

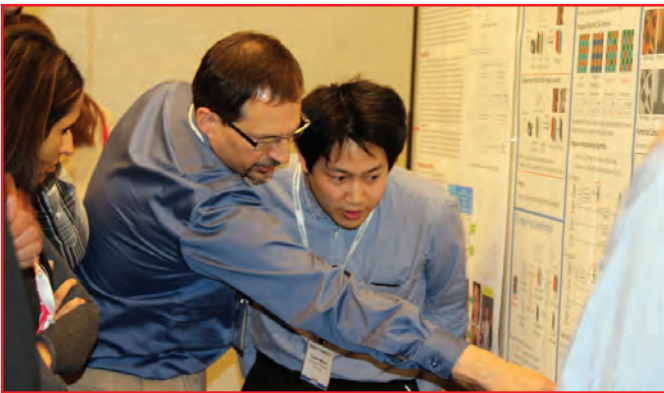
# FINAL PROGRAM

IS&T International Symposium on

# Electronic Imaging

SCIENCE AND TECHNOLOGY

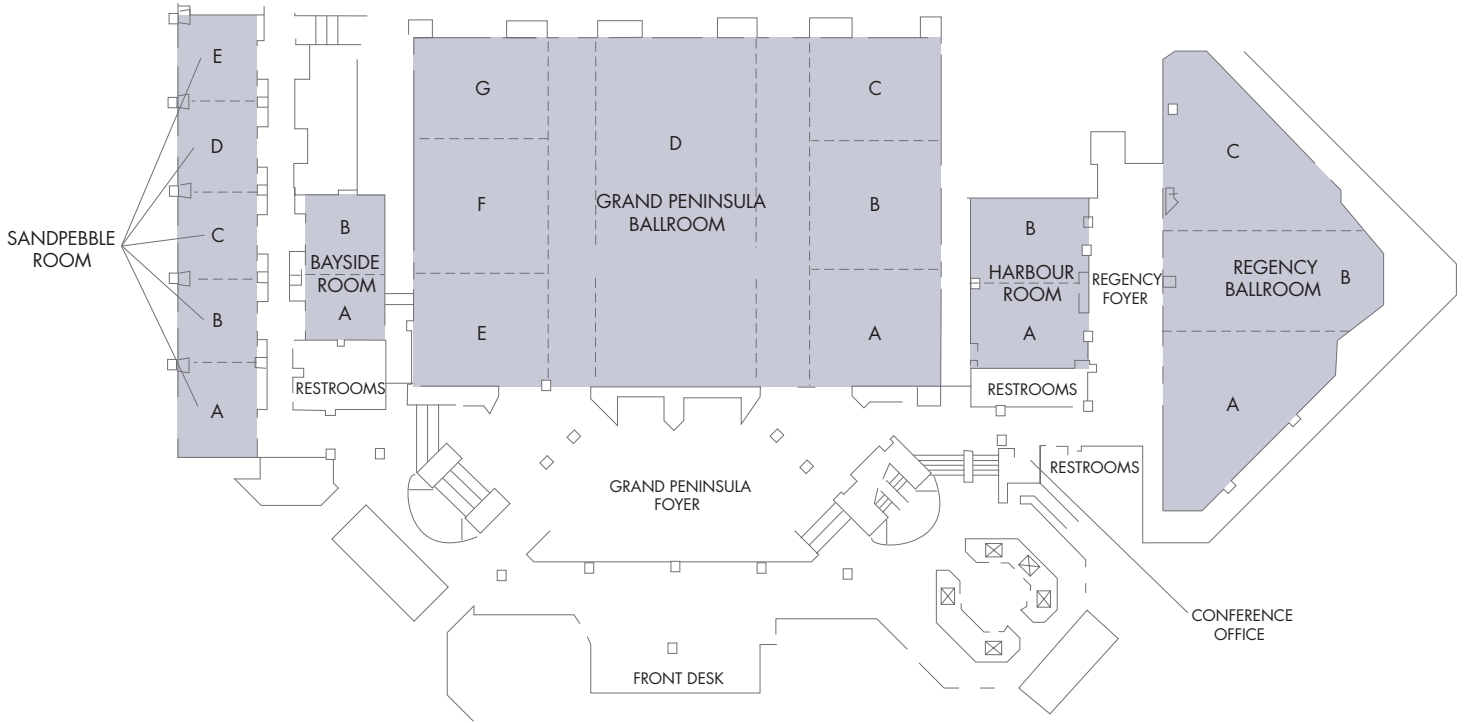
29 January – 2 February 2017 • Burlingame, CA, USA



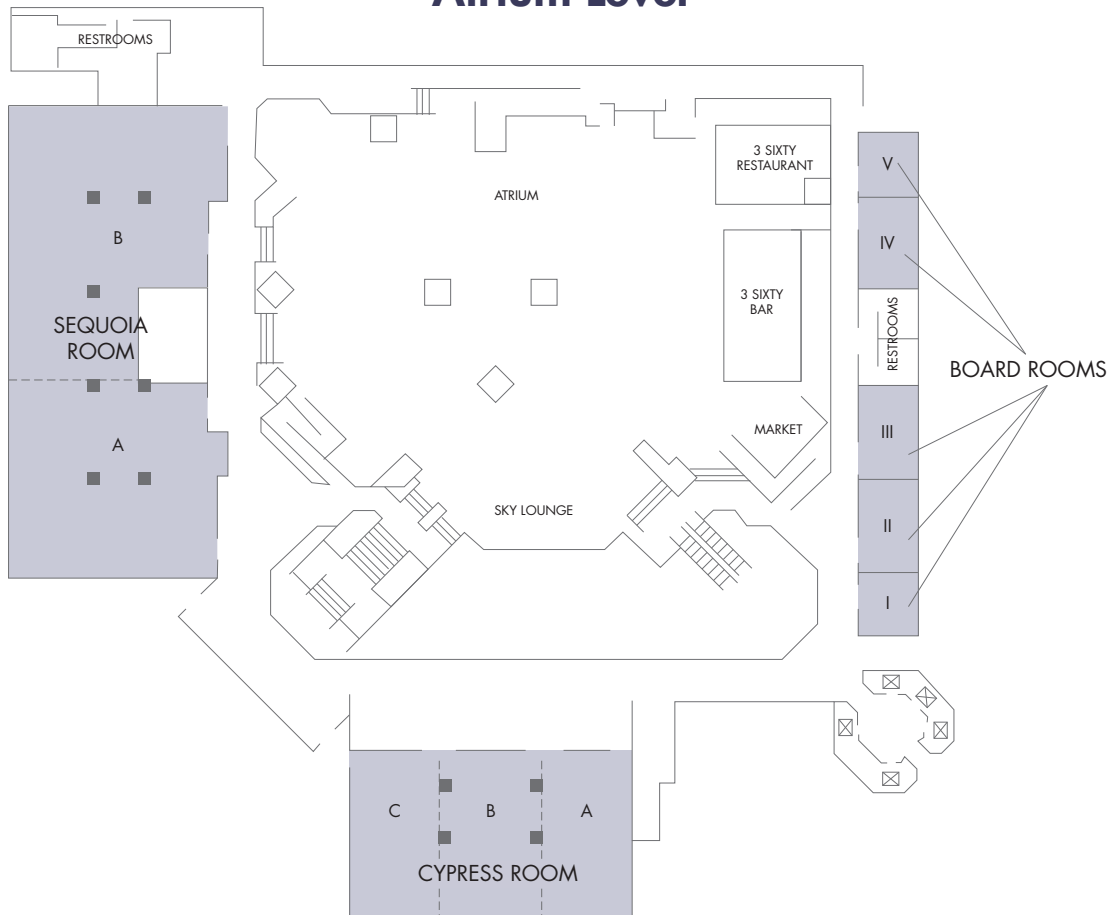
- SHORT COURSES • EXHIBITS • DEMONSTRATION SESSION • PLENARY TALKS •
- INTERACTIVE PAPER SESSION • SPECIAL EVENTS • TECHNICAL SESSIONS •

# Hyatt San Francisco Airport Floor Plans

## Lobby Level



## Atrium Level



IS&T International Symposium on

# Electronic Imaging

SCIENCE AND TECHNOLOGY

29 January – 2 February 2017

Hyatt Regency San Francisco Airport  
1333 Bayshore Highway  
Burlingame, California USA



*2017 Symposium  
Co-Chair*

**Joyce Farrell**  
Stanford University (USA)



*2017 Symposium  
Co-Chair*

**Nitin Sampat**  
Rochester Institute of  
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*2017 Short Course  
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**Jonathan B. Phillips**  
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*2017 Short Course  
Co-Chair*

**Mohamed-Chaker Larabi**  
University of Poitiers (France)



*Past Symposium Chair*

**Choon-Woo Kim**  
Inha Univ.  
(Republic of Korea)

## Welcome

On behalf of IS&T—the Society for Imaging Science and Technology—we would like to welcome you to the 29th annual International Symposium on Electronic Imaging.

Imaging is pervasive in the human experience—from the way we view the world each day to the photographs we take on our smart phones to its exciting use in technologies related to national security, space exploration, entertainment, medical, and printing applications—and an increasingly vital part of our lives.

This week you have the opportunity to hear the latest research from the world's leading experts in imaging, image processing, sensors, color, and augmented/virtual reality/3D, to name but a few of the applications and technologies covered by the event. You also have many opportunities to develop both your career and business by networking with leading researchers and entrepreneurs in the field.

The Electronic Imaging Symposium is the premier international meeting in this exciting technological area, one that brings together academic and industry colleagues to discuss topics on the forefront of research and innovation. We look forward to seeing you and welcoming you to this unique event.

—Joyce Farrell and Nitin Sampat, *El2017 Symposium Co-chairs*

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## UPCOMING IS&T EVENTS

May 15-18, 2017; Riga, Latvia  
Archiving 2017

September 11 – 15, 2017; Lillehammer, Norway  
25th Color and Imaging Conference (CIC25)

November 5 – 9, 2017; Denver, CO  
Printing for Fabrication  
33rd International Conference on Digital Printing  
Technologies (formerly NIP)

November 8 – 9, 2017; Denver, CO  
Technologies in Digital Photo Fulfillment

Jan. 28 – Feb. 1, 2018; SFO/Burlingame, California  
Electronic Imaging 2018

Learn more at [www.imaging.org](http://www.imaging.org).

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*Plan Now to Participate  
Join us for Electronic Imaging 2018  
Burlingame, California, 28 January – 1 February, 2018*



## El Symposium Leadership

### El 2017 Symposium Committee

#### Symposium Co-Chairs

**Joyce Farrell**, Stanford University (United States)

**Nitin Sampat**, Rochester Institute of Technology (United States)

#### Symposium Short Course Co-Chairs

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

**Mohamed-Chaker Larabi**, University of Poitiers (France)

#### At-large Conference Chair Representative

**Adnan Alattar**, Digimarc (United States)

#### Past Symposium Chair

**Choon-Woo Kim**, Inha University (Republic of Korea)

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Photo: Can Balcioglu

*IS&T expresses its deep appreciation to the symposium chairs, conference chairs, program committee members, session chairs, and authors who generously give their time and expertise to enrich the Symposium. It would not be possible without the dedicated contributions of our participants and members.*



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## Symposium Overview

### Explore the Electronic Imaging of tomorrow

Imaging is integral to the human experience—from personal photographs taken every day with mobile devices to autonomous imaging algorithms in self-driving cars to the mixed reality technology that underlies new forms of entertainment. At EI 2017, leading researchers, developers, and entrepreneurs from around the world discuss, learn about, and share the latest imaging developments from industry and academia.

