

IS&T International Symposium on
**Electronic
Imaging**
SCIENCE AND TECHNOLOGY

PROCEEDINGS

28 January 2018 – 1 February 2018 • Burlingame, CA, USA

Image Sensors and Imaging Systems 2018

Editors: **Arnaud Darmont**, APHESA SPRL (Belguim),
Arnaud Peizerat, Commissariat à l'Énergie Atomique (France),
Ralf Widenhorn, Portland State Univ. (United States)

These papers represent the program of Electronic Imaging 2018,
held January 28 – February 1, 2018, at the Hyatt Regency San Francisco Airport in Burlingame, CA.

Copyright 2018

Society for Imaging Science and Technology
7003 Kilworth Lane • Springfield, VA 22151 USA
703/642-9090
703/642-9094 fax
info@imaging.org
www.imaging.org

All rights reserved. These proceedings, or parts thereof, may not be reproduced in any form without the written permission of the Society.

ISSN 2470-1173
<https://doi.org/10.2352/ISSN.2470-1173.2018.11.IMSE-561>
Manuscripts are reproduced from PDFs as submitted and approved by authors
no editorial changes have been made.

Image Sensors and Imaging Systems 2018

Symposium Chairs

Joyce Farrell, Stanford University (United States)

Andrew Woods, Curtin University (Australia)

Symposium Short Course Chairs

Susan Farnand, Rochester Institute of Technology (United States)

Mohamed-Chaker Larabi, University of Poitiers (France)

Jonathan B. Phillips, Google, Inc. (United States)

At-large Conference Chair Representative

Adnan Alattar, Digimarc (United States)

Past Symposium Chair

Nitin Sampat, Rochester Institute of Technology (United States)

Conference Chairs

Arnaud Darmont, APHESA SPRL (Belgium) and European Machine Vision Association (Spain)

Arnaud Peizerat, Commissariat à l'Énergie Atomique (France)

Ralf Widenhorn, Portland State Univ. (United States)

Conference Committee

Morley M. Blouke, Portland State Univ. (retired) (United States)

Nick Bulitka, Lumenera Corp. (Canada)

Calvin Chao, Taiwan Semiconductor Manufacturing Company (Taiwan)

Glenn H. Chapman, Simon Fraser Univ. (Canada)

Tobi Delbrück, Institute of Neuroinformatics, University of Zurich and ETH Zurich (Switzerland)

James A. DiBella, Imperx (United States)

Antoine Dupret, Commissariat à l'Énergie Atomique (France)

Boyd A. Fowler, OminVision Technologies, Inc. (United States)

Rihito Kuroda, Tohoku Univ. (Japan)

Kevin J. Matherson, Microsoft Corp. (United States)

Clemenz Portmann, Google Inc. (United States)

Alice L. Reinheimer, e2v (United States)

Gilles Sicard, Commissariat à l'Énergie Atomique (France)

Nobukazu Teranishi, Univ. of Hyogo (Japan)

Jean-Michel Tualle, Univ. Paris 13 (France)

Orly Yadid-Pecht, Univ. of Calgary (Canada)

Xinyang Wang, GPIXEL (China)

IMSE 2018 thanks Conference Sponsors



www.melexis.com/tof

Image Sensors and Imaging Systems 2018

Wednesday, January 31, 2018

Color and Spectral Imaging

Session Chair: Ralf Widenhorn, Portland State University (United States)

8:50 – 9:40 am

Cypress A

8:50

Conference Opening Remarks

9:00

IMSE-292

Color channel reconstruction for multi-color multi-view images using disparity and color similarity-based local linear regression, Daniel Kiesel, Thomas Richter, Jürgen Seiler, and André Kaup, Friedrich-Alexander University Erlangen-Nuremberg (Germany)

9:20

IMSE-293 [no paper]

Tutorial talk: Introduction to spectral response (QE) curves, their meaning and their measurement, Arnaud Darmont, APHESA SPRL and Imaging Courses (Belgium)

Keynote: Color and Spectral Imaging

Session Chair: Ralf Widenhorn, Portland State University (United States)

9:40 – 10:20 am

Cypress A

IMSE-313 [no paper]

Quantum efficiency and color, Jörg Kunze, Basler AG (Germany)

Dr. Jörg Kunze received his PhD in Physics from the University of Hamburg (2004). He joined Basler in 1998, where he started as an electronics developer and where he currently is the team leader of New Technology. Dr. Kunze serves as an expert for image sensors, camera hardware, noise, color fidelity, 3D- and computational imaging and he develops new algorithms for color image signal processing. The majority of the Basler patents name him as inventor.

