

PROCEEDINGS OF SPIE

# ***MIPPR 2015: Multispectral Image Acquisition, Processing, and Analysis***

**Zhiguo Cao**  
**Jayaram K. Udupa**  
**Henri Maître**  
*Editors*

**31 October–1 November 2015**  
**Enshi, China**

*Organized by*  
Huazhong University of Science and Technology (China)  
Hubei University for Nationalities (China)

*Sponsored by*  
National Key Laboratory of Science and Technology on Multi-spectral Information Processing  
(China)  
Huazhong University of Science and Technology (China)  
Hubei University for Nationalities (China)  
Hubei Association of Automation (China)

*Published by*  
SPIE

**Volume 9811**

Proceedings of SPIE 0277-786X, V. 9811

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

MIPPR 2015: Multispectral Image Acquisition, Processing, and Analysis, edited by Zhiguo Cao,  
Jayaram K. Udupa, Henri Maître, Proc. of SPIE Vol. 9811, 981101 · © 2015 SPIE  
CCC code: 0277-786X/15/\$18 · doi: 10.1117/12.2230199

Proc. of SPIE Vol. 9811 981101-1

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](http://SPIDigitalLibrary.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 *MIPPR 2015: Multispectral Image Acquisition, Processing, and Analysis*, edited by Zhiguo Cao, Jayaram K. Udupa, Henri Maître, Proceedings of SPIE Vol. 9811 (SPIE, Bellingham, WA, 2015) Six-digit Article CID Number.

ISSN: 0277-786X  
ISSN: 1996-756X (electronic)  
ISBN: 9781510600522

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](http://SPIE.org)

Copyright © 2015, 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/15/\$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. 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 six-digit CID article numbering system structured as follows:

- 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.

# Contents

- vii *Authors*
- ix *Symposium Committee*
- xiii *Introduction*

---

## MULTISPECTRAL IMAGE ACQUISITION

---

- 9811 02 **A liquid crystal microlens array with aluminum and graphene electrodes for plenoptic imaging [9811-101]**
- 9811 03 **Surface plasmonic lightening characteristics through liquid crystal microlens arrays controlled electrically [9811-115]**
- 9811 04 **A mission-oriented orbit design method of remote sensing satellite for region monitoring mission based on evolutionary algorithm [9811-109]**
- 9811 05 **Planar micro-nano-coils for electrically driving liquid crystal microlenses based on wireless power transmission [9811-105]**
- 9811 06 **Surface plasmon polaritons excited over sub-wavelength aluminum structures by terahertz radiation [9811-102]**
- 9811 07 **An arrayed infrared filter based on liquid crystal Fabry-Perot effect for electrically tunable spectral imaging detection [9811-106]**
- 9811 08 **Dual-mode liquid crystal microlens arrays [9811-113]**
- 9811 09 **Graphene-based liquid crystal microlens arrays [9811-110]**
- 9811 0A **Simulation of the emission properties of patterned metal-based nanostructures [9811-108]**
- 9811 0B **Double layers liquid-crystal microlens arrays used in optical switches [9811-112]**
- 9811 0C **Spectral image reconstruction through the PCA transform [9811-103]**
- 9811 0D **ISAR imaging based on sparse subbands fusion [9811-120]**
- 9811 0E **A method for reducing the sidelobes in superoscillation imaging [9811-125]**

---

## MULTISPECTRAL IMAGE PROCESSING AND ANALYSIS

---

- 9811 0F **A review of image quality assessment methods with application to computational photography (Invited Paper) [9811-23]**
- 9811 0G **Specifics of processing SRS lidar signals in GHz frequency range [9811-67]**