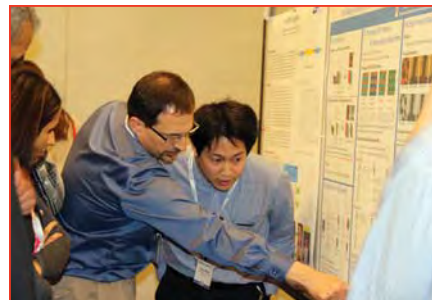
The 2017 event features 18 technical conferences and two featured sessions covering all aspects of electronic imaging, including:

- Augmented and virtual reality displays and processing
- Autonomous machine imaging algorithms
- Computational and digital photography
- Human vision, color, perception, and cognition
- Image and video processing and communication via the web
- Mobile imaging
- Imaging sensors
- Image quality
- Display and hardcopy
- Media security and forensics
- Machine vision and machine learning

Research and applications of these technologies are discussed in the fields of communications, security, transportation, education, space exploration, medicine, entertainment, and more.

Technical courses taught by experts from academia and industry augment the main technical program of symposium plenary, and conference keynote, oral, and interactive (poster) presentations.

Technology demonstrations by industry and academia participants and a focused exhibition showcase the latest developments driving next generation electronic imaging products.



### Exhibitors

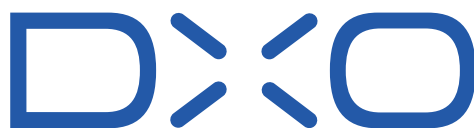
#### Exhibit Hours

Tuesday 10 AM – 7 PM  
Wednesday 10 AM – 4 PM



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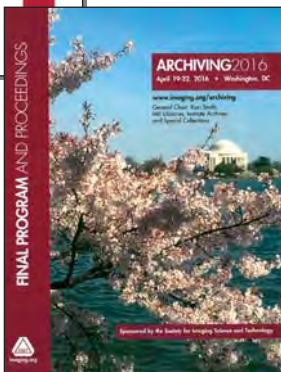
Imaging Materials, Devices, Processes, Systems, and Applications • Image Quality • Color and Vision Science • Perception • Image Processing Algorithms • Image Understanding • Image Permanence • Multispectral and Hyperspectral Imaging • Digital Printing and Fabrication • Color in Devices • 3D Printing • Digital Preservation • Printed Electronics • Bio-Printing • Photo Sharing Technologies • and more . . .



### LIBRARY HOLDINGS

- *Journal of Imaging Science and Technology (JIST)*
- Archiving Conference Proceedings
- CIC: Color and Imaging Conference Proceedings
- CGIV: European Conference on Colour in Graphics, Imaging, and Vision Proceedings
- International Symposium on Technologies for Digital Photo Fulfillment Proceedings
- Digital Printing / Digital Fabrication Conference Proceedings

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\* Members have unlimited access to full papers; non-members have unlimited access to abstracts and can purchase full papers; **everyone** has free access to Electronic Imaging volumes beginning in 2016.

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your resource for imaging knowledge



## Plenary Speakers

### Giga-scale 3D Computational Microscopy



Monday, January 30, 2017  
2:00 — 3:00 PM  
Grand Peninsula Ballroom D

**Laura Waller** (Univ. of California, Berkeley)

Dr. Waller discusses work on computational imaging methods for fast capture of gigapixel-scale 3D intensity and phase images in a commercial microscope. Her

lab's experimental setups employ illumination-side and detection-side coding of angle (Fourier) space with simple hardware and fast acquisition. The result is high-resolution reconstructions across a large field-of-view, achieving high space-bandwidth-time product. Experimentally, they have achieved real-time 3D and phase imaging with digital aberration correction and mitigation of scattering effects, by sparsity-constrained nonlinear optimization methods.

*Laura Waller is the Ted Van Duzer Endowed Assistant Professor of Electrical Engineering and Computer Sciences (EECS) at UC Berkeley. She is a Senior Fellow at the Berkeley Institute of Data Science, with affiliations in Bioengineering and Applied Sciences & Technology. She was a Postdoctoral Researcher and Lecturer of Physics at Princeton University (2010-2012) and received her BS (2004), MEng (2005), and PhD (2010) in EECS from the Massachusetts Institute of Technology (MIT). She is recipient of the Moore Foundation Data-Driven Investigator Award, Bakar Fellowship, Carol D. Soc Distinguished Graduate Mentoring Award, NSF CAREER Award, and Packard Fellowship for Science and Engineering.*

### VR 2.0: Making Virtual Reality better than Reality



Tuesday, January 31, 2017  
2:00 — 3:00 PM  
Grand Peninsula Ballroom D

**Gordon Wetzstein** (Stanford University)

Virtual reality is a new medium that provides unprecedented user experiences. Eventually, VR/AR systems will redefine education, communication, entertainment,

collaborative work, simulation, training, telesurgery, and basic vision research. In all of these applications, the primary interface between the user and the digital world is the near-eye display. While today's VR systems struggle to provide natural and comfortable viewing experiences, next-generation computational near-eye displays have the potential to provide visual experiences that are better than the real world. In this talk, we explore the frontiers of VR systems engineering.

*Gordon Wetzstein is an assistant professor of Electrical Engineering and—by courtesy—of Computer Science at Stanford University. He is the leader of the Stanford Computational Imaging Group, an interdisciplinary research group focused on advancing imaging, microscopy, and display systems. At the intersection of computer graphics, machine vision, optics, scientific computing, and perception, Wetzstein's research has a wide range of applications in next-generation consumer electronics, scientific imaging, human-computer interaction, remote sensing, and many other areas. Prior to joining Stanford in 2014, Wetzstein was a Research Scientist in the Camera Culture Group at the MIT Media Lab. He received a PhD in computer science from the*

*University of British Columbia (2011) and graduated with Honors from the Bauhaus in Weimar, Germany before that. His doctoral dissertation focuses on computational light modulation for image acquisition and display and won the Alain Fournier PhD Dissertation Annual Award. He organized the IEEE 2012 and 2013 International Workshops on Computational Cameras and Displays, founded displayblocks.org as a forum for sharing computational display design instructions with the DIY community, and has presented a number of courses on computational displays and computational photography at ACM SIGGRAPH. Wetzstein is the recipient of an NSF CAREER award, International Conference on Computational Photography (ICCP) best paper awards (2011 and 2014), and a Laval Virtual Award (2005).*

### Designing VR Video Camera Systems



Wednesday, February 1, 2017  
2:00 — 3:00 PM  
Grand Peninsula Ballroom D

**Brian Cabral** (Facebook, Inc.)

Unlike traditional digital video camera systems that are fairly linear and composed of a single streaming optical and digital pipeline, VR video capture systems

are not. They are composed of multiple, possibly homogenous, optical and digital components—all of which must operate as if they were one seamless optical system. The design of VR video cameras requires a whole new set of technologies and engineering approaches. The arrangement of cameras, optical choices, and SNR—all of which play important roles in every camera design—become far more complex for a VR camera and require tight coupling to the computational system components.

*Brian Cabral is director of engineering at Facebook specializing in computational photography, computer vision, and computer graphics. He is the holder of numerous patents (filed and issued) and leads the Surround 360 VR camera team. He has published a number of diverse papers in the area of computer graphics and imaging including the pioneering Line Integral Convolution algorithm. Brian's interests include computational photography, computer graphics and image processing hardware and software, numerical computation, differential geometry, hardware and software architecture, computational geometry, and statistical learning.*

# Short Course Daily Schedule

See page 105 for course descriptions.

Sunday January 29								
8:00 to 10:00		<b>EI02</b> Burns/Williams - Introduction to Image Quality Testing: Targets, Software, and Standards	<b>EI03</b> Matherson/Artmann - Concepts, Procedures, and Practical Aspects of Measuring Resolution in Mobile and Compact Imaging Devices and the Impact of Image Processing	<b>EI04</b> Hodgson - Electronic Imaging of Secure Documents	<b>EI05</b> Rabbani - Advanced Image Enhancement and Deblurring	<b>EI06</b> Ptucha - Fundamentals of Deep Learning	<b>EI08</b> Agam - 3D Imaging	
10:15 to 12:15	<b>EI01</b> Woods/Merritt - Stereoscopic Display Application Issues	<b>EI09</b> Matherson/Artmann - Color and Calibration in Mobile Imaging Devices	<b>EI10</b> Rizzi/McCann - High-Dynamic-Range Imaging in Cameras, Displays, and Human Vision	<b>EI12</b> Viggiano - Psychophysics Lab: In Depth and Step-by- Step				
1:30 to 3:30		<b>EI14</b> Hemami/Pappas - Perceptual Metrics for Image and Video Quality in a Broader Context: From Perceptual Transparency to Structural Equivalence	<b>EI15</b> Darmont - Introduction to CMOS Image Sensor Technology	<b>EI16</b> Ho - 3D Video Processing Techniques for Immersive Environments	<b>EI17</b> Rogowitz - Perception and Cognition for Imaging	<b>EI18</b> Matherson/Artmann - Camera Module Calibration for Mobile Imaging Devices	<b>EI19</b> Pulli/Gitudhuri - OpenVX: A Standard API for Accelerating Computer Vision	<b>EI13</b> Costa - Real-time and Parameter-free Anomaly Detection from Image Streams
3:45 to 5:45							<b>EI20</b> Ferzli - Computer Vision for Autonomous Driving	
Monday January 30								
	<b>EI22</b> Sharma - Introduction to Digital Color Imaging 8:30–12:45	<b>EI23</b> Matherson/Artmann - Noise Sources at the Camera Level and the Use of International Standards for Its Characterization 10:30–12:30						
Tuesday February 1								
8:30 to 12:45	<b>EI24</b> Stork - Joint Design of Optics and Image Processing for Imaging Systems							

## Special Events

### Monday, January 30, 2017

---

#### Symposium Welcome Reception

Atrium

**5:00 – 6:00 pm**

Join colleagues for a light reception featuring beer, wine, soft drinks, and hors d'oeuvres. Make plans to enjoy dinner with old and new friends at one of the many area restaurants. Conference registration badges are required for entrance.

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#### SD&A Conference 3D Theater

Grand Peninsula Ballroom D

**6:00 – 7:30 pm**

Hosted by **Andrew J. Woods**, Curtin Univ. (Australia)

The 3D Theater Session of each year's Stereoscopic Displays and Applications Conference showcases the wide variety of 3D content that is being produced and exhibited around the world. All 3D footage screened in the 3D Theater Session is shown in high-quality polarized 3D on a large screen. The final program will be announced at the conference and 3D glasses will be provided.

### Tuesday, January 31, 2017

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#### Women in Electronic Imaging Breakfast

Location provided at Registration Desk

**7:15 – 8:45 am**

Start your day with female colleagues and senior women scientists to share stories and make connections at the Women in Electronic Imaging breakfast. The complimentary breakfast is open to EI full registrants. Space is limited to 40 people. Visit the onsite registration desk for more information about this special event.

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#### Industry Exhibition

Grand Peninsula Foyer

**10:00 am – 7:30 pm**

EI's annual industry exhibit provides a unique opportunity to meet company representatives working in areas related to electronic imaging. The exhibit highlights products and services, as well as offers the opportunity to meet prospective employers.

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#### Symposium Demonstration Session

Grand Peninsula Ballroom E

**5:30 – 7:30 pm**

This symposium-wide, hands-on, interactive session, which traditionally has showcased the largest and most diverse collection of stereoscopic and

electronic imaging research and products in one location, represents a unique networking opportunity. Attendees can see the latest research in action, compare commercial products, ask questions of knowledgeable demonstrators, and even make purchasing decisions about a range of electronic imaging products. The demonstration session hosts a vast collection of stereoscopic products providing a perfect opportunity to witness a wide array of stereoscopic displays with your own two eyes.

