

PROCEEDINGS



Sensors, Cameras, and Systems for Industrial and Scientific Applications XIV

**Ralf Widenhorn
Antoine Dupret**
Editors

**6–7 February 2013
Burlingame, California, United States**

Sponsored by
IS&T—The Society for Imaging Science and Technology
SPIE

Cosponsored by
Qualcomm Inc. (United States)

Published by
SPIE

Volume 8659

Proceedings of SPIE 0277-786X, V.8659

Sensors, Cameras, and Systems for Industrial and Scientific Applications XIV, edited by
Ralf Widenhorn, Antoine Dupret, Proc. of SPIE-IS&T Electronic Imaging, SPIE Vol. 8659,
865901 · © 2013 SPIE · CCC code: 0277-786X/13/\$18 · doi: 10.1117/12.2024906

Proc. of SPIE Vol. 8659 865901-1

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 publishers are 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 *Sensors, Cameras, and Systems for Industrial and Scientific Applications XIV*, edited by Ralf Widenhorn, Antoine Dupret, Proceedings of SPIE-IS&T Electronic Imaging, SPIE Vol. 8659. Article CID Number (2013)

ISSN: 0277-786X

ISBN: 9780819494320

Copublished 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

and

IS&T—The Society for Imaging Science and Technology

7003 Kilworth Lane, Springfield, Virginia, 22151 USA

Telephone +1 703 642 9090 (Eastern Time) · Fax +1 703 642 9094

imaging.org

Copyright © 2013, Society of Photo-Optical Instrumentation Engineers and The Society for Imaging Science and Technology.

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 the publishers 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/13/\$18.00.

Printed in the United States of America.

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

vii *Conference Committee*

SESSION 1

- 8659 02 **Fundamental performance differences of CMOS and CCD imagers: part V** [8659-1]
J. R. Janesick, T. Elliott, J. Andrews, J. Tower, J. Pinter, SRI International Sarnoff (United States)
- 8659 03 **Kirana: a solid state megapixel uCMOS image sensor for ultra-high speed imaging** [8659-2]
J. Crooks, B. Marsh, R. Turchetta, Rutherford Appleton Lab. (United Kingdom); K. Taylor, W. Chan, Specialised Imaging Ltd. (United Kingdom); A. Lahav, A. Fenigstein, Tower Semiconductor, Ltd. (Israel)
- 8659 04 **Back-side-illuminated image sensor with burst capturing speed of 5.2 Tpixel per second** [8659-3]
T. Arai, J. Yonai, T. Hayashida, H. Ohtake, NHK Science & Technical Research Labs. (Japan); H. van Kuijk, Teledyne DALSA (Netherlands); T. G. Etoh, Ritsumeikan Univ. (Japan)

SMART SENSORS

- 8659 05 **A custom CMOS imager for multi-beam laser scanning microscopy and an improvement of scanning speed** [8659-4]
M.-W. Seo, K. Kagawa, K. Yasutomi, S. Kawahito, Shizuoka Univ. (Japan)
- 8659 06 **An ultrafast ultracompact sensor for diffuse wave spectroscopy** [8659-5]
K. Barjean, D. Ertori, E. Tinet, Lab. de Physique des Lasers, CNRS, Univ. Paris 13 (France); A. Dupret, CEA-LETI MINATEC (France); M. Vasiliu, Institut d'Electronique Fondamentale, CNRS, Univ. Paris-Sud 11 (France); J.-M. Tualle, Lab. de Physique des Lasers, CNRS, Univ. Paris 13 (France)
- 8659 07 **A 3D image sensor with adaptable charge subtraction scheme for background light suppression** [8659-6]
J. Shin, B. Kang, K. Lee, J. D. K. Kim, Samsung Advanced Institute of Technology (Korea, Republic of)
- 8659 08 **High performance 7.4-micron interline transfer CCD platform for applied imaging markets** [8659-7]
D. A. Carpenter, J. A. DiBella, R. Kaser, B. Kecskemety, S. L. Kosman, J. P. McCarten, C. Parks, Truesense Imaging, Inc. (United States)