- 9811 OH **An approach for hyperspectral image classification utilization spatial-spectral combined kernel SVM** [9811-2]
- 9811 OI **Research on LASIS interferogram processing** [9811-46]
- 9811 OJ **A novel feature point matching method of remote sensing images** [9811-17]
- 9811 OK **Image denoising by principal basis analysis** [9811-29]
- 9811 OL **Blind estimation of affine transformation using 2D cyclostationarity of resampled images** [9811-27]
- 9811 OM **Weak edge enhancement based on contextual modulation of non-classical receptive field** [9811-26]
- 9811 ON **TS-MRF sonar image segmentation based on the levels feature information** [9811-3]
- 9811 OO **A new method for mobile phone image denoising** [9811-4]
- 9811 OP **Genetic-algorithm-based image binarization approach and its quantitative evaluation via pooling** [9811-16]
- 9811 OQ **Weighted least-squares algorithm for phase unwrapping based on confidence level in frequency domain** [9811-38]
- 9811 OR **Classification of PolSAR image based on quotient space theory** [9811-42]
- 9811 OS **Hardware architecture design of a fast global motion estimation method** [9811-40]
- 9811 OT **Hologram production and representation for corrected image** [9811-54]
- 9811 OU **Hidden refresh scheme for dual-port gain cell eDRAM** [9811-43]
- 9811 OV **The design and implementation of signal decomposition system of CL multi-wavelet transform based on DSP builder** [9811-15]
- 9811 OW **FPGA design and implementation of Gaussian filter** [9811-7]
- 9811 OX **Research based on the SoPC platform of feature-based image registration** [9811-25]
- 9811 OY **High capacity image steganography method based on framelet and compressive sensing** [9811-21]
- 9811 OZ **Object detection in side scan sonar** [9811-24]
- 9811 10 **Study on classification of pork quality using hyperspectral imaging technique** [9811-41]
- 9811 11 **A content-based digital audio watermarking algorithm** [9811-51]
- 9811 12 **Evaluation of multiple and multiscale morphological profiles on the classification of hyperspectral image** [9811-28]

- 9811 13 **Pixel gray value correction for wide angle view image** [9811-5]
- 9811 14 **The application of residential distribution monitoring based on GF-1 images** [9811-39]
- 9811 15 **A quasi-rigorous model based on improved ICP algorithm in the application of auto-calibration of airborne LiDAR system** [9811-56]
- 9811 16 **Video conference quality assessment based on cooperative sensing of video and audio** [9811-57]
- 9811 17 **A case study on the urban impervious surface distribution based on a BCI index** [9811-58]
- 9811 18 **Multispectral image filtering method based on image fusion** [9811-59]
- 9811 19 **A robust digital watermarking algorithm based on framelet and SVD** [9811-60]
- 9811 1A **Research on temporal features of LEMP based on Laplace wavelet in time and frequency domain** [9811-66]
- 9811 1B **The fractional energy spectrum integral of the fractional Fourier transform of chirp signal** [9811-72]
- 9811 1C **Ambiguity noise analysis of a SAR system** [9811-77]
- 9811 1D **Automatic human micro-Doppler signature separation by Hough transform** [9811-80]
- 9811 1E **Efficient simulation for fixed-receiver bistatic SAR with time and frequency synchronization errors** [9811-85]



## Authors

Numbers in the index correspond to the last two digits of the six-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first four 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.