### Wednesday, February 1, 2017

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#### Industry Exhibition

Grand Peninsula Foyer

**10:00 am – 4:00 pm**

EI's annual industry exhibit provides a unique opportunity to meet company representatives working in areas related to electronic imaging. The exhibit highlights products and services, as well as offers the opportunity to meet prospective employers.

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#### Interactive Paper (Poster) Session

Atrium

**5:30 – 7:00 pm**

Conference attendees are encouraged to attend the Interactive Paper (Poster) Session where Interactive Paper authors display their posters and are available to answer questions and engage in in-depth discussions about their papers. Light refreshments are provided. Please note that conference registration badges are required for entrance and that posters may be previewed by all attendees beginning on Monday.

Authors are asked to set up their posters starting at 10:00 am on Monday. Pushpins are provided; other supplies can be obtained at the Registration Desk. Authors must remove poster materials at the conclusion of the Interactive Session. Posters not removed are considered unwanted and will be removed by staff and discarded. IS&T does not assume responsibility for posters left up before or after the Interactive Session.

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

Atrium

**5:30 – 7:00 pm**

This 1st annual event will bring invited students together with academic and industry representatives who may have opportunities to offer, and will provide each student with an opportunity to present and discuss their academic work via an interactive poster session.

Student presenters expand their professional network and explore employment opportunities with the audience of academic and industry representatives.

## Conference Keynotes Talks

Monday, January 30, 2017

### AVM: Key Learnings from Automated Vehicle Development

Session Chair: Buyue Zhang, Intel Corporation (United States)

8:50 – 9:50 am

Grand Peninsula Ballroom B

AVM-009

**Architectures for automated driving**, Jack Weast, Intel Corporation (United States)

Jack Weast is a Principal Engineer and the Chief Systems Engineer for Autonomous Driving Solutions at Intel Corporation. In his 17 year career at Intel, Weast has built a reputation as a change agent in new industries with significant technical and architectural contributions to a wide range of industry-first products and standards that range from one the world's first Digital Media Adapters to complex heterogeneous high performance compute solutions in markets that are embracing high performance computing for the first time. With an End to End Systems perspective, he combines a unique blend of embedded product experience with a knack for elegant Software and Systems design that will accelerate the adoption of Autonomous Driving. Weast is the co-author of "UPnP: Design By Example", an Associate Professor at Portland State University, and the holder of numerous patents with dozens pending.

### MWSF: Media Forensics

Session Chair: Adnan Alattar, Digimarc Corporation (United States)

8:50 – 10:10 am

Regency Ballroom A

MWSF-316

**The nimble challenges for media forensics**, P. Jonathon Phillips, National Institute of Standards and Technology (NIST) (United States)

Jonathon Phillips is a leading technologist in the fields of computer vision, biometrics, and face recognition. He is at the National Institute of Standards and Technology (NIST), where he runs challenge problems and evaluations to advance biometric technology. His previous efforts include the Iris Challenge Evaluations (ICE), the Face Recognition Vendor Test (FRVT), the Face Recognition Grand Challenge and FERET. From 2000-2004, Phillips was assigned to DARPA. For his work on the FRVT 2002 he was awarded the Dept. of Commerce Gold Medal. His work has been reported in the New York Times, the BBC, and the Economist. He has appeared on NPR's Science Friday show. In an Essential Science Indicators analysis of face recognition publication over the past decade, Phillips' work ranks at #2 by total citations and #1 by cites per paper. In 2013, he won the inaugural Mark Everingham Prize. He is a fellow of the IEEE and IAPR.

### HVEI: Human Vision - Unifying Theory from Peripheral Vision

Session Chair: Bernice Rogowitz, Visual Perspectives (United States)

9:10 – 10:00 am

Regency Ballroom B

HVEI-111

**Vision at a glance (Invited)**, Ruth Rosenholtz, MIT (United States)

Ruth Rosenholtz is a Principal Research Scientist in the Dept. of Brain and Cognitive Sciences at MIT. Her lab studies human vision, including visual search, peripheral vision, perceptual organization, and the impact of visual clutter on task performance. Rosenholtz earned her PhD in electrical engineering and computer science, University of California at Berkeley (1994). Prior to MIT, she held research positions with the (Xerox) Palo Alto Research Center, NASA Ames, and with Utrecht University.

### IQSP: Automated Video Quality Measurement and Application

Session Chair: Elaine Jin, Google Inc. (United States)

10:50 – 11:30 am

Harbour

IQSP-222

**How to use video quality metrics for something other than video compression**, Anil Kokaram, Google/YouTube (United States)

Anil Kokaram is the Engineering Manager for the media algorithms team in YouTube. The team is responsible for developing video processing algorithms for quality improvement in various pipelines. Kokaram is also a Professor at Trinity College Dublin, Ireland and continues to supervise a small number of students at www.sigmedia.tv in the EE Dept there. His main expertise is in the broad areas of DSP for Video Processing, Bayesian Inference, and motion estimation. He has published more than 100 refereed papers in these areas. In 2007 he was awarded a Science and Engineering Academy Award for his work in video processing for post-production applications. He was founder of a company (GreenParrotPictures) producing video enhancement software that was acquired by Google in 2011. He is a former Associate Editor of the IEEE Transactions on CCs and Systems for Video Technology and IEEE Transactions on Image Processing.

### DPMI: Accelerated Computational Tools

Session Chair: Michael Kriss, MAK Consultants (United States)

10:50 – 11:30 am

Grand Peninsula Ballroom A

DPMI-067

**Heterogeneous computational imaging**, Kari Pulli, Intel Corporation (United States)

Kari Pulli is a Senior Principal Engineer at Intel Corporation, working as the CTO of the Imaging and Camera Technologies Group. He has a long history in Computational Photography, Computer Vision, and Computer Graphics (earlier

jobs include VP of Computational Imaging at Light, Sr. Director at NVIDIA Research, Nokia Fellow, with numerous publications (h-index = 30). Pulli has a PhD from the University of Washington, Seattle. He has also been a researcher / lecturer at Stanford, MIT, and University of Oulu. He has contributed to many multimedia standards at the Khronos Group, including OpenVX, and is a regular speaker and contributor at SIGGRAPH, CVPR, and many other conferences.

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### CVAS: Computer Vision, Robotic Cameras, Sports Applications

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Session Chairs: Mustafa Jaber, NantVision Inc. (United States) and Grigorios Tsagakatakis, FORTH (Greece)

**3:30 – 4:30 pm**

Cypress B

CVAS-348

**Automated sports broadcasting**, Peter Carr, Disney Research (United States)

Peter Carr is a Senior Research Engineer at Disney Research, Pittsburgh. He received his PhD from the Australian National University (2010), under the supervision of Prof. Richard Hartley. His thesis, "Enhancing Surveillance Video Captured in Inclement Weather", explored single-view depth estimation using graph cuts, as well as real-time image processing on graphics hardware. As part of his earlier PhD work in sports analysis, Carr was a research intern at Mitsubishi Electric Research Labs. He received a Master's in physics from the Centre for Vision Research at York University in Toronto, Canada, and a Bachelor's of Applied Science (engineering physics) from Queen's University in Kingston, Canada.

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### AVM: Functional Safety and Security in Autonomous System Design

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Session Chair: Umit Batur, Faraday Future (United States)

**3:30 – 4:30 pm**

Grand Peninsula Ballroom B

AVM-016

**Needs and challenges analysis for reference architectures in autonomous systems**, Justyna Zander, Intel Corporation (United States)

Justyna Zander is Software Architect and Technology Lead in autonomous driving at Intel Corporation. Before joining Intel, she spent over a year working on self-driving cars, ADAS, and functional safety as a senior consultant in Germany. She engaged with Fortune 500 companies including most prestigious automotive OEMs. Prior to that, Zander was a postdoctoral research scientist at Harvard University and a senior scientist at the Fraunhofer Institute in Germany. She holds PhD, MSc, and two BSc degrees in computer science and electrical engineering. Her expertise includes modeling, simulation, deep learning, validation, and verification, functional safety, computing platforms, and rapid prototyping with worldwide operations focus. A frequent public speaker, she holds 6 patents, has 8 patent applications at USPTO, and has co-authored more than 40 publications and 3 books. Her publications have been cited more than 550 times. Zander is recognized internationally with countless awards (IEEE, European Union, NIST, etc). She regularly serves as a technical committee member for more than 50 journals and conferences, and is invited by NSF, EU Commission, and national councils to advise on government strategy and research roadmaps.

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### SD&A: 3D and VR on a User's Desk

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Session Chair: Andrew Woods, Curtin University (Australia)

**3:30 – 4:30 pm**

Grand Peninsula Ballroom D

SD&A-362

**Stereoscopic displays, tracking, interaction, education, and the web**, David Chavez, zSpace, Inc. (United States)

David Chavez brings 20 years of experience in start-up companies, working with technologies ranging from GSM infrastructure to laptops, printers, PDAs and smartphones, in both consumer and commercial product spaces. He has managed product development teams through the full range of the product life cycle, from initial concept to volume production. Chavez has extensive experience working with suppliers and manufacturing partners worldwide, with a particular emphasis in Asia. He has held various positions in product development organizations such as pen-based computer companies GO & EO, Hewlett Packard, and Handspring.

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### HVEI: Media Content Semantics - Transmitting Meaning

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Session Chair: Thrasylvoulos Pappas, Northwestern University (United States)

**3:30 – 4:20 pm**

Regency Ballroom B

HVEI-117

**Movies and meaning: From low-level features to mind reading (Invited)**, Sergio Benini, University of Brescia (Italy)

Sergio Benini received his MSc in electronic engineering (cum laude) at the University of Brescia (2000) with a thesis granted by Italian Academy of Science. Between '01 and '03 he was with Siemens Mobile Communications R&D. He received his PhD in information engineering from the University of Brescia (2006), working on video content analysis. During his PhD he spent one year in British Telecom Research, United Kingdom, working in the "Content & Coding Lab." Since 2005 he has been an Assistant Professor at the University of Brescia. In 2012, he co-founded Yonder, a spin-off company specialized in NLP, Machine Learning, and Cognitive Computing.

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## Tuesday, January 31, 2017

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### AVM: Autonomous Vehicle Navigation in Planetary Exploration

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Session Chair: Darnell Moore, Texas Instruments (United States)

**8:50 – 9:50 am**

Grand Peninsula Ballroom B

AVM-018

**Common themes in autonomous navigation on earth and in space**, Larry Matthies, Jet Propulsion Laboratory (United States)

Larry Matthies received his PhD in computer science from Carnegie Mellon University in 1989, then moved to the Jet Propulsion Laboratory, where he is a Senior Research Scientist and supervisor of the Computer Vision Group. His research interests include 3-D perception, state estimation, terrain classification, and dynamic scene analysis for autonomous navigation of unmanned vehicles

on Earth and in space. He has been a principal investigator in many programs involving robot vision funded by NASA, Army, Navy, DARPA, and commercial sponsors. He and his group have achieved several firsts in computer vision for space exploration, including development of vision algorithms used by rovers and landers in the 2003 Mars Exploration Rover mission. He is an Adjunct Professor of Computer Science at the University of Southern California, a lecturer in computer vision at Caltech, and a member of the editorial boards of the *Autonomous Robots journal* and the *Journal of Field Robotics*. He is a Fellow of the IEEE and was a joint winner in 2008 of the IEEE's *Robotics and Automation Award* for his contributions to robotic space exploration.

### IQSP/DPMI: Mobile Device Camera IQ Joint Session

Session Chairs: Susan Farnand, Rochester Institute of Technology, and Jackson Roland, Apple Inc. (United States)

**8:50 – 9:20 am**

Grand Peninsula Ballroom A

This session is jointly sponsored by: Image Quality and System Performance XIV and Digital Photography and Mobile Imaging XIII.