HIGH-PERFORMANCE SENSORS

- 8659 09 **A 33M-pixel wide color gamut image capturing system using four CMOS image sensors at 120 Hz** [8659-8]
T. Soeno, NHK Science & Technical Research Labs. (Japan); K. Omura, NHK Engineering Services, Inc. (Japan); T. Yamashita, R. Funatsu, M. Sugawara, M. Okui, NHK Science & Technical Research Labs. (Japan)
- 8659 0A **A 3Mpixel ROIC with 10 μ m pixel pitch and 120Hz frame rate digital output** [8659-9]
E. Ilan, N. Shiloah, S. Elkind, R. Dobromislin, W. Freiman, A. Zviagintsev, I. Nevo, O. Cohen, F. Khinich, A. Adin, R. Talmor, Y. Milstain, SCD Semiconductor Devices (Israel)
- 8659 0B **Dynamic capability of sensors with nonlinear pixels utilized by security cameras** [8659-11]
A. Johannesson, H. Eliasson, S. Fors, Axis Communications AB (Sweden)

NOISE AND CHARACTERIZATION

- 8659 0C **Empirical formula for rates of hot pixel defects based on pixel size, sensor area, and ISO** [8659-13]
G. H. Chapman, R. Thomas, Simon Fraser Univ. (Canada); Z. Koren, I. Koren, Univ. of Massachusetts, Amherst (United States)
- 8659 0D **A statistical evaluation of low frequency noise of in-pixel source follower-equivalent transistors with various channel types and body bias** [8659-14]
R. Kuroda, A. Yonezawa, A. Teramoto, T.-L. Li, Y. Tochigi, S. Sugawa, Tohoku Univ. (Japan)
- 8659 0E **New analog readout architecture for low noise CMOS image sensors using column-parallel forward noise-canceling circuitry** [8659-15]
T. -L. Li, Y. Goda, S. Wakashima, R. Kuroda, S. Sugawa, Tohoku Univ. (Japan)
- 8659 0F **A novel pixel design with hybrid type isolation scheme for low dark current in CMOS image sensor** [8659-16]
S. H. Choi, Sungkyunkwan Univ. (Korea, Republic of) and SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Y. T. Kim, M. S. Oh, Y. H. Park, J. J. Cho, Y. H. Jang, H. J. Han, J. W. Choi, H. W. Park, S. I. Jung, H. S. Oh, J. C. Ahn, H. Goto, C. Y. Choi, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Y. Roh, Sungkyunkwan Univ. (Korea, Republic of)

TECHNOLOGICAL IMPROVEMENTS

- 8659 0G **Continuous fabrication technology for improving resolution in RGB-stacked organic image sensor** [8659-17]
T. Sakai, H. Seo, S. Aihara, M. Kubota, NHK Science and Technology Research Labs. (Japan); M. Furuta, Kochi Univ. of Technology (Japan)

- 8659 OH **Biological tissue identification using a multispectral imaging system** [8659-18]
C. Delporte, Univ. Pierre et Marie Curie (France) and Lab. d'Electronique et Electromagnétisme, UR2, Univ. Pierre et Marie Curie (France); S. Sautrot, Univ. Denis Diderot (France) and Lab. d'Electronique et Electromagnétisme, UR2, Univ. Pierre et Marie Curie (France); M. Ben Chouikha, Univ. Pierre et Marie Curie (France) and Lab. d'Electronique et Electromagnétisme, UR2, Univ. Pierre et Marie Curie (France); F. Viénot, Muséum National d'Histoire Naturelle (France); G. Alquié, Univ. Pierre et Marie Curie (France) and Lab. d'Electronique et Electromagnétisme, UR2, Univ. Pierre et Marie Curie (France)
- 8659 OI **A CMOS image sensor using floating capacitor load readout operation** [8659-19]
S. Wakashima, Y. Goda, T. -L. Li, R. Kuroda, S. Sugawa, Tohoku Univ. (Japan)
- 8659 OJ **A UV Si-photodiode with almost 100% internal Q.E. and high transmittance on-chip multilayer dielectric stack** [8659-20]
Y. Koda, R. Kuroda, T. Nakazawa, Y. Nakao, S. Sugawa, Tohoku Univ. (Japan)