Ai, Qing, 1A  
An, Zhihui, 0R  
Bai, Jun, 10  
Cai, Chao, 0M  
Cao, XiaoWang, 12  
Chang, Wenge, 1C, 1E  
Chen, Cheng, 05, 09  
Chen, Jialin, 16  
Chen, Wei, 18  
Chen, Xiaolin, 17  
Chen, Yanping, 0H  
Chen, Yao, 0Z  
Chen, Zengping, 0D, 1B  
Cheng, Binbin, 0Z  
Cheng, Wang, 0I  
Cong, Yangming, 0C  
Cui, Yan, 14  
Elizarov, V. V., 0G  
Fan, Di, 08, 0B  
Fan, Jun, 0Q  
Gao, Shihong, 1A  
Grishkanich, A. S., 0G  
Gui, Yuanmiao, 0H  
He, Zhibiao, 0Y, 19  
Hu, Huijun, 0P  
Hu, Wei, 05, 08, 09  
Huang, He, 14  
Huang, Yan, 0V  
Huo, Yingdong, 0E  
Jiang, San, 15  
Jiao, Gui Chao, 0T  
Jiao, Shuai, 0Q, 0R  
Jin, Lianghai, 0O  
Jin, Min, 0O  
Jin, Tian, 1D  
Jing, Juanjuan, 0I  
Kascheev, S. V., 0G  
Lei, Bangjun, 0N  
Lei, Yu, 02, 05, 06, 07, 08, 09, 0A, 0B  
Li, Gang, 0D  
Li, Lelin, 15  
Li, Qin, 1A  
Li, Suju, 14  
Li, Weijun, 06, 0A  
Li, Xiang, 0O  
Li, Xiangyang, 1C, 1E  
Liang, Chaobing, 0S  
Lin, Jiuning, 07  
Liu, Boqi, 13  
Liu, Cheng-Guang, 0K  
Liu, Limin, 0R  
Liu, Maofu, 0P  
Liu, Ming, 14  
Liu, Xiaomei, 0N  
Liu, Xiaomeng, 0R  
Liu, Ya, 0P  
Liu, Yunchuan, 0E  
Luo, Jun, 02, 05, 06, 07, 08, 09, 0A, 0B  
Ma, Long, 0C  
Maître, Henri, 0F  
Ni, Jiangqun, 0L  
Niu, Hanben, 0E  
Ou, Junhai, 0L  
Peng, Sha, 0A  
Qiu, Lei, 1D  
Qiu, Xuwei, 0C  
Quan, Tingwei, 19  
Sang, Cheng-Wei, 0K  
Sang, Hongshi, 02, 05, 07, 08, 09, 0A, 0S, 0U  
Shen, Xin, 04  
Shen, Xubang, 0S, 0U  
Shi, Yue-dong, 0X  
Sidorov, I. S., 0G  
Su, Xue Mei, 0T  
Su, Shaoying, 1B  
Sun, Bingyun, 0H  
Sun, Genyun, 17  
Sun, Hong, 0K  
Tang, Qingle, 03  
Tian, Biao, 0D  
Tian, Haishan, 1C  
Tian, Xin, 16  
Tong, Qing, 02, 05, 06, 07, 08, 09, 0A, 0B  
Wan, Yanyan, 0Q  
Wang, Cheng, 08, 0B  
Wang, Fubei, 0I  
Wang, Haibin, 10  
Wang, Hailei, 0H  
Wang, Han, 0J  
Wang, Jinzhen, 1B  
Wang, Junxi, 16  
Wang, Leiguang, 12  
Wang, Shaohua, 0Q, 0R  
Wang, ShaoJun, 0J  
Wang, Wen, 0U  
Wang, Wenwu, 0Z  
Wang, Zhenjie, 17  
Wang, Zhihui, 0V, 0X

Wu, Qiongshui, 0I  
Wu, Tao, 0N  
Wu, Wei, 14  
Wu, Xuelian, 0H  
Wu, Yong, 09  
Xia, Ping, 0N  
Xiao, Jie, 0M  
Xiao, Moyan, 0Y, 19  
Xie, Changsheng, 02, 05, 06, 07, 08, 09, 0A, 0B  
Xu, Shiyu, 0D  
Xu, Wen Li, 11  
Xu, Xiangyang, 0O  
Xu, Yuanquan, 0J  
Yan, Feifei, 1E  
Yang, Cankun, 0Q  
Yang, Zhihui, 0W  
Yao, Huang, 04  
Ye, Lu, 16  
Yu, Jie, 0Q, 0R  
Yuan, Ying, 06  
Zeng, Shan, 10  
Zhang, Bo, 0B  
Zhang, Jing, 04  
Zhang, Jun, 1D  
Zhang, Liping, 11  
Zhang, Rui, 0T  
Zhang, Wei, 18  
Zhang, Xinyu, 02, 05, 06, 07, 08, 09, 0A, 0B  
Zhang, Xiuhua, 13  
Zhang, Xubing, 0J  
Zhao, Wenfei, 12  
Zhao, Yi, 11  
Zhevlakov, A. P., 0G  
Zhong, Jianwei, 1A  
Zhou, Cheng, 16  
Zhou, Dongbo, 0H  
Zhou, Feng, 13  
Zhou, Gang, 0W  
Zhou, Jinsong, 0I  
Zhou, Zheng, 16  
Zhou, Zhimin, 1D  
Zou, Jiangwei, 1B  
Zhu, Teng, 0R  
Zhu, Yaping, 06, 0A

