

PROCEEDINGS OF SPIE

***Mathematics of Data/Image Pattern  
Coding, Compression, and  
Encryption with Applications XIII***

**Mark S. Schmalz  
Gerhard X. Ritter  
Junior Barrera  
Jaakko T. Astola**  
*Editors*

**21 and 24 August 2011  
San Diego, California, United States**

*Sponsored and Published by*  
SPIE

**Volume 8136**

Proceedings of SPIE, 0277-786X, v. 8136

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

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 *Mathematics of Data/Image Pattern Coding, Compression, and Encryption with Applications XIII*, edited by Mark S. Schmalz, Gerhard X. Ritter, Junior Barrera, Jaakko T. Astola, Proceedings of SPIE Vol. 8136 (SPIE, Bellingham, WA, 2011) Article CID Number.

ISSN 0277-786X  
ISBN 9780819487469

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 © 2011, 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/11/\$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

[SPIDigitalLibrary.org](http://SPIDigitalLibrary.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

v	<i>Conference Committee</i>
vii	<i>Introduction</i>

---

## SESSION 1 PATTERN RECOGNITION THEORY

---

- 8136 02 **Noise tolerant dendritic lattice associative memories** [8136-01]  
G. X. Ritter, M. S. Schmalz, E. Hayden, M. Tucker, Univ. of Florida (United States)
- 8136 03 **Algorithms for adaptive nonlinear pattern recognition** [8136-02]  
M. S. Schmalz, G. X. Ritter, E. Hayden, Univ. of Florida (United States); G. Key, Frontier Technology, Inc. (United States)
- 8136 04 **Massively parallel computation of lattice associative memory classifiers on multicore processors** [8136-03]  
G. X. Ritter, M. S. Schmalz, E. T. Hayden, Univ. of Florida (United States)
- 8136 05 **Fractal-based watermarking of color images** [8136-04]  
L. McLauchlan, Texas A&M Univ.-Kingsville (United States); M. Mehrübeoglu, Texas A&M Univ. Corpus Christi (United States)

---

## SESSION 2 ERROR MEASUREMENT AND ANALYSIS

---

- 8136 06 **The optimum discrete scan-type approximation of low-pass type signals bounded by a measure like Kullback-Leibler divergence** [8136-05]  
Y. Kida, Ohu Univ. (Japan); T. Kida, Tokyo Institute of Technology (Japan)
- 8136 07 **Extension of the concept of multi-legged-type signals to the optimum multidimensional running approximation of multidimensional band-limited signals** [8136-06]  
Y. Kida, Ohu Univ. (Japan); T. Kida, Tokyo Institute of Technology (Japan)
- 8136 08 **Limited-photon 3D image recognition using photon-counting integral imaging** [8136-11]  
C. M. Do, Univ. of Connecticut (United States)

---

## SESSION 3 IMAGING THEORY I: MODELING

---

- 8136 09 **Aligning images with CAD models via quaternion optimization** [8136-08]  
P. F. Stiller, Texas A&M Univ. (United States)
- 8136 0A **The optimum approximation of multidimensional vector signals by multi-input multi-output matrix filter banks** [8136-09]  
Y. Kida, Ohu Univ. (Japan); T. Kida, Tokyo Institute of Technology (Japan)

- 8136 0B **The optimum running approximation of band-limited signals based on new concept of multi-legged-type signals in a hyper domain** [8136-10]  
Y. Kida, Ohu Univ. (Japan); T. Kida, Tokyo Institute of Technology (Japan)
- 8136 0C **3D model-based still image object categorization** [8136-23]  
R.-D. Petre, T. Zaharia, Institut Télécom (France) and MAP5, CNRS, Univ. Paris Descartes (France)

---

**SESSION 4 IMAGING THEORY II: WITH APPLICATIONS**

---

- 8136 0D **Multidimensional feature extraction from 3D hyperspectral images** [8136-21]  
M. Mehrubeoglu, Texas A&M Univ. Corpus Christi (United States); L. McLauchlan, Texas A&M Univ.-Kingsville (United States)
- 8136 0E **Interactive region-based retrieval** [8136-22]  
A. Bursuc, T. Zaharia, Institut Télécom (France) and MAP5, CNRS, Univ. Paris Descartes (France); F. Prêteux, Mines ParisTech (France)
- 8136 0F **Optimizing feature extraction in image analysis using experimented designs: a case study evaluating texture algorithms for describing appearance retention in carpets** [8136-13]  
S. A. Orjuela, Univ. Gent (Belgium) and Antonio Nariño Univ. (Colombia); R. A. Quinones, B. Ortiz-Jaramillo, F. Rooms, R. De Keyser, W. Philips, Univ. Gent (Belgium)
- 8136 0H **Edge pattern analysis for edge detection and localization** [8136-14]  
B. Jiang, National Institute of Aerospace (United States)

---

**POSTER SESSION**

---

- 8136 0J **A comparative test of different compression methods applied to solar images** [8136-16]  
D. Del Moro, Univ. degli Studi di Roma Tor Vergata (Italy); E. Pietropaolo, Univ. degli Studi dell'Aquila (Italy); F. Giannattasio, F. Berrilli, Univ. degli Studi di Roma Tor Vergata (Italy)
- 8136 0K **The research on pattern recognition in distributed fiber vibrant sensor system** [8136-18]  
H. Wu, D. Zhao, Fudan Univ. (China); H. Xu, HoHai Univ. (China)
- 8136 0L **Image analysis and pattern recognition for the localization of medical devices in the operational field** [8136-19]  
P. Chirco, M. Zanarini, SOFTEC Technology & Research (Italy)

