other larger NASA data repositories, the IMAGESEER database is deliberately much smaller and focused in scope. Through a graphically-rich web site for browsing and downloading all of the selected datasets, benchmarks, and tutorials, IMAGESEER provides a widely accessible database of NASA-centric, easy to read, image data along with the following information: basic knowledge of the application domains, "truth

data" results (e.g., classification maps for image classification algorithms, transformation parameters for image registration algorithms, features locations for image analysis algorithms) and specific problems to be solved (or challenges), as defined by domain scientists.

The first prototype includes a representative sampling of NASA multispectral and hyperspectral images from several Earth Science instruments, along with a few small tutorials (also referred to as Imagepedia). Image processing techniques are currently represented with cloud detection, image registration, and map cover/classification. For each technique, corresponding data are selected from four different geographic regions, i.e., mountains (Colorado), urban (Los Angeles), water coastal (Chesapeake Bay), and agriculture (Illinois) areas. Satellite images have been collected from several instruments - Landsat-5 and -7 Thematic Mappers, Earth Observing -1 (EO-1) Advanced Land Imager (ALI) and Hyperion, and the Moderate Resolution Imaging Spectroradiometer (MODIS). After geo-registration, these images are available in simple common formats such as GeoTIFF and raw formats, along with associated benchmark data. These benchmarks or validation data include cloud cover masks and assessments, geo-registered scenes and classification maps from the National Land Cover Data (NLCD) database gathered in 1992 and 2001 by the Multi-Resolution Land Characteristics Consortium (MRLC).

Eventually, the database will include additional data from Earth Science, Planetary and Exploration Science, as well as additional challenges such as gap filling/in-painting, planetary-specific challenges such as crater and boulder detection and counting and mineralogy, and exploration-specific challenges such as obstacle avoidance and path planning. IMAGESEER is ideal for helping educators and students learn image processing techniques needed for and with actual NASA data and for helping researchers develop new algorithms or adapt existing algorithms to NASA data and challenges, therefore fostering collaboration between NASA and research organizations.

For more information, visit the IMAGESEER website at http://imageseer.nasa.gov

The second paper:

SpecTIR hyperspectral airborne Rochester experiment data collection campaign [8390-79]
Jared Herweg, John P. Kerekes, Rochester Institute of Technology (United States); Oliver Weatherbee, SpecTIR, LLC (United States); David Messinger, Jan van Aardt, Emmett Ientilucci, Zoran Ninkov, Carl Salvaggio, Nina G. Raqueño, Jason Faulring, Rochester Institute of Technology (United States); Joseph Meola, Air Force Research Lab. (United States)

In July of 2010, the Digital Imaging and Remote Sensing (DIRS) Laboratory at The Rochester Institute of Technology (RIT) conducted a coincident multi-modal imagery data collection campaign. With the help of SpecTIR LLC, Kucera International, and a host of people, the SpecTIR Hyperspectral Airborne Rochester Experiment (SHARE) was executed. SHARE contains data from an airborne hyperspectral imager, a laser detection and ranging (LiDAR) system, and a high resolution multi-spectral imaging system collected over the Rochester, New York area 26–29July 2010. The data supports nine simultaneous unique experiments, several of which leverage data from multiple modalities. In addition, the SHARE data collection should provide the remote sensing research community with a multi-modal data package resource suitable for additional uni- and multi-modal phenomenology studies. The data collection sites include the Genesee River, a portion of the city of Rochester, which is included as part of the Digital Imaging and Remote Sensing Image Generation (DIRSIG) Mega Scene 1, and the RIT campus itself. As such, open water, wetlands, and urban environments are included in SHARE data set. The data are hosted at http://dirs.cis.rit.edu/resources and are meant to be a community sharable resource, freely downloadable, for use in scientific inquiry.

We would like to take this opportunity to offer special thanks to Jacqueline J. Le Moigne et al and Jared Herweg et al for presenting this information at our conference, and to their respective organizations for making this data available to our community of spectral remote sensing researchers.

**Sylvia S. Shen**
**Paul E. Lewis**