# Symposium Committee

## *Symposium Chairs*

**M. V. Srinivasan**, The University of Queensland (Australia)  
**Deren Li**, Wuhan University (China)

## *Symposium Honorary Chair*

**Bo Zhang**, Tsinghua University (China)

## *Session Chairs*

- 1 Pattern Recognition and Computer Vision  
**Qiang Li**, The University of Chicago (United States)
- 2 Automatic Target Recognition and Navigation  
**Hanyu Hong**, Wuhan Institute of Technology (China)
- 3 Remote Sensing Image Processing and Geographic Information Systems  
**Weichao Xu**, Guangdong University of Technology (China)
- 4 Multispectral Image Processing and Analysis & Multispectral Image Acquisition  
**Jiangqun Ni**, Sun Yat-sen University (China)
- 5 Pattern Recognition and Computer Vision & Parallel Processing of Images and Optimization Techniques & Medical Imaging and Processing  
**J. K. Udupa**, University of Pennsylvania (United States)
- 6 Pattern Recognition and Computer Vision  
**Bir Bhanu**, University of California, Riverside (United States)
- 7 Remote Sensing Image Processing and Geographic Information Systems  
**Bruce Hirsch**, Drexel University (United States)
- 8 Other Applications  
**Irwin King**, The Chinese University of Hong Kong (Hong Kong China)

*Program Committee*

**Christian Bauckhage**, Fraunhofer IAIS (Germany)  
**Bir Bhanu**, University of California, Riverside (United States)  
**Zhiguo Cao**, Huazhong University of Science and Technology (China)  
**Chunqi Chang**, Shenzhen University (China)  
**C. H. Chen**, University of Massachusetts Dartmouth (United States)  
**Xinjian Chen**, Soochow University (China)  
**Jinkui Chu**, Dalian University of Technology (China)  
**Melba M. Crawford**, Purdue University (United States)  
**Armin B. Cremers**, Universität Bonn (Germany)  
**Mingyue Ding**, Huazhong University of Science and Technology (China)  
**Jufu Feng**, Beijing University (China)  
**Aaron Fenster**, The University of Western Ontario (Canada)  
**Wei Guo**, Hebei Normal University (China)  
**Bruce Hirsch**, Drexel University (United States)  
**Xinhan Huang**, Huazhong University of Science and Technology (China)  
**Horace H. S. Ip**, City University of Hong Kong (Hong Kong China)  
**Jun Jo**, Griffith University (Australia)  
**Irwin King**, The Chinese University of Hong Kong (Hong Kong China)  
**Lihua Li**, Hangzhou Dianzi University (China)  
**Deren Li**, Wuhan University (China)  
**Xuelong Li**, University of London (United Kingdom)  
**Qiang Li**, The University of Chicago (United States)  
**Stan Z. Li**, Chinese Academy of Sciences (China)  
**Xingde Li**, Johns Hopkins University (United States)  
**Jianguo Liu**, Huazhong University of Science and Technology (China)  
**Qinghuo Liu**, Institute of Automation (China)  
**Hanqing Lu**, Institute of Automation (China)  
**Henri Maître**, Télécom ParisTech (France)  
**Jiangqun Ni**, Sun Yat-sen University (China)  
**Laszlo Nyul**, University of Szeged (Hungary)  
**Jonathan Roberts**, Commonwealth Scientific and Industrial Research Organisation (Australia)  
**Punam K. Saha**, The University of Iowa (United States)  
**Nong Sang**, Huazhong University of Science and Technology (China)  
**Xubang Shen**, Chinese Academy of Sciences (China)  
**M. V. Srinivasan**, The University of Queensland (Australia)  
**Hong Sun**, Wuhan University (China)  
**Katarina Svanberg**, Lund University (Sweden)  
**Jianjun Tan**, Hubei University for Nationalities (China)  
**Dacheng Tao**, Nanyang Technological University (Singapore)  
**Hengqing Tong**, Wuhan University of Technology (China)  
**J. K. Udupa**, University of Pennsylvania (United States)  
**Jinxue Wang**, SPIE  
**Baoming Wu**, Third Military Medical University (China)  
**Weichao Xu**, Guangdong University of Technology (China)  
**Pingkun Yan**, Philips Research North America (United States)  
**Yuan Yuan**, Aston University (United Kingdom)