*Author Index*

# Conference Committee

## *Program Track Chair*

**Khan M. Iffekharuddin**, The University of Memphis (United States)

## *Conference Chairs*

**Mark S. Schmalz**, University of Florida (United States)

**Gerhard X. Ritter**, University of Florida (United States)

**Junior Barrera**, Universidade de São Paulo (Brazil)

**Jaakko T. Astola**, Tampere University of Technology (Finland)

## *Program Committee*

**Stefano Baronti**, Istituto di Fisica Applicata Nello Carrara (Italy)

**Mark L. Fowler**, Binghamton University (United States)

**Victoria T. Franques**, U.S. Department of Energy (United States)

**Andrea Garzelli**, Università degli Studi di Siena (Italy)

**Abdelsalam Sumi Helal**, University of Florida (United States)

**Lifford McLaughlan**, Texas A&M University-Kingsville (United States)

**Mehrube Mehrübeoglu**, Texas A&M University Corpus Christi  
(United States)

**Daniel S. Myers**, Sandia National Laboratories (United States)

**James F. Scholl**, Hnu Photonics (United States)

## *Session Chairs*

- 1 Pattern Recognition Theory  
**Peter F. Stiller**, Texas A&M University (United States)
- 2 Error Measurement and Analysis  
**Mark S. Schmalz**, University of Florida (United States)
- 3 Imaging Theory I: Modeling  
**Mark S. Schmalz**, University of Florida (United States)
- 4 Imaging Theory II: with Applications  
**Yuichi Kida**, Ohu University (Japan)



## Introduction

Image compression, encryption, and pattern recognition are emerging as crucial supporting technologies for numerous applications in fields as diverse as military imaging, medical technology, video transmission and gaming, and generative multimedia. Image compression is directed toward decreasing data burden, thus increasing storage efficiency, as well as supporting increases in effective communication channel bandwidth and data security. Applications considered in this conference include remote sensing, Internet delivery of still imagery and video, as well as storage, retrieval, and processing of medical, military, or environmental image processing. Increasingly, image compression is being used to precondition data prior to processing – a wide range of research has addressed the benefits of developing special compression transforms that extract key object features from compressed sensor datastreams.

Researchers are focusing, in general, on the quantification of error in compression and, in particular, error in decompressed imagery. One example is the development of theory for successive approximations that support iterative or recursive representation of imaging data and partitioning of remote sensing datacubes into spectral regions and features of mission-specific interest. Although numerous subjective (e.g., perceptual) measures have been developed for assessing image quality in decompressed imagery, few measures objectively address non-perceptual problems such as local (e.g., feature-specific) distortion in objects or classes of objects typically present in medical or military images. Additional problems in image and video quality measures include correspondence with human evaluations of image quality, as well as the effect of compression error on pattern classification, for example, in medical imaging, military target recognition, or security applications that integrate compression and digital watermarking.

This conference on the mathematics of data and image pattern recognition, compression, and encryption addresses theory, design, analysis, and testing of pattern recognition, compression, and encryption (e.g., watermarking) algorithms. In response to conference presenters' and attendees' requests in this and previous years, we continue to emphasize security, watermarking, and theory/practice of error analysis and measurement, in the context of higher-level processes such as pattern classification. Example applications include pattern recognition in high noise and clutter, as well as survivable watermarks. Thus, the first session of this conference addresses several theoretical issues in pattern recognition, in particular, emerging types of neural networks that perform accurately in high noise and clutter.

The second session continues the previous year's theme of error analysis, with models for information-theoretic analysis of recursive filters, and analysis of multidimensional band-limited signals.

The third and fourth sessions address imaging theory, emphasizing techniques for successive approximation applied to model-based image understanding, and 3D object recognition from CAD models. Multidimensional feature extraction and edge pattern analysis are also featured applications.

The poster session addresses the application of compression and pattern recognition to solar imaging and distributed sensor systems, with medical sensors as an illustrative application.

Throughout its 14-year history, this conference has successfully convened numerous scientific researchers from international institutions to discuss development of theory, analysis, and test technology for data/image pattern recognition, segmentation, understanding, compression, coding, and encryption. However, much research remains in the basic mathematical nature, characterization, and performance analysis of pattern recognition and compression algorithms. For example, how can data semantics facilitate analysis and compression of digital imagery? How can we structure our compression and pattern recognition algorithms to combine adaptive learning approaches with adaptive segmentation techniques? A continuing topic of interest is the merging of compression and pattern recognition to facilitate eventual successes in image understanding.

The next conference in this series will take place at SPIE Optics+Photonics in 2013. It will continue the topical focus of this conference, extending the area of pattern recognition to further analyze semantics of audio and video signals, as well as placing emphasis upon error analysis in the survivability of watermarking. The continued emphasis on theory and algorithms for data security will motivate engineers, scientists, and algorithm designers to investigate new areas of compression, coding, and encryption technologies. Further emphasis will be directed toward theory and algorithms that support exploitation of compressed digital signals and imagery from sensor networks. Sensing and processing using compressed hyperspectral datastreams are planned topics for our 2013 conference. We also plan to continue emphasizing error analysis and performance metrics for compression, computation, and image/video perception, with illustrative examples in military, law enforcement, medical, environmental, and commercial imagery and video.

**Mark S. Schmalz**  
**Gerhard X. Ritter**  
**Junior Barrera**  
**Jaakko T. Astola**