IQSP-249

**Towards the development of the IEEE P1858 CPIQ standard – A validation study**, Elaine Jin<sup>1</sup>, Jonathan Phillips<sup>1</sup>, Susan Farnand<sup>2</sup>, Margaret Belska<sup>3</sup>, Vinh Tran<sup>3</sup>, Ed Chang<sup>1</sup>, Yixuan Wang<sup>3</sup>, and Benjamin Tseng<sup>4</sup>; <sup>1</sup>Google Inc. (United States), <sup>2</sup>Rochester Institute of Technology (United States), <sup>3</sup>NVIDIA (United States), and <sup>4</sup>Apkudo (Australia)

Elaine W. Jin holds a PhD in optical engineering from Zhejiang University in China, and a PhD in psychology from the University of Chicago. She has worked in the imaging industry for 15+ years including employment at Polaroid Corporation, Eastman Kodak Company, Micron Technologies, Aptina Imaging, Marvell Semiconductors, and Intel Corporation. She currently is a staff image scientist at Google, working on developing cutting-edge consumer hardware products. Her primary research interests include imaging systems design and analysis, color imaging, and psychophysics. She has published 22 journal and conference papers, and authored 14 US patents / patent applications. She joined the CPIQ initiative (Camera Phone Image Quality) in 2006, and since then has made major contributions in the development of the softcopy quality ruler method, and the CPIQ metrics for visual noise, texture blur, spatial frequency responses, chroma level, and color uniformity. She currently leads the Color/Tone Subgroup of the IEEE CPIQ Standard Working Group.

### MAAP: Communicating Material Appearance

Session Chair: Ingeborg Tastl, HP Labs, HP Inc. (United States)

**3:30 – 4:10 pm**

Grand Peninsula Ballroom C

MAAP-277

**The future of material communication via the Appearance Exchange Format (AxF)**, Marc Ellens, Gero Mueller, and Francis Lamy, X-Rite, Inc. (United States)

Marc S. Ellens is a Senior Research Scientist with X-Rite-Pantone in Grand Rapids, MI. He received his BS in mathematics and computer science from Calvin College, and his PhD in computer aided geometric design from the

University of Utah. In the past, Ellens has worked on CNC programming and at Lectra Systemes developing design applications for the textile industry. Now at X-Rite for more than 10 years, he has been involved in research and development efforts beyond color toward the capture and reproduction of appearance. Ellens has presented at the NVIDIA GPU Technology conference, Autodesk's Automotive Innovation Forums, and the IS&T Electronic Imaging Conference. He is named in three patents related to material visualization and reproduction.

### MWSF: Camera Verification in Practice

Session Chair: Nasir Memon, New York University (United States)

**3:30 – 4:30 pm**

Regency Ballroom A

MWSF-339

**PRNU in practice**, Walter Bruehs, Federal Bureau of Investigation (United States)

Walter E. Bruehs is employed by the Federal Bureau of Investigation as the Supervisory Photographic Technologist in the Forensic Audio, Video, and Image Analysis Unit, where he is an Examiner of Questioned Photographic Evidence. Part of Bruehs' responsibilities focus on seeking out and researching emerging digital imaging technologies as they apply to the Forensic arena. He heads a program designed to identify digital images to digital cameras or to other sets of digital images, based on the sensor noise of the capture device. He has a MS in electrical engineering from the University of Maine at Orono, as well as a BS in electrical engineering from Clarkson University. Prior to working at the FBI, he worked as an Imaging Scientist in the research labs of the Eastman Kodak Company, where he co-authored a patent, "Method and System for Improving an Image Characteristic Based on Image Content."

## Wednesday February 1, 2017

### IMSE/DPMI: Sharp High-quality Color Interpolation Joint Session

Session Chairs: Kevin Matherson, Microsoft Corporation (United States), and Dietmar Wueller, Image Engineering GmbH & Co. KG (Germany)

**8:50 – 9:30 am**

Grand Peninsula Ballroom A

This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.

IMSE-077

**Bayer pattern and image quality**, Jörg Kunze, Basler AG (Germany)

Jörg Kunze has 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. Kunze serves as an expert for image sensors, camera hardware, noise, color fidelity, 3D- and computational imaging and develops new algorithms for color image signal processing. The majority of the Basler patents name him as inventor.

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**IMAWM: Web Scale Multimedia Analysis I**

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Session Chair: Jan Allebach, Purdue University (United States)

**9:10 – 10:10 am**

Cypress A

IMAWM-157

**The internet on things: Delivering augmented reality experiences in context**, Michael Gormish, Blippar (United States)

Michael Gormish is Principal Scientist at Blippar on the infrastructure team working on image retrieval and multiple computer vision products. Gormish is an image processing and computer vision scientist and engineer who invented algorithms used in products including video games, digital cinema, satellite and medical image acquisition and transport. He earned a PhD in electrical engineering dealing with image and data compression from Stanford University. In his twenty year career at Ricoh, he led several aspects of the JPEG 2000 standardization and provided key inventions used in photocopiers, digital cameras, tablets and imaging services. He was awarded the status of Ricoh Patent Master for being a co-inventor on more than 100 US patents. He has served the research community as an Associate Editor of the IEEE Signal Processing Magazine, Associate Editor of the Journal of Electronic Imaging, Program Chair of the Document Engineering Conference, and technical committee member and reviewer for numerous conferences and journals. Currently he is interested changing the world via mobile image understanding.

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**DPMI/IMSE: Machine Vision Retina Improvement** Joint Session

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Session Chairs: Thomas Vogelsang, Rambus Inc., and Ralf Widenhorn, Portland State University (United States)

**10:50 – 11:30 am**

Grand Peninsula Ballroom A

This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.

DPMI-080

**Silicon retina technology (Invited)**, Tobi Delbruck, Institute for Neuroinformatics (INI) (Switzerland)

Tobi Delbruck (IEEE M'99-SM'06-F'13) received a PhD from Caltech (1993). He is currently a professor of physics and electrical engineering at ETH Zurich in the Institute of Neuroinformatics, University of Zurich and ETH Zurich, Switzerland, where he has been since 1998. His group, which he coordinates together with Shih-Chii Liu, focuses on neuromorphic event-based sensors and sensory processing. He has co-organized the Telluride Neuromorphic Cognition Engineering summer workshop and the live demonstration sessions at ISCAS and NIPS. Delbruck is past Chair of the IEEE CAS Sensory Systems Technical Committee. He worked on electronic imaging at Arithmos, Synaptics, National Semiconductor, and Foveon and has founded 3 spin-off companies, including inilabs.com, a non-for-profit organization that has distributed hundreds of R&D prototype neuromorphic sensors to more than a hundred organizations around the world. He has been awarded 9 IEEE awards.

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**SD&A: 360° Multi-Camera Content Creation**

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Session Chair: Gregg Favalora, Draper (United States)

**11:30 am – 12:30 pm**

Grand Peninsula Ballroom D

SD&A-375

**360° 3D capture: Meeting the need in VR**, Timothy Macmillan<sup>1</sup> and David Newman<sup>2</sup>; <sup>1</sup>Consultant and <sup>2</sup>GoPro Inc. (United States)

Tim MacMillan is an award-winning photographic artist whose career with Camera Array systems began in the 1980's. In the 1990's he established Time-Slice Films Ltd. to produce content and innovate array technology for clients such as the BBC, Sky TV, Discovery Channel, and many others. His distinctive approach has been influential in the development of special effects widely used today. MacMillan's work spans both the artistic and technical, with his early camera technology now in the (United Kingdom) Science Museum. As well as architecting and designing Array systems, he has also worked in HD Broadcast Product Development with Grass Valley Cameras, and is currently Senior Manager of Advanced Products at GoPro Cameras.

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**IMSE/DPMI: Comparing CMOS Image Sensor Architectures** Joint Session

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Session Chairs: Thomas Vogelsang, Rambus Inc., and Ralf Widenhorn, Portland State University (United States)

**11:50 am – 12:40 pm**

Grand Peninsula Ballroom A

This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.

IMSE-082

**CMOS image sensor pixel design and optimization**, Boyd Fowler, OmniVision Technologies (United States)

Boyd Fowler's research interests include CMOS image sensors, low noise image sensors, noise analysis, data compression, and machine learning and vision. He received his MSEE (1990) and PhD (1995) from Stanford University. After finishing his PhD he stayed at Stanford University as a research associate in the Electrical Engineering Information Systems Laboratory until 1998. In 1998, Fowler founded Pixel Devices International in Sunnyvale California. Between 2005 and 2013, Fowler was CTO and VP of Technology at Fairchild Imaging. He is currently at OmniVision Technologies leading the marketing department. Fowler has authored numerous technical papers, book chapters and patents.

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**VDA: Topological Data Analysis**

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Session Chair: Thomas Wischgoll, Wright State University (United States)

**3:30 – 4:30 pm**

Cypress B

VDA-383

**Topological analysis at the extreme scale: Finding features in large data sets**, Gunther Weber; Lawrence Berkeley National Laboratory and University of California, Davis (United States)

Gunther Weber is a Staff Scientist in LBNL's Computational Research Division and an Adjunct Associate Professor of Computer Science at UC Davis. His research interests include computer graphics, scientific visualization, topological data analysis methods, parallelization of visualization algorithms, hierarchical data representation methods, and bioinformatics. Prior to joining LBNL, Weber worked as a Project Scientist at the Institute for Data Analysis and Visualization (IDAV) at UC Davis focusing on visualization of three-dimensional gene expression data (with researchers of LBNL's Genomics and Life Sciences divisions), topological exploration of scalar data, and visualization of brain imaging data and experimental earthquake data. Weber earned his PhD in computer science, from the University of Kaiserslautern, Germany (2003).

### Thursday, February 2, 2017

#### ERVR: Immersive Visualization Room - Design and Build

Session Chairs: Margaret Dolinsky, Indiana University, and Ian McDowall, Intuitive Surgical / Fakespace Labs (United States)

**9:10 – 10:10 am**

Sandpebble A

ERVR-098

**VR journeys from the dark ages to a bright future**, Gregory Dawe, University of California, San Diego (United States)

Gregory Dawe, the design engineer who made many iterations of CAVE systems possible, will share his perspective on the progression of virtual reality from the first CRT based CAVE system and how it was enhanced during the digital projector era to where we are now with present day flat panel systems. He will discuss the technological quest to improve brightness, resolution and contrast in the crusade to exceed human acuity.

#### IMSE: Sensor design and technology

Session Chairs: Arnaud Peizerat, CEA, and Jean-Michel Tualle, University Paris 13 (France)

**9:50 – 10:20 am**

Harbour

IMSE-188

**A 128×128, 34μm pitch, 8.9mW, 190mK NETD, TECless Uncooled IR bolometer image sensor with columnwise processing**, Laurent Alacoque<sup>1</sup>, Sébastien Martin<sup>1</sup>, Wilfried Rabaud<sup>1</sup>, Édith Beigné<sup>1</sup>, and Antoine Dupret<sup>2</sup>; <sup>1</sup>Minatec Campus and <sup>2</sup>CEA (France)

Laurent Alacoque was born in Lyon, France in 1974. He received the engineering degree in electronics and information processing from the Ecole Supérieure de Chimie Physique et Electronique of Lyon (ESCPE) (1998). In the same year, he joined the Institut National de Sciences Appliquées (INSA) on Villeurbanne Campus for a PhD on the application of Asynchronous Logic to Analogue-Digital Conversion. He received his PhD (2002), and joined the CEA-Leti in 2003, first as a postdoctoral student and then as a member of the smart-imaging laboratory. Since then, his work focuses on the imaging chain, from pixel level design, imager-specific Analogue-Digital Conversion, to Image Signal Processing algorithms.