**Liangpei Zhang**, Wuhan University (China)  
**Jun Zhang**, Waseda University (Japan)  
**Qieshi Zhang**, Waseda University (Japan)  
**Tianxu Zhang**, Huazhong University of Science and Technology (China)  
**Kaichun Zhao**, Tsinghua University (China)  
**Sheng Zheng**, China Three Gorges University (China)  
**Yanfei Zhong**, Wuhan University (China)  
**Jie Zhou**, Tsinghua University (China)

*Organizing Committee Chair*

**Jianguo Liu**, Huazhong University of Science and Technology (China)

*Co-organizing Committee Chairs*

**Jinxue Wang**, SPIE  
**Jianjun Tan**, Hubei University for Nationalities (China)

*General Secretary*

**Faxiong Zhang**, Huazhong University of Science and Technology (China)

*Associated General Secretaries*

**Yongdan Zhu**, Hubei University for Nationalities (China)  
**Lulu Yuan**, Huazhong University of Science and Technology (China)

*Secretaries*

**Cheng Zhang, Yufeng Huang, Bin Zhu, Fuyao Ling, Bo Huang, Jieyu Li, Mengzhou Ma, Li Cao, Fan Liu, Yang Huang, Wei Jiang**, Huazhong University of Science and Technology (China)



# Introduction

Welcome to proceedings from the 9th International Symposium on Multispectral Image Processing and Pattern Recognition (MIPPR 2015), which was held in Enshi, Hubei, China, 31 October to 1 November 2015.

MIPPR 2015 is a biennial symposium which focuses mainly on the latest research in multispectral image processing and pattern recognition. The symposium had a broad charter. Multispectral was interpreted as not just multiple-wavelength in a narrow sense but also multi-sensor, multi-modal, and multimedia. The symposium covered many disciplines such as sensing, image processing, computer vision, and pattern recognition and involved the development of efficient processing algorithms and their optimization and implementation. The wide range of applications considered included automatic target recognition, autonomous navigation, medical image processing, remote sensing, geographic information systems, and many others.

The symposium provided a forum for scientists, professors, engineers, and graduate students from universities, industries, and government laboratories to meet and exchange ideas and discuss theories, techniques, algorithms, and applications in multispectral image processing and pattern recognition. As expected, there were ample discussions both inside and outside the lecture halls, and it was an exciting meeting.

In response to our call for papers, we received 326 submissions. Based on the reviews provided by an excellent program committee we accepted 245 papers covering many aspects of multispectral image processing and pattern recognition. To ensure a high-quality conference, all abstracts and proceedings of SPIE manuscripts were reviewed by peers for technical merit and English expression. The proceedings from MIPPR 2015 consist of the following five volumes, which are all included in the SPIE Digital Library:

- *MIPPR 2015: Multispectral Image Acquisition, Processing, and Analysis (SPIE Volume 9811)*
- *MIPPR 2015: Automatic Target Recognition and Navigation (SPIE Volume 9812)*
- *MIPPR 2015: Pattern Recognition and Computer Vision (SPIE Volume 9813)*
- *MIPPR 2015: Parallel Processing of Images and Optimization; and Medical Imaging Processing (SPIE Volume 9814)*
- *MIPPR 2015: Remote Sensing Image Processing, Geographic Information Systems; and Other Applications (SPIE Volume 9815).*

The realization of a conference depends upon the hard work of many dedicated people. We thank all the members of the organizing committee who put together

MIPPR 2015 for the benefit of all the researchers and for making this conference a success. We hope the papers and the research results presented at this symposium will inspire new research in all the areas related to multispectral image processing and pattern recognition.

**Bir Bhanu**