10:00 am – 4:00 pm Industry Exhibition

10:20 – 10:50 am Coffee Break

Depth Sensing JOINT SESSION

Session Chair: Calvin Chao, Taiwan Semiconductor Manufacturing Co. Ltd. (Taiwan)

10:50 – 11:50 am

Cypress A

This session is jointly sponsored by: Image Sensors and Imaging Systems 2018, and 3D Image Processing, Measurement (3DIPM), and Applications 2018.

10:50

IMSE-325 [no paper]

Mobile 3D imaging using handheld lens array sheet and single camera, Shoaib Soomro¹, Osman Eldes¹, Kaan Aksit², and Hakan Urey¹; ¹Koç University (Turkey) and ²NVIDIA Research (United States)

11:10

IMSE-326

A distance measurement method using a time-of-flight CMOS range image sensor with 4-tap output pixels and multiple time-windows, Kohei Yamada, Komazawa Akihito, Taishi Takasawa, Keita Yasutomi, Keiichiro Kagawa, and Shoji Kawahito, Shizuoka University (Japan)

11:30

IMSE-327 [no paper]

3D CMOS image sensor based on white pixel with off-center rectangular apertures, Byoung-Soo Choi¹, Sang-Hwan Kim¹, Jimin Lee¹, Chang-Woo Oh¹, Seunghyuk Chang², JongHo Park², SangJin Lee², and Jang-Kyoo Shin¹; ¹Kyungpook National University and ²Center for Integrated Smart Sensors (Republic of Korea)

Keynote I: Technology and Design for High Performance Imaging

Session Chair: Arnaud Darmont, APHESA SPRL (Belgium)

11:50 am – 12:30 pm

Cypress A

IMSE-354

Dark current limiting mechanisms in CMOS image sensors, Dan McGrath¹, Steve Tobin¹, Vincent Goiffon², Pierre Magnan², and Alexandre Le Roch³; ¹BAE Systems (United States), ²Université de Toulouse (France), and ³CNES (France)

Dr. Dan McGrath is Sr. Principal II Semiconductor Engineer at BAE Systems. Dr. McGrath has worked for 38 years specializing in the device physics of silicon-based pixels, CCD and CIS, and in the integration of image-sensor process enhancements in the manufacturing flow. He chose his first job because it offered that "studying defects in image sensors means doing physics" and has kept this passion front-and-center in his work. He has pursued this work at Texas Instruments, Polaroid, Atmel, Eastman Kodak, Aptina, and BAE Systems and has worked with manufacturing facilities in France, Italy, Taiwan, and the United States. His publications include the first megapixel CCD and the basis for dark current spectroscopy (DCS). He received his PhD from The Johns Hopkins University.

Image Sensors and Imaging Systems Wednesday Morning Author Q&A

Session Chair: Arnaud Darmont, APHESA SPRL (Belgium)

12:30 – 12:45 pm

Cypress A

12:45 – 2:00 pm Lunch

Plenary Session

2:00 – 3:00 pm

Grand Peninsula Ballroom D

Ubiquitous, Consumer AR Systems to Supplant Smartphones, Ronald T. Azuma, Intel, Corp. (United States)

Dr. Ronald T. Azuma, researcher and augmented reality pioneer, shares his vision for achieving ubiquitous, consumer AR systems. Recent large investments in augmented reality reflect the commercial interest in its inherent potential to replace current smartphone technology, but much remains to be done. In his talk, Dr. Azuma gives a vision for achieving this goal, which requires not just solving numerous technical challenges but also determining new, compelling AR experiences that will establish AR as a new platform and novel form of media.

Dr. Azuma leads a team in Intel Labs that designs and prototypes novel experiences and key enabling technologies to enable new forms of media. These technology areas include computational imaging and photography, computational displays, and head-worn displays. Dr. Azuma is recognized as a pioneer and innovator in augmented reality, and has held prominent leadership roles in that research area, including leading and implementing research projects and demonstrations in areas such as AR, visualization, and mobile applications. Dr. Azuma received his BSc (1988) in electrical engineering from University of California, Berkeley, and MS (1990) and PhD (1995) in computer science from University of North Carolina, Chapel Hill. Prior to joining Intel, he was a research leader at Nokia Research Center Hollywood, and a senior researcher at Hughes Research Laboratories.