#### IMSE/AVM: History and Standards for Automotive Vision Systems

Performance Joint Session

Session Chairs: Arnaud Darmont, APHESA SPRL (Belgium), Ralf Widenhorn, Portland State University (United States), and Buyue Zhang, Intel Corporation (United States)

**11:50 am – 12:30 pm**

Harbour

This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Autonomous Vehicles and Machines 2017.

IMSE-196

**Automotive imaging**, Patrick Denny, Valeo (Ireland)

Patrick Denny is a Senior Research Engineer and a Valeo Senior Expert and has worked for the last 15 years at Valeo Vision Systems, Ireland. He received his PhD in physics (2000) from the National University of Ireland, Galway, where he is also Adjunct Professor of Automotive Electronics. Denny has in excess of 20 years experience in scientific and technological development internationally, designing, innovating and developing automotive imaging technologies for BMWV, Jaguar Land Rover, Daimler, VW, and other OEMs. His research interests include several aspects of automotive vision system image quality, sensor components, algorithmic design, systems, machine learning and data analytics.

#### IMSE: Image Sensors for Devices of Internet of Things

Session Chairs: Arnaud Darmont, APHESA SPRL (Belgium), and Ralf Widenhorn, Portland State University (United States)

**2:40 – 3:20 pm**

Harbour

IMSE-195

**In the quest of vision-sensors-on-chip: Pre-processing sensors for data reduction**, Angel Rodríguez-Vázquez, Universidad de Sevilla (Spain)

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 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 world-wide 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.



## Joint Sessions

### Monday, January 30, 2017

#### Surface Appearance Modeling and Reproduction Joint Session

Session Chair: Francisco Imai (United States)

**3:30 – 4:50 pm**

Regency Ballroom C

This session is jointly sponsored by: Material Appearance 2017 and Color Imaging XXII: Displaying, Processing, Hardcopy, and Applications.

3:30 MAAP-288

**Modeling and reproducing effect paints**, Gary Meyer and Avery Musbach, Univ. of Minnesota (United States)

3:50 MAAP-289

**How to design a recto-verso print displaying different images in various everyday-life lighting conditions**, Nicolas Dalloz<sup>1,2</sup>, Serge Mazauric<sup>1,3</sup>, Mathieu Hebert<sup>1</sup>, and Thierry Fournel<sup>1</sup>; <sup>1</sup>Univ. Lyon, UJM-Saint-Etienne, CNRS, Institut d'Optique Graduate School, <sup>2</sup>Institut d'Optique Graduate School, and <sup>3</sup>CPE Lyon (France)

4:10 MAAP-290

**Appearance decomposition and reconstruction of textured fluorescent objects**, Shoji Tominaga, Keiji Kato, Keita Hirai, and Takahiko Horiuchi, Chiba University (Japan)

4:30 MAAP-291

**Assessing the proper color of translucent materials by an extended two-flux model from measurements based on an integrating sphere**, Lionel Simonot<sup>1</sup>, Mathieu Hebert<sup>2</sup>, Serge Mazauric<sup>2,3</sup>, and Roger Hirsch<sup>4</sup>; <sup>1</sup>Université de Poitiers (France), <sup>2</sup>Université Jean Monnet de Saint Etienne (France), <sup>3</sup>CPE Lyon, Domaine Scientifique de la Doua (France), and <sup>4</sup>École Polytechnique Fédérale de Lausanne (Switzerland)

### Tuesday, January 31, 2017

#### Keynote: Mobile Device Camera IQ Joint Session

Session Chairs: Susan Farnand, Rochester Institute of Technology, and Jackson Roland, Apple Inc. (United States)

**8:50 – 9:20 am**

Grand Peninsula Ballroom A

This session is jointly sponsored by: Image Quality and System Performance XIV and Digital Photography and Mobile Imaging XIII.

IQSP-249

**Towards the development of the IEEE P1858 CPIQ standard – A validation study**, Elaine Jin<sup>1</sup>, Jonathan Phillips<sup>1</sup>, Susan Farnand<sup>2</sup>, Margaret Belska<sup>3</sup>, Vinh Tran<sup>3</sup>, Ed Chang<sup>1</sup>, Yixuan Wang<sup>3</sup>, and Benjamin Tseng<sup>4</sup>; <sup>1</sup>Google Inc. (United States), <sup>2</sup>Rochester Institute of Technology (United States), <sup>3</sup>NVIDIA (United States), and <sup>4</sup>Apkudo (Australia)

*Elaine W. Jin holds a PhD in optical engineering from Zhejiang University in China, and a PhD in psychology from the University of Chicago. She has worked in the imaging industry for 15+ years including employment*

*at Polaroid Corporation, Eastman Kodak Company, Micron Technologies, Aptina Imaging, Marvell Semiconductors, and Intel Corporation. She currently is a staff image scientist at Google, working on developing cutting-edge consumer hardware products. Her primary research interests include imaging systems design and analysis, color imaging, and psychophysics. She has published 22 journal and conference papers, and authored 14 US patents / patent applications. She joined the CPIQ initiative (Camera Phone Image Quality) in 2006, and since then has made major contributions in the development of the softcopy quality ruler method, and the CPIQ metrics for visual noise, texture blur, spatial frequency responses, chroma level, and color uniformity. She currently leads the Color/Tone Subgroup of the IEEE CPIQ Standard Working Group.*

#### Human Vision and Stereoscopic Imaging Joint Session

Session Chairs: Nicolas Holliman, University of Newcastle (United Kingdom), and Thrasyvoulos Pappas, Northwestern University (United States)

**8:50 – 10:10 am**

Grand Peninsula Ballroom D

This session is jointly sponsored by: Stereoscopic Displays and Applications XXVIII and Human Vision and Electronic Imaging 2017.

8:50 HVEI-378

**Depth-compressed expression for providing natural, visual experiences with integral 3D displays**, Yasuhito Sawahata and Toshiya Morita, Japan Broadcasting Corporation (Japan)

9:10 HVEI-379

**Blind quality prediction of stereoscopic 3D images**, Jiheng Wang<sup>1</sup>, Qingbo Wu<sup>2</sup>, Abdul Rehman<sup>1</sup>, Shiqi Wang<sup>1</sup>, and Zhou Wang<sup>1</sup>; <sup>1</sup>University of Waterloo (Canada) and <sup>2</sup>University of Electronic Science and Technology of China (China)

9:30 SD&A-380

**Pseudo-haptic by stereoscopic images and effects on muscular activity**, Takashi Kawai<sup>1</sup>, Fumiya Ohta<sup>1</sup>, Sanghyun Kim<sup>1</sup>, and Hiroyuki Morikawa<sup>1,2</sup>; <sup>1</sup>Waseda University and <sup>2</sup>Aoyama Gakuin University (Japan)

9:50 SD&A-381

**The effects of proximity cues on visual comfort when viewing stereoscopic contents (JIST-first)**, Yaohua Xie<sup>1</sup>, Danli Wang<sup>2</sup>, and Heng Qiao<sup>3</sup>; <sup>1</sup>Chinese Academy of Sciences, <sup>2</sup>Institute of Software, Chinese Academy of Sciences, and <sup>3</sup>Central University of Finance and Economics (China)

#### Surface Appearance Assessment and Digital Methods I Joint Session

Session Chair: Greg Ward, Dolby Laboratories (United States)

**9:10 – 10:10 am**

Grand Peninsula Ballroom C

This session is jointly sponsored by: Material Appearance 2017 and 3D Image Processing, Measurement (3DIPM), and Applications 2017.

9:10 MAAAP-282  
**Graininess appearance of goniochromatic samples in lighting cabinets,**  
*Paola Iacomussi, Michela Radis, and Giuseppe Rossi, INRIM (Italy)*

9:30 MAAAP-283  
**Measurement and evaluation method of orange peel,** *Takuroh Sone and Shuhei Watanabe, Ricoh Company, Ltd. (Japan)*

9:50 MAAAP-284  
**Enhanced RTI for gloss reproduction,** *Peter Fornaro, Andrea Bianco, and Lukas Rosenthaler, University of Basel (Switzerland)*

**Mobile Device Camera IQ** Joint Session

Session Chairs: Susan Farnand, Rochester Institute of Technology, and Jackson Roland, Apple Inc. (United States)

**9:20 – 10:20 am**  
 Grand Peninsula Ballroom A

This session is jointly sponsored by: Image Quality and System Performance XIV and Digital Photography and Mobile Imaging XIII.

9:20 IQSP-250  
**A methodology for perceptual image quality assessment of smartphone cameras – Color quality,** *Susan Farnand, Rochester Institute of Technology (United States)*

9:40 IQSP-251  
**Assessing the ability of simulated laboratory scenes to predict the image quality performance of HDR captures (and rendering) of exterior scenes using mobile phone cameras,** *Amelia Spooner<sup>1</sup>, Ashley Solter<sup>1</sup>, Fernando Voltolini de Azambuja<sup>1</sup>, Nitin Sampat<sup>1</sup>, Stephen Viggiano<sup>1</sup>, Brian Rodricks<sup>2</sup>, and Cheng Lu<sup>3</sup>; <sup>1</sup>Rochester Institute of Technology, <sup>2</sup>SensorSpace, LLC, and <sup>3</sup>Intel Corporation (United States)*

10:00 DPMI-252  
**Cell phone rankings!,** *Dietmar Wueller, Image Engineering GmbH & Co. KG (Germany)*

**Surface Appearance Assessment and Digital Methods II** Joint Session

Session Chair: Mathieu Hebert, Université Jean Monnet de Saint Etienne (France)

**10:50 – 11:50 am**  
 Grand Peninsula Ballroom C

This session is jointly sponsored by: Material Appearance 2017 and 3D Image Processing, Measurement (3DIPM), and Applications 2017.

10:50 MAAAP-285  
**Consistent tool-independent virtual material appearance,** *Dar'ya Guarnera<sup>1</sup>, Giuseppe Claudio Guarnera<sup>1</sup>, Cornelia Denk<sup>2</sup>, and Mashhuda Glencross<sup>1,3</sup>; <sup>1</sup>Loughborough University (United Kingdom), <sup>2</sup>BMW Research (Germany), and <sup>3</sup>Switch That Limited (United Kingdom)*

11:10 MAAAP-286  
**Interactive object surface retexturing using perceptual quality indexes,** *Keita Hirai, Wataru Suzuki, Yoshimitsu Yamada, and Takahiko Horiuchi, Chiba University (Japan)*

**MTF** Joint Session

Session Chairs: Peter Burns, Burns Digital Imaging, and Feng Li, GoPro Inc. (United States) **10:50 am – 12:30 pm**

Grand Peninsula Ballroom A

This session is jointly sponsored by: Image Quality and System Performance XIV and Digital Photography and Mobile Imaging XIII.

10:50 IQSP-253  
**Characterization of entire imaging plane spatial frequency response,** *Victor Lenchenkov, Orit Skorka, Stan Micinski, and Radu Ispasoiu, ON Semiconductor (United States)*

11:10 IQSP-254  
**Reverse-projection method for measuring camera MTF,** *Stan Birchfield, Microsoft Corporation (United States)*

11:30 IQSP-255  
**Texture MTF from images of natural scenes,** *Riccardo Branca<sup>1</sup>, Sophie Triantaphyllidou<sup>1</sup>, and Peter Burns<sup>2</sup>; <sup>1</sup>University of Westminster (United Kingdom) and <sup>2</sup>Burns Digital Imaging (United States)*

11:50 DPMI-256  
**Camera phone texture preservation measurements with modulation transfer function: An alternative approach for noise estimation of random texture chart images,** *Nitin Suresh<sup>1,2</sup>, Joshua Pfefer<sup>1</sup>, and Quanzeng Wang<sup>1</sup>; <sup>1</sup>U.S. Food and Drug Administration and <sup>2</sup>University of Maryland (United States)*

12:10 IQSP-257  
**The effects of misregistration on the dead leaves cross-correlation texture blur analysis,** *Ranga Burada<sup>1</sup>, Robert Sumner<sup>1</sup>, and Noah Kram<sup>2</sup>; <sup>1</sup>Imatest, LLC and <sup>2</sup>Rochester Institute of Technology (United States)*

**Image Interpolation, Restoration, and Denoising** Joint Session

Session Chairs: Karen Egiazarian, Tampere University of Technology (Finland), and Radka Tezaur, Intel Corporation (United States)

**3:30 – 5:30 pm**  
 Grand Peninsula Ballroom A

This session is jointly sponsored by: Digital Photography and Mobile Imaging XIII and Image Processing: Algorithms and Systems XV.