APPLICATIONS

- 8659 OK **High sensitivity analysis of speckle patterns: a technological challenge for biomedical optics (Invited Paper)** [8659-21]
J.-M. Tualle, K. Barjean, E. Tinet, D. Etti, Lab. de Physique des Lasers, CNRS, Univ. Paris 13 (France)
- 8659 OL **Gesture recognition on smart cameras** [8659-22]
A. Dziri, S. Chevobbe, M. Darouich, CEA LIST (France)
- 8659 OM **3DS-colorimeter based on a mobile phone camera for industrial applications** [8659-23]
J. Miettinen, VTT Technical Research Ctr. of Finland (Finland); J. B. Martinkauppi, Univ. of Vaasa (Finland); P. Suopajarvi, VTT Technical Research Ctr. of Finland (Finland)
- 8659 ON **A single lens with no moving parts for rapid, high-resolution, 3D image capture** [8659-24]
D. Gray, H. Chen, J. Czechowski, K. Zhang, J. Tu, F. Wheeler, M. Yamada, J. P. Cilia, R. DeMuth, E. Heidari, G. Abramovich, K. Harding, GE Global Research (United States)
- 8659 OO **Measurement and description method for image stabilization performance of digital cameras** [8659-25]
N. Aoki, Nikon Corp. (Japan); H. Kusaka, Panasonic Corp. (Japan); H. Otsuka, Canon Inc. (Japan)
- 8659 OP **Interconnected network of cameras** [8659-26]
M. Hosseini Kamal, H. Afshari, Y. Leblebici, A. Schmid, P. Vanderghenst, Ecole Polytechnique Fédérale de Lausanne (Switzerland)

INTERACTIVE PAPER SESSION

- 8659 OQ **Creation of North-East Indian face database for human face identification** [8659-29]
K. Saha, P. Saha, M. K. Bhowmik, Tripura Univ. (India); D. Bhattacharjee, M. Nasipuri, Jadavpur Univ. (India)

- 8659 OR **Optical characterization parameters by study and comparison of subwavelength patterns for color filtering and multispectral purpose** [8659-30]
J. Matanga, Lab. Electronique, Informatique et Image, CNRS, Univ. de Bourgogne (France); Y. Lacroute, Lab. Interdisciplinaire Carnot de Bourgogne, CNRS, Univ. de Bourgogne (France); P. Gouton, Lab. Electronique, Informatique et Image, CNRS, Univ. de Bourgogne (France); E. Bourillot, Lab. Interdisciplinaire Carnot de Bourgogne, CNRS, Univ. de Bourgogne (France)
- 8659 OS **Characterization of a solid state air corona charging device** [8659-28]
M. Young, B. Xu, S. Buhler, K. Littau, Palo Alto Research Ctr., Inc. (United States)

Author Index

Conference Committee

Symposium Chair

Gaurav Sharma, University of Rochester (United States)

Symposium Cochair

Sergio R. Goma, Qualcomm Inc. (United States)

Conference Chairs

Ralf Widenhorn, Portland State University (United States)

Antoine Dupret, CEA LETI MINATEC (France)

Conference Program Committee

Morley M. Blouke, Portland State University (United States)

Erik Bodegom, Portland State University (United States)

Glenn H. Chapman, Simon Fraser University (Canada)

Arnaud Darmont, Aphesa SPRL (Belgium)

James A. DiBella Sr., Truesense Imaging, Inc. (United States)

Boyd A. Fowler, BAE Systems Imaging Solutions (United States)

Kevin J. Matherson, Microsoft Corporation (United States)

Valérie Nguyen, CEA LETI MINATEC (France)

Alice L. Reinheimer, e2v (United States)

Franz Riedlberger, TowerJazz (Germany)

Nobukazu Teranishi, Panasonic Corporation (Japan)

Xinyang Wang, Chinese Academy of Sciences (China)

Session Chairs

- 1 Session 1
Ralf Widenhorn, Portland State University (United States)
- 2 Smart Sensors
Arnaud Darmont, Aphesa SPRL (Belgium)
- 3 High-Performance Sensors
Kevin J. Matherson, Microsoft Corporation (United States)
- 4 Noise and Characterization
Boyd A. Fowler, BAE Systems Imaging Solutions (United States)

- 5 Technological Improvements
Antoine Dupret, CEA LETI MINATEC (France)
- 6 Applications
Alice L. Reinheimer, e2v (United States)