3:00 – 3:30 pm Coffee Break

Keynote II: Technology and Design for High Performance Imaging

Session Chair: Arnaud Peizerat, CEA (France)

3:30 – 4:10 pm

Cypress A

IMSE-360 [no paper]

Sub-electron low-noise CMOS image sensors, Angel Rodríguez-Vázquez, Universidad de Sevilla (Spain)

Prof. Ángel Rodríguez-Vázquez (IEEE Fellow, 1999) conducts research on the design of analog and mixed-signal frontends for sensing and communication, including smart imagers, vision chips and low-power sensory-processing microsystems. He received his Bachelor's (University of Seville, 1976) and PhD in physics-electronics (University of Seville, 1982) with several national and international awards, including the IEEE Rogelio Segovia Torres Award (1981). After research stays at UC Berkeley and Texas A&M University, he became a Full Professor of Electronics at the University of Sevilla in 1995. He co-founded the Institute of Microelectronics of Sevilla, under the umbrella of the Spanish Council Research (CSIC) and the University of Sevilla and started a research group on Analog and Mixed-Signal Circuits for Sensors and Communications. In 2001 he was the main promoter and co-founder of the start-up company AnaFocus Ltd. and served as CEO, on leave from the University, until June 2009, when the company reached maturity as a worldwide provider of smart CMOS imagers and vision systems-on-chip. He has authored 11 books, 36 additional book chapters, and some 150 journal articles in peer-review specialized publications. He was elected Fellow of the IEEE for his contributions to the design of chaos-based communication chips and neuro-fuzzy chips. His research work has received some 6,954 citations; he has an h-index of 42 and an i10-index of 143.

High Speed Imaging

Session Chair: Arnaud Peizerat, CEA (France)

4:10 – 5:10 pm

Cypress A

4:10

IMSE-397 [no paper]

Multi-collection-gate image sensors – present status and perspective, Takeharu Etoh, Ritsumeikan University (Japan)

4:30

IMSE-398

A preliminary chip evaluation toward over 50Mfps burst global shutter stacked CMOS image sensor, Manabu Suzuki, Masashi Suzuki, Rihito Kuroda, and Shigetoshi Sugawa, Tohoku University (Japan)

4:50

IMSE-399 [no paper]

Back to CCD's panels? An ultra-high speed CMOS sensor architecture, Alex Krymski, Alexima (United States)

Image Sensors and Imaging Systems 2018 Interactive (Poster) Papers Oral Previews

Session Chair: Ralf Widenhorn, Portland State University (United States)

5:10 – 5:30 pm

Cypress A

In this session interactive poster authors will each provide a brief oral preview of their poster presentation, which will be presented fully in the Image Sensors and Imaging Systems 2018 Interactive Papers Session at 5:30 pm on Wednesday.

5:10

IMSE-400

Response curve programming of HDR image sensors based on discretized information transfer and scene information, Arnaud Darmont, APHESA SPRL (Belgium)

5:20

IMSE-401

Exploring hot pixel characteristics for 7 to 1.3 micron pixels, Glenn Chapman¹, Rohan Thomas¹, Klinsmann Meneses¹, Parham Purbakht¹, Israel Koren², and Zahava Koren²; ¹Simon Fraser University (Canada) and ²University of Massachusetts Amherst (United States)

Symposium Interactive Papers (Poster) Session

5:30 – 7:30 pm

The Grove

Meet the Future: A Showcase of Student and Young Professionals Research

5:30 – 7:30 pm

The Grove

Thursday, February 1, 2018

Keynote: Imaging Sensors and Technologies for Automotive Intelligence JOINT SESSION

Session Chairs: Arnaud Darmont, APHESA SPRL (Belgium); Joyce Farrell, Stanford University (United States); and Darnell Moore, Texas Instruments (United States)

8:50 – 9:30 am

Grand Peninsula Ballroom BC

This session is jointly sponsored by: Autonomous Vehicles and Machines 2018, Image Sensors and Imaging Systems 2018, and Photography, Mobile, and Immersive Imaging 2018.

PMII-415

Advances in automotive image sensors, Boyd Fowler¹ and Johannes Solhusvik²; ¹OmniVision Technologies (United States) and ²OmniVision Technologies Europe Design Center (Norway)

Dr. Boyd Fowler joined OmniVision in December 2015 as the vice president of marketing and was appointed chief technology officer in July 2017. Dr. Fowler's research interests include CMOS image sensors, low noise image sensors, noise analysis, data compression, and machine learning and vision. Prior to joining OmniVision, he was co-founder and vice president of engineering at Pixel Devices, where he focused on developing high-performance CMOS image sensors. After Pixel Devices was acquired by Agilent Technologies, Dr. Fowler was responsible for advanced development of commercial CMOS image sensor products. In 2003, Dr. Fowler joined Fairchild Imaging as the CTO and vice president of technology, where he developed SCMOS image sensors for high-performance scientific applications. After Fairchild Imaging was acquired by BAE Systems, Dr. Fowler was appointed the technology director of the CCD/CMOS image sensor business. He has authored numerous technical papers, book chapters, and patents. Dr. Fowler received his MSEE and PhD in electrical engineering from Stanford University (1990 and 1995 respectively).