3:30 DPMI-083  
**BM3D-HVS: Content-adaptive denoising for improved visual quality (Invited),** *Karen Egiazarian<sup>1,2</sup>, Aram Danielyan<sup>2</sup>, Nikolay Ponomarenko<sup>1,2</sup>, Alessandro Foi<sup>1,2</sup>, Oleg Ieremeiev<sup>3</sup>, and Vladimir Lukin<sup>3</sup>; <sup>1</sup>Tampere University of Technology (Finland), <sup>2</sup>Noiseless Imaging Oy (Finland), and <sup>3</sup>National Aerospace University (Ukraine)*

3:50 IPAS-084  
**Refining raw pixel values using a value error model to drive texture synthesis,** *Henry Dietz, University of Kentucky (United States)*

4:10 IPAS-085  
**Color interpolation based on colorization for RGB-white color filter array,** *Paul Oh<sup>1</sup>, Sukho Lee<sup>2</sup>, and Moon Gi Kang<sup>1</sup>; <sup>1</sup>Yonsei University and <sup>2</sup>Dongseo University (Republic of Korea)*

4:30 IPAS-086  
**Video frame synthesizing method for HDR video capturing system with four image sensors,** *Takayuki Yamashita<sup>1,2</sup> and Yoshihiro Fujita<sup>1</sup>; <sup>1</sup>Ehime University and <sup>2</sup>NHK (Japan)*

4:50 DPMI-088  
**Robust defect pixel detection and correction for Bayer Imaging Systems**,  
*Noha El-Yamany, Intel Corporation (Finland)*

**Wednesday, February 1, 2017**

**Keynote: Sharp High-quality Color Interpolation** Joint Session

Session Chairs: Kevin Matherson, Microsoft Corporation (United States), and Dietmar Wueller, Image Engineering GmbH & Co. KG (Germany)

**8:50 – 9:30 am**  
 Grand Peninsula Ballroom A

This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.

**Conference Chair Opening Remarks**

**Bayer pattern and image quality**, *Jörg Kunze, Basler AG (Germany)* IMSE-077

Jörg Kunze has 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. Kunze serves as an expert for image sensors, camera hardware, noise, color fidelity, 3D- and computational imaging and develops new algorithms for color image signal processing. The majority of the Basler patents name him as inventor.

**Input Signal Quality & Characterization** Joint Session

Session Chairs: Kevin Matherson, Microsoft Corporation (United States), and Dietmar Wueller, Image Engineering GmbH & Co. KG (Germany)

**9:30 – 10:10 am**  
 Grand Peninsula Ballroom A

This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.

9:30 IMSE-078  
**Accurate joint geometric camera calibration of visible and far-infrared cameras**, *Takashi Shibata<sup>1,2</sup>, Masayuki Tanaka<sup>1</sup>, and Masatoshi Okutomi<sup>1</sup>*;  
<sup>1</sup>Tokyo Institute of Technology and <sup>2</sup>NEC Corporation (Japan)

9:50 DPMI-079  
**Interferometric measurement of sensor MTF and crosstalk**, *Todor Georgiev, Jennifer Gille, Amber Sun, Lyubomir Baev, and Tharun Battula, Qualcomm Technologies, Inc. (United States)*

**Keynote: Machine Vision Retina Improvement** Joint Session

Session Chairs: Thomas Vogelsang, Rambus Inc., and Ralf Widenhorn, Portland State University (United States)

**10:50 – 11:30 am**  
 Grand Peninsula Ballroom A

This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.

**Silicon retina technology (Invited)**, *Tobi Delbruck, Institute for Neuroinformatics (INI) (Switzerland)*

Tobi Delbruck (IEEE M'99-SM'06-F'13) received a PhD from Caltech (1993). He is currently a professor of physics and electrical engineering at ETH Zurich in the Institute of Neuroinformatics, University of Zurich and ETH Zurich, Switzerland, where he has been since 1998. His group, which he coordinates together with Shih-Chii Liu, focuses on neuromorphic event-based sensors and sensory processing. He has co-organized the Telluride Neuromorphic Cognition Engineering summer workshop and the live demonstration sessions at ISCAS and NIPS. Delbruck is past Chair of the IEEE CAS Sensory Systems Technical Committee. He worked on electronic imaging at Arithmos, Synaptics, National Semiconductor, and Foveon and has founded 3 spin-off companies, including inilabs.com, a non-for-profit organization that has distributed hundreds of R&D prototype neuromorphic sensors to more than a hundred organizations around the world. He has been awarded 9 IEEE awards.

**Emerging Imaging Sensor & Hardware** Joint Session

Session Chairs: Thomas Vogelsang, Rambus Inc., and Ralf Widenhorn, Portland State University (United States)

**11:30 – 11:50 am**  
 Grand Peninsula Ballroom A

This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.

11:30 DPMI-081  
**TIK: A time domain continuous imaging testbed using conventional still images and video**, *Henry Dietz, John Fike, Paul Eberhart, Katie Long, Clark Demaree, and Jong Wu, University of Kentucky (United States)*

**Keynote: Comparing CMOS Image Sensor Architectures** Joint Session

Session Chairs: Thomas Vogelsang, Rambus Inc., and Ralf Widenhorn, Portland State University (United States)

**11:50 am – 12:40 pm**  
 Grand Peninsula Ballroom A

This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.

**CMOS image sensor pixel design and optimization**, *Boyd Fowler, OmniVision Technologies (United States)* IMSE-082

**Image Sensors and Imaging Systems 2017 Awards**  
 Boyd Fowler's research interests include CMOS image sensors, low noise image sensors, noise analysis, data compression, and machine learning and vision. He received his MSEE (1990) and PhD (1995) from Stanford University. After finishing his PhD he stayed at Stanford University as a research associate in the Electrical Engineering Information Systems Laboratory until 1998. In 1998, Fowler founded Pixel Devices International in Sunnyvale California. Between 2005 and 2013, Fowler was CTO and VP of Technology at Fairchild Imaging. He is currently at OmniVision Technologies leading the marketing department. Fowler has authored numerous technical papers, book chapters and patents.

**Visualization Facilities** Joint Session

Session Chairs: Margaret Dolinsky, Indiana University (United States), and Andrew Woods, Curtin University (Australia)

**3:30 – 5:40 pm**

Grand Peninsula Ballroom D

This session is jointly sponsored by: Stereoscopic Displays and Applications XXVIII and The Engineering Reality of Virtual Reality 2017.

3:30 SD&A-105

**Designing a cloud-based 3D visualization engine for smart cities,** *Nicolas Holliman, Stephen Dowsland, Mark Turner, Richard Cloete, and Tom Picton, Newcastle University (United Kingdom)*

3:50 SD&A-106

**Interactive computer graphics, stereo and VR practice at the Electronic Visualization Laboratory University of Illinois at Chicago,** *Maxine Brown<sup>1</sup>, Jason Leigh<sup>2</sup>, Tom DeFanti<sup>3</sup>, and Daniel Sandin<sup>1</sup>; <sup>1</sup>The University of Illinois at Chicago, <sup>2</sup>University of Hawai'i at Manoa, and <sup>3</sup>University of California, San Diego (United States)*

4:10 ERVR-107

**Designing at the Advanced Visualization Lab at Indiana University,** *Margaret Dolinsky<sup>1</sup>, Eric Wernert<sup>2</sup>, Michael Boyles<sup>2</sup>, and Chris Eller<sup>2</sup>; <sup>1</sup>School of Art and Design, Indiana University and <sup>2</sup>Advanced Visualization Lab, Indiana University (United States)*

4:30 ERVR-108

**Exploring Calit2,** *Jürgen Schulze and Gregory Dawe, University of California, San Diego (United States)*

4:50 SD&A-109

**3D-Stereoscopic immersive analytics projects at Monash University and University of Konstanz,** *Björn Sommer<sup>1,3</sup>, David G. Barnes<sup>1,4</sup>, Sarah Boyd<sup>1</sup>, Thomas Chandler<sup>1</sup>, Maxime Cordeil<sup>1</sup>, Karsten Klein<sup>1,3</sup>, Toan Nguyen<sup>4</sup>, Hieu Nim<sup>1,5</sup>, Kingsley Stephens<sup>1</sup>, Dany VohP, Elliott Wilson<sup>1</sup>, Jon McCormack<sup>1</sup>, Kim Marriott<sup>1</sup>, and Falk Schreiber<sup>1,3</sup>; <sup>1</sup>Monash University (Australia), <sup>2</sup>Swinburne University of Technology (Australia), <sup>3</sup>University of Konstanz (Germany), <sup>4</sup>Monash Immersive Visualization Platform at Monash University (Australia), and <sup>5</sup>Australian Regenerative Medicine Institute of Monash University (Australia)*

5:10 SD&A-110

**Image distortions in large-scale immersive display systems – Cylinder and wedge displays,** *Andrew Woods<sup>1</sup>, Joshua Hollick<sup>1</sup>, Jesse Helliwell<sup>1</sup>, and Paul Bourke<sup>2</sup>; <sup>1</sup>Curtin University and <sup>2</sup>University of Western Australia (Australia)*

5:30  
**SD&A Closing Remarks,** *Nicolas Holliman, Newcastle University (United Kingdom)*

**Thursday, February 2, 2017**

**Keynote: History and Standards for Automotive Vision Systems**

**Performance** Joint Session

Session Chairs: Arnaud Darmont, APHESA SPRL (Belgium); Ralf Widenhorn, Portland State University (United States); and Buyue Zhang, Intel (United States)

**11:50 am – 12:30 pm**

Harbour

This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Autonomous Vehicles and Machines 2017.

IMSE-196

**Automotive imaging,** *Patrick Denny, VALEO (Ireland)*

Patrick Denny is a Senior Research Engineer and a Valeo Senior Expert and has worked for the last 15 years at Valeo Vision Systems, Ireland. He received his PhD in physics (2000) from the National University of Ireland, Galway, where he is also Adjunct Professor of Automotive Electronics. Denny has in excess of 20 years experience in scientific and technological development internationally, designing, innovating and developing automotive imaging technologies for BMW, Jaguar Land Rover, Daimler, VW, and other OEMs. His research interests include several aspects of automotive vision system image quality, sensor components, algorithmic design, systems, machine learning and data analytics.

**Interactive Workshop: How can COLOR imaging provide US with powerful INSIGHTS?** Joint Session

Moderator: Fritz Lebowsky, STMicroelectronics (France)

**2:00 – 5:00 pm**

Regency Ballroom C

This session is jointly sponsored by: Color Imaging XXII: Displaying, Processing, Hardcopy, and Applications and Material Appearance 2017.

COLOR-062

**Interactive Workshop: How can color imaging provide us with powerful insights?,** *Fritz Lebowsky, STMicroelectronics (France)*

We would very much like to have you participate in a special session in which we encourage asking questions and exchange ideas that frequently trouble us during research and development projects. The presence of experts in COLOR imaging and perhaps Electronic Imaging at large will provide a unique opportunity of efficiently and lively sharing simple/stupefying ideas enabling fascinating engineering concepts which may also stimulate your own future research and development projects!

## Paper Schedule by Day/Time

### Monday, January 30, 2017

#### 8:50 am

- AVM-009 Architectures for automated driving (*Weast*)  
 COIMG-453 Deep neural networks for synchrotron X-ray imaging (*Yang*)  
 DPMI-063 Stabilized high-speed video from camera arrays (*El Choubassi*)  
 IQSP-218 Blind image quality assessment using multiscale local binary patterns (IJST-first) (*Garcia Freitas*)  
 MWFSF-316 The nimble challenges for media forensics (*Phillips*)  
 SD&A-353 Expert viewers' preferences for higher frame rate 3D film (IJST-first) (*Allison*)

#### 9:10 am

- COIMG-415 Synchrotron x-ray diffraction dynamic sampling for protein crystal centering (*Simpson*)  
 DPMI-064 Panoramic background estimation from RGB-D videos (*Bampis*)  
 HVEI-111 Vision at a glance (Invited) (*Rosenholtz*)  
 IQSP-219 Dimension reduction-based attributes selection in no-reference learning-based image quality algorithms (*Charrier*)  
 SD&A-354 Investigating aircrew depth perception standards using a stereoscopic simulation environment (*Winterbottom*)

#### 9:30 am

- COIMG-416 An iterative method to estimate and recover systematic and random errors in grating based x-ray phase contrast imaging (*Lim*)  
 DPMI-065 Accurate measurement of point to point distances in 3D camera images (*Seshadrinathan*)  
 IQSP-220 GPGPU based implementation of a high performing No Reference (NR)- IQA algorithm, BLINDS-II (*Yadav*)  
 SD&A-355 Estimation of altitude in stereoscopic-3D versus 2D real-world scenes (*Deas*)

#### 9:40 am

- CVAS-342 Virtual tracking shots for sports analysis (*Bennett*)

#### 9:50 am

- AVM-010 3D Perception: multi-camera embedded structure-from-motion prototype for real-time mapping (*Mueller*)  
 COIMG-417 A model based neuron detection approach using sparse location priors (*Majee*)  
 DPMI-066 A novel framework for fast MRF optimization (*Somanath*)  
 IQSP-221 No-reference image contrast assessment based on just-noticeable-difference (*Kim*)

SD&A-356

Study of objective parameters of 3D visual fatigue based on analysis of salient area (*Du*)

#### 10:00 am

- CVAS-343 Aerodynamic analysis via foreground segmentation (*Carey*)

#### 10:10 am

- AVM-451 Measuring MTF with wedges: Pitfalls and best practices (*Koren*)  
 COIMG-449 Multi-resolution Data Fusion (MDF) for computational electron microscopy (*Sreehari*)

#### 10:30 am

- HVEI-112 Eidolons: Effects of capricious local sign (Invited) (*Koenderink*)  
 MWFSF-317 Embedding information into objects fabricated with 3-D printers by forming fine cavities inside them (*Suzuki*)

#### 10:50 am

- AVM-012 Free-view multi-camera visualization and harmonization for automotive systems (*Zlokica*)  
 COIMG-418 High spatial resolution detection method for point light source in scintillator (*Xu*)  
 CVAS-344 Goal! Event detection in sports video (*Tsagakatakis*)  
 DPMI-067 Heterogeneous computational imaging (*Pulli*)  
 IQSP-222 How to use video quality metrics for something other than video compression (*Kokaram*)  
 MAAP-273 Comparison between angularly and spectrally resolved gloss measurements with gloss measurements carried out on a national reference goniometer for gloss calibration (*Charriere*)  
 SD&A-357 Architectures and codecs for real-time light field streaming (IJST-first) (*Kovács*)  
 VIPC-398 A fast TU mode decision algorithm based on residual difference for HEVC (*Li*)

#### 10:55 am

- MWFSF-319 High-capacity reversible data hiding in encrypted images using MSB prediction (*Puteaux*)

#### 11:00 am

- HVEI-113 Careful methods and measurements for comparisons between men and machines (Invited) (*Wichmann*)

#### 11:10 am

- AVM-013 Accelerated stereo matching for autonomous vehicles using upright pinhole camera model (*Chen*)

## Paper Schedule by Day/Time

COIMG-419	A randomized approach to reduce metal artifacts in x-ray computed tomography ( <i>Castañón</i> )	MAAP-276	Optimal LED selection for multispectral lighting reproduction ( <i>LeGendre</i> )
CVAS-345	Pose estimation for deriving kinematic parameters of competitive swimmers ( <i>Zecha</i> )	SD&A-360	Multilevel light modulation of three-dimensional magneto-optic spatial light modulator using optically addressing method ( <i>Nakamura</i> )
MAAP-274	A normal vector and BTF profile measurement system using a correlation camera and scanning dome illumination ( <i>Kimachi</i> )	VIPC-401	Compression of infrared images ( <i>Mantel</i> )
SD&A-358	Wide viewing angle projection-type integral 3D display system with multiple UHD projectors ( <i>Vatanabe</i> )	<b>12:00 pm</b>	
VIPC-399	A fast intra mode decision algorithm for HEVC ( <i>Liao</i> )	HVEI-116	Emerging visual representations in deep learning networks (Invited) ( <i>Oliva</i> )
<b>11:20 am</b>		<b>12:10 pm</b>	
MWSF-320	The A Priori knowledge based secure payload estimation for additive model ( <i>Ma</i> )	AVM-011	Real-time flight altitude estimation using phase correlation with gram polynomial decimation ( <i>Badshah</i> )
<b>11:30 am</b>		COIMG-422	Fast and robust discrete computational imaging ( <i>Tuysuzoglu</i> )
AVM-014	Perspectively correct bird's views using stereo vision, Christian Fuchs and Dietrich Paulus, University of Koblenz-Landau ( <i>Germany</i> )	DPMI-070	Representation and compression for cinematic VR (Invited) ( <i>Lakshman</i> )
COIMG-420	Joint segmentation and material recognition in dual-energy CT images ( <i>Castañón</i> )	IQSP-225	Image quality assessment by comparing CNN features between images (IJST-first) ( <i>Ali Amirshahi</i> )
CVAS-346	Comparison of a virtual game-day experience on varying devices ( <i>Miller</i> )	SD&A-361	Integral three-dimensional display with high image quality using multiple flat-panel displays ( <i>Okaichi</i> )
DPMI-068	Is there a multi-camera future? (Invited) ( <i>Macmillan</i> )	VIPC-402	Graph regularized sparse coding by modified online dictionary learning ( <i>Sha</i> )
HVEI-114	Perceptual and engineering implications of cascaded gain control models (Invited) ( <i>Simoncelli</i> )	<b>2:00 pm</b>	
IQSP-223	MS-UNIQUE: Multi-model and sharpness-weighted unsupervised image quality estimation ( <i>Prabhushankar</i> )	PLENARY	Giga-scale 3D computational microscopy ( <i>Waller</i> )
MAAP-275	Polarimetric multispectral bidirectional reflectance distribution function measurements using a Fourier transform instrument ( <i>Boher</i> )	<b>3:30 pm</b>	
SD&A-359	A novel hardware based method for multiview glassless 3D display ( <i>Chen</i> )	AVM-016	Needs and challenges analysis for reference architectures in autonomous systems ( <i>Zander</i> )
VIPC-400	Diamond frequency domain inter frame motion estimation for HEVC ( <i>Abdelazim</i> )	COIMG-423	Linear mapping based inverse tone mapping ( <i>Kim</i> )
<b>11:50 am</b>		CVAS-348	Automated sports broadcasting ( <i>Carr</i> )
AVM-015	A sense and avoid algorithm using surround stereo vision for drones ( <i>Godaliyadda</i> )	DPMI-071	Quantifying the luminance ratio of interior and exterior scenes: Challenges and tradeoffs in definitions, current standards, measurement methodologies and instrumentation, capturing capabilities of digital cameras, effects of veiling glare ( <i>Voltoni de Azambuja</i> )
COIMG-421	MultiGPU acceleration of branchless distance driven projection and backprojection for Clinical Helical CT (IJST-first) ( <i>Mitra</i> )	HVEI-117	Movies and meaning: From low-level features to mind reading (Invited) ( <i>Benini</i> )
CVAS-347	Digital playbook – A teaching tool for American football ( <i>Vorstandlechner</i> )	IQSP-226	Potential contrast – A new image quality measure ( <i>Shaus</i> )
DPMI-069	Capturing light field video for 6-DOF VR playback (Invited) ( <i>Jiang</i> )	MAAP-288	Modeling and reproducing effect paints ( <i>Meyer</i> )
IQSP-224	Microarchitectural analysis of a GPU implementation of the most apparent distortion image quality assessment algorithm ( <i>Kannan</i> )	MWSF-321	Benefits of combining forensic image creation and file carving ( <i>Steinebach</i> )
		SD&A-362	Stereoscopic displays, tracking, interaction, education, and the web ( <i>Chavez</i> )
		VIPC-403	A coarse-to-fine framework for video object segmentation ( <i>Zhang</i> )

**3:50 pm**

- COIMG-424 Performance of the 14 skin-colored patches to accurately estimate the human skin (*Choi*)
- DPMI-072 Sensitivity analysis applied to ISO recommended camera color calibration methods to determine how much of an advantage, if any, does spectral characterization of the camera offer over the chart-based approach (*Sampat*)
- IQSP-227 Observer calibrator for color vision research (*Zhou*)
- MAAP-289 How to design a recto-verso print displaying different images in various everyday-life lighting conditions (*Dalloz*)
- VIPC-404 A fast and accurate segmentation method for medical images (*Wu*)

**3:55 pm**

- MWSF-322 Codec-embedded MP3 partial encryption for DRM (*Steinebach*)

**4:10 pm**

- COIMG-425 Skin-representative region in a face for finding true skin color (*Suk*)
- DPMI-073 Perceptual optimization driven by image quality metrics (Invited) (*Wang*)
- IQSP-228 Knowledge based taxonomic scheme for full reference objective image quality measurement models (IJST-first) (*Lahoulou*)
- MAAP-290 Appearance decomposition and reconstruction of textured fluorescent objects (*Tominaga*)
- VIPC-405 Adaptive combination of local motion, appearance, and shape for video segmentation (IJST-first) (*Lee*)

**4:20 pm**

- HVEI-119 On the role of color in visual saliency (*Etchebehere*)
- MWSF-323 How to recompress a JPEG crypto-compressed image? (*Itier*)

**4:30 pm**

- AVM-017 Enabling functional safety ASIL compliance for autonomous driving software systems (*Chitnis*)
- DPMI-074 Looming challenges in mobile imaging quality: New technologies and new markets (Invited) (*Cardinal*)
- IQSP-229 A RGB-NIR data set for evaluating dehazing algorithms (*Lüthen*)
- MAAP-291 Assessing the proper color of translucent materials by an extended two-flux model from measurements based on an integrating sphere (*Simonot*)

**Tuesday, January 31, 2017**

**8:50 am**

- AVM-018 Common themes in autonomous navigation on earth and in space (*Matthies*)
- COIMG-454 Atomistic simulations of interface characteristics in materials systems (*Rickman*)
- COLOR-026 Wide-gamut mobile-device displays: Gamut-mapping and color enhancement challenges (*Safaei-Rad*)
- HVEI-378 Depth-compressed expression for providing natural, visual experiences with integral 3D displays (*Sawahata*)
- IPAS-197 Compressed sensing MRI using curvelet sparsity and nonlocal total variation (*Pour Yazdanpanah*)
- IQSP-249 Towards the development of the IEEE P1858 CPIQ standard – A validation study (*Jin*)
- MWSF-324 Pre-training via fitting deep neural network to rich-model features extraction procedure and its effect on deep learning for steganalysis (*Zeng*)
- VIPC-406 Improvement of infrared image based on directional anisotropic wavelet transform (*Jin*)

