

# **IS&T International Symposium on Electronic Imaging Science and Technology 2018**

Image Sensors and Imaging Systems 2018

Burlingame, California, USA  
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## **Editors:**

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Arnaud Peizerat  
Ralf Widenhorn**

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# 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 Soomro<sup>1</sup>, Osman Eldes<sup>1</sup>, Kaan Aksit<sup>2</sup>, and Hakan Urey<sup>1</sup>; <sup>1</sup>Koç University (Turkey) and <sup>2</sup>NVIDIA 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 Choi<sup>1</sup>, Sang-Hwan Kim<sup>1</sup>, Jimin Lee<sup>1</sup>, Chang-Woo Oh<sup>1</sup>, Seunghyuk Chang<sup>2</sup>, JongHo Park<sup>2</sup>, SangJin Lee<sup>2</sup>, and Jang-Kyoo Shin<sup>1</sup>; <sup>1</sup>Kyungpook National University and <sup>2</sup>Center 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 McGrath<sup>1</sup>, Steve Tobin<sup>1</sup>, Vincent Goiffon<sup>2</sup>, Pierre Magnan<sup>2</sup>, and Alexandre Le Roch<sup>3</sup>; <sup>1</sup>BAE Systems (United States), <sup>2</sup>Université de Toulouse (France), and <sup>3</sup>CNES (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 front-ends 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 promotor 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 Chapman<sup>1</sup>, Rohan Thomas<sup>1</sup>, Klinsmann Meneses<sup>1</sup>, Parham Purbakht<sup>1</sup>, Israel Koren<sup>2</sup>, and Zahava Koren<sup>2</sup>; <sup>1</sup>Simon Fraser University (Canada) and <sup>2</sup>University 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 Fowler<sup>1</sup> and Johannes Solhusvik<sup>2</sup>; <sup>1</sup>OmniVision Technologies (United States) and <sup>2</sup>OmniVision 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<sup>1,2</sup>, Sharath Patil<sup>1</sup>, Marcelo Mizuki<sup>1</sup>, Saad Ahmad<sup>1</sup>, and Maarten Kuijk<sup>2</sup>; <sup>1</sup>Melexis Inc. (United States) and <sup>2</sup>Vrije 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 unsecure 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<sup>1,2</sup>, Laurent Alacoque<sup>1,2</sup>, Antoine Dupret<sup>1,2</sup>, Gilles Sicard<sup>1,2</sup>, and Jean Louis de Bougrenet de la Tocnaye<sup>3</sup>; <sup>1</sup>University Grenoble Alpes, <sup>2</sup>CEA-Leti, and <sup>3</sup>IMT-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 Wang<sup>1</sup> and Albert Theuwissen<sup>1,2</sup>; <sup>1</sup>Delft University of Technology (the Netherlands) and <sup>2</sup>Harvest 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

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

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**3:50 – 4:20 pm**

*Cypress A*

**Conference Closing Remarks**  
**Wrap-up Author Q&A**