Imaging Sensors and Technologies for Automotive Intelligence JOINT SESSION

Session Chairs: Arnaud Darmont, APHESA SPRL (Belgium); Patrick Denny, Valeo Vision Systems (Ireland); and Joyce Farrell, Stanford University (United States)

9:30 – 9:50 am

Grand Peninsula Ballroom BC

This session is jointly sponsored by: Autonomous Vehicles and Machines 2018, Image Sensors and Imaging Systems 2018, and Photography, Mobile, and Immersive Imaging 2018.

9:30

IMSE-422

Partial reset HDR image sensor with improved fixed pattern noise performance, Volodymyr Seliuchenko^{1,2}, Sharath Patil¹, Marcelo Mizuki¹, Saad Ahmad¹, and Maarten Kuijk²; ¹Melexis Inc. (United States) and ²Vrije University Brussel (Belgium)

9:50 – 10:50 am Coffee Break

Keynote: Novel Vision Techniques and Applications

Session Chair: Nick Bulitka, Lumenera Corp (Canada)

10:50 – 11:30 am

Cypress A

IMSE-438 [no paper]

Security imaging in an insecure world, Anders Johannesson, Axis Communications AB (Sweden)

Dr. Anders Johannesson is a senior expert engineer at Axis Communications AB in Lund, Sweden. He received his BS in physics (1987) and his PhD (1992); both from Lund University, Sweden. His thesis work involved imaging polarimetry and spectroscopy of features in the solar atmosphere. This work was continued at Caltech, (United States). He has also been involved in development within industrial and consumer imaging at a number of companies in Europe including Dialog Semiconductor. He joined Axis Communications in 2006 and is part of the core technology team for surveillance and security imaging. His focus is on the image sensor.

Novel Vision Techniques and Applications

Session Chair: Nick Bulitka, Lumenera Corp (Canada)

11:30 am – 12:20 pm

Cypress A

11:30

IMSE-447

A near pixel depth from focus architecture for video rate depth estimation, Simon Emberger^{1,2}, Laurent Alacoque^{1,2}, Antoine Dupret^{1,2}, Gilles Sicard^{1,2}, and Jean Louis de Bougrenet de la Tocnaye³; ¹University Grenoble Alpes, ²CEA-Leti, and ³IMT Atlantique (France)

11:50

IMSE-448 [no paper]

Mobile GPU implementation of wide dynamic range image compression based on multi-scale histogram synthesis, Jie Yang, Douglas McDonald, Ulian Shahnovich, and Orly Yadid-Pecht, University of Calgary (Canada)

12:10

Novel Techniques and Applications Author Q&A

12:20 – 2:00 pm Lunch

Noise, Performance, and Characterization

Session Chair: Arnaud Darmont, APHESA SPRL (Belgium)

2:00 – 3:30 pm

Cypress A

2:00

IMSE-456 [no paper]

Using wavelets to analyze RTS noise in irradiated CMOS image sensors, Benjamin Hendrickson, Portland State University (United States)

2:20

IMSE-457

Lag-induced image artifacts in still imaging with CIS, Leo Anzagira, Orit Skorka, Pulla Reddy Ailuri, and Radu Ispasoiu, ON Semiconductor Corporation (United States)

2:40

IMSE-458

Two calibration methods to improve the linearity of a CMOS image sensor, Fei Wang¹ and Albert Theuwissen^{1,2}; ¹Delft University of Technology (the Netherlands) and ²Harvest Imaging (Belgium)

3:00

IMSE-459

Characterization of image sensor resolution by single-pixel illumination,
Victor Lenchenkov, Orit Skorka, Robert Gravelle, Ulrich Boettiger, and Radu Ispasoiu, ON Semiconductor Corporation (United States)

3:20

Noise, Performance, and Characterization Author Q&A

3:30 – 3:50 pm Coffee Break

Image Sensors and Imaging Systems 2018 Wrap-up Q&A

3:50 – 4:20 pm

Cypress A

Conference Closing Remarks

Wrap-up Author Q&A