**9:00 am**

- SRV-349 Traffic light recognition and dangerous driving events detection from surveillance video of vehicle camera (*Guan*)

**9:10 am**

- COIMG-426 A phase-coded aperture camera with programmable optics (*Chen*)
- COLOR-027 Methods of defining a gamut boundary based on a face/vertex encoding (*Green*)
- HVEI-379 Blind quality prediction of stereoscopic 3D images (*Wang*)
- IPAS-198 Brand detection framework in LG wavelet domain (*Mangiatordi*)
- MAAP-282 Graininess appearance of goniochromatic samples in lighting cabinets (*Iacomussi*)
- VIPC-407 New diamond half-pel hexagon search algorithm for block matching motion estimation (*Abdelazim*)

**9:15 am**

- MWSF-325 Histogram layer, moving convolutional neural networks towards feature-based steganalysis (*Sedighianaraki*)

**9:20 am**

- IQSP-250 A methodology for perceptual image quality assessment of smartphone cameras – color quality (*Farnand*)
- SRV-350 A combined HOG and deep convolution network cascade for pedestrian detection (*Lipetski*)

**9:30 am**

- COIMG-427 Wavefront correction using self-interference incoherent digital holography (*Bang*)
- COLOR-028 Gamut mapping in RGB colour spaces with the iterative ratios diffusion algorithm (*Farup*)
- IPAS-199 Texture representations in different basis functions for image synthesis using system criteria analysis (*Voronin*)
- MAAP-283 Measurement and evaluation method of orange peel (*Sone*)
- SD&A-380 Pseudo-haptic by stereoscopic images and effects on muscular activity (*Kawai*)
- VIPC-408 Self-example-based edge enhancement algorithm for around view monitor images (*Choi*)

**9:40 am**

- IQSP-251 Assessing the ability of simulated laboratory scenes to predict the image quality performance of HDR captures (and rendering) of exterior scenes using mobile phone cameras. (*Spooner*)
- MWSF-326 Model based steganography with precover (*Denemark*)
- SRV-352 A multi-scale approach to skin pixel detection (*Roheda*)

**9:50 am**

- AVM-019 Milpet – The self-driving wheelchair (*Echefu*)
- COIMG-428 Non-iterative image reconstruction for single photon image sensors (*Chan*)
- COLOR-029 Checklist for daltonization methods: Requirements and characteristics of a good recoloring method (*Simon-Liedtke*)
- IPAS-200 2-D octonion discrete fourier transform: Fast algorithms (*Grigoryan*)
- MAAP-284 Enhanced RTI for gloss reproduction (*Fornaro*)
- SD&A-381 The effects of proximity cues on visual comfort when viewing stereoscopic contents (JIST-first) (*Xie*)
- VIPC-409 Adaptive multireference prediction using a symmetric framework (*Liu*)

**10:00 am**

- SRV-351 Detecting and estimating sound events locations through a microphone array (*Martínez-García*)

**10:10 am**

- COLOR-030 On the edge: A scalable daltonization method focusing on color contrasts and color edges (*Simon-Liedtke*)

**10:30 am**

- MWSF-327 A preliminary study on convolutional neural networks for camera model identification (*Bondi*)

**10:40 am**

- AVM-020 Efficient pre-processor for CNN (*Mody*)
- HVEI-120 Interactions between saliency and utility (*Scott*)

**10:50 am**

- COIMG-429 Single image super-interpolation using adjusted self-exemplars (*Kim*)
- COLOR-033 Estimating appearance differences of 3D objects with an RGB camera (*Sun*)
- IPAS-201 Artifact suppression in compressed images using residual-based deep convolutional network (*Nam*)
- IQSP-253 Characterization of entire imaging plane spatial frequency response (*Lenchenkov*)
- MAAP-285 Consistent tool-independent virtual material appearance (*Guarnera*)
- SD&A-363 See-through projection 3D display using time-division multiplexing (*Kajimoto*)
- VIPC-411 Semi-supervised learning feature representation for historical Chinese character recognition (*Yu*)

**10:55 am**

- MWSF-328 Design principles of convolutional neural networks for multimedia forensics (*Bayar*)

**11:00 am**

- AVM-021 Free-space detection with self-supervised and online trained fully convolutional networks (*Sanberg*)
- HVEI-121 Perceptual evaluation of psychovisual rate-distortion enhancement in video coding (*Duanmu*)

**11:10 am**

- COIMG-430 Temporal super-resolution for time domain continuous imaging (*Dietz*)
- COLOR-034 A metric for the evaluation of color perceptual smoothness (*Marchessoux*)
- IPAS-202 Full-reference metrics multidistortional analysis (*Ieremeiev*)
- IQSP-254 Reverse-projection method for measuring camera MTF (*Birchfield*)
- MAAP-286 Interactive object surface retexturing using perceptual quality indexes (*Hirai*)
- SD&A-364 Flat autostereoscopic 3D display with enhanced resolution using a static color filter barrier (*Lurk*)
- VIPC-412 Document image classification on the basis of layout information (*Zavalishin*)

**11:20 am**

- AVM-022 Motion estimation using visual odometry and deep learning localization (*Bag*)
- HVEI-122 Balancing Type I errors and statistical power in video quality assessment (*Brunstrom*)



## Paper Schedule by Day/Time

MWSF-329 Image recapturing detection with convolutional and recurrent neural network (*Li*)

### 11:30 am

COIMG-431 Edge-aware light-field flow for depth estimation and occlusion detection (*Zhou*)

COLOR-035 Towards a perceptually-motivated color space for high dynamic range imaging (*Abebe*)

IPAS-203 ICA-based background subtraction method for an FPGA-SoC (*Carrizosa-Corral*)

IQSP-255 Texture MTF from images of natural scenes (*Branca*)

SD&A-365 Portrait and landscape mode convertible stereoscopic display using parallax barriers (*Minami*)

### 11:40 am

AVM-023 Deep reinforcement learning framework for autonomous driving (*El Sallab*)

HVEI-123 On the perceptual factors underlying the quality of post-compression enhancement of textures (*Yaacob*)

### 11:45 am

MWSF-330 Autoencoder with recurrent neural networks for video forgery detection (*D'Avino*)

### 11:50 am

COIMG-432 Evaluating age estimation using deep convolutional neural nets (*Belver*)

DPMI-256 Camera phone texture preservation measurements with modulation transfer function: An alternative approach for noise estimation of random texture chart images (*Suresh*)

IPAS-204 A robust line segmentation for Arabic printed text with diacritics (*Mohammad*)

SD&A-366 Digital holographic display with two-dimensional and three-dimensional convertible feature by high speed switchable diffuser (*Hong*)

### 12:00 pm

AVM-024 Automatic glare detection via photometric, geometric, and global positioning information (*Andalibi*)

HVEI-124 Do gaze disruptions indicate the perceived quality of non-uniformly coded natural scenes? (*Rai*)

### 12:10 pm

COIMG-452 3-D Shape recovery from real images using a symmetry prior (*Jayadevan*)

IQSP-257 The effects of misregistration on the dead leaves cross-correlation texture blur analysis (*Burada*)

SD&A-382 A low-cost static volumetric display based on layered high incidence angle scattering (*Frayne*)

### 12:20 pm

AVM-025 Pose estimation from rigid face landmarks for driver monitoring systems (*Shankar*)

HVEI-125 Subjective evaluation of distortions in first-person videos (*Bai*)

### 2:00 pm

PLENARY VR 2.0: Making virtual reality better than reality (*Wetzstein*)

### 3:30 pm

COIMG-433 Augmenting salient foreground detection using Fiedler vector for multi-object segmentation (*Kucer*)

COLOR-036 Color discrimination threshold for medical test devices (*Hassani*)

DPMI-083 BM3D-HVS: Content-adaptive denoising for improved visual quality (Invited) (*Egiazarian*)

HVEI-126 Image and video compression for mobile: Is my screen small enough? (Invited) (*Delp*)

IQSP-230 Towards a quantitative evaluation of multi-imaging systems (*Vlachomitrou*)

MAAP-277 The future of material communication via the Appearance Exchange Format (AxF) (*Ellens*)

MWSF-339 PRNU in practice (*Bruehs*)

SD&A-367 Real time depth estimation method using hybrid camera system (*Baek*)

### 3:40 pm

HVEI-127 Business perspectives on perceptually lossless and lossy quality (Invited) (*Daly*)

### 3:50 pm

COIMG-434 Non-destructive localization of overpaintings in Byzantine miniature illuminations (*Psarrou*)

COLOR-037 Content-dependent adaptation in a soft proof matching experiment (*High*)

HVEI-128 Usage perspectives on perceptually lossless and lossy quality and assessment (Invited) (*Corriveau*)

IPAS-084 Refining raw pixel values using a value error model to drive texture synthesis (*Dietz*)

IQSP-231 Resolution enhancement through superimposition of projected images: An evaluation of the image quality (*Hansen*)

SD&A-368 Pixel based adaptive normalized cross correlation for illumination invariant stereo matching (*Chang*)

### 4:00 pm

HVEI-129 Subjective assessment and the criteria for visually lossless compression (Invited) (*Wilcox*)

### 4:10 pm

COIMG-435 Computing height and width of in situ sorghum plants using 2.5d infrared images (*Baharav*)

- COLOR-038 Comparisons of measures of blurriness in transparent displays (*Yang*)
- HVEI-130 Masked detection of compression artifacts on laboratory, consumer, and mobile displays (Invited) (*Zhang*)
- IPAS-085 Color interpolation based on colorization for RGB-white color filter array (*Oh*)
- IQSP-232 Evaluation of major factors affecting spatial resolution of gamma-rays camera (*Xie*)
- MAAP-278 Material with visual effects: Study of the gonioapparency of the anodized titanium (*Cridling*)
- SD&A-369 Guide image filtering based disparity range control in stereo vision (*Mun*)

**4:20 pm**

- HVEI-131 Industry and business perspectives on the distinctions between visually lossless and lossy video quality: Mobile and large format displays (Invited) (*Brunnstrom*)

**4:30 pm**

- COIMG-436 Non-parametric texture synthesis using texture classification (*Ziga*)
- COLOR-039 The smallest projection optics for the vertical shaped ultra short throw projector (*Takano*)
- IPAS-086 Video frame synthesizing method for HDR video capturing system with four image sensors (*Yamashita*)
- IQSP-233 Development and image quality evaluation of 8K high dynamic range cameras with hybrid log-gamma (*Funatsu*)
- MAAP-279 Adapted modulation transfer function method for characterization and improvement of 2.5D printing. (*PAGE*)

**4:50 pm**

- COIMG-437 On-the-fly performance evaluation of large-scale fiber tracking (*Yu*)
- COLOR-040 Pareto optimality in primary selection for multiprimary displays (*Xie*)
- DPMI-088 Robust defect pixel detection and correction for Bayer Imaging Systems (*El-Yamany*)
- IQSP-234 Detection of streaks caused by dust in the sheetfed scanners (*Kenzhebalin*)
- MAAP-280 Evaluating an image based multi-angle measurement setup using different reflection models (*Sole*)

**5:10 pm**

- COIMG-438 Point cloud based approach to biomass feature extraction (*Jin*)
- IQSP-235 Effect of dark current distribution on image quality (*Skorka*)
- MAAP-281 Model-based skin pigment cartography by high-resolution hyperspectral imaging (IJST-First) (*Seroul*)

**Wednesday, February 1, 2017**

**8:50 am**

- COLOR-041 Color halftoning based on Neugebauer Primary Area Coverage (*Jiang*)
- HVEI-132 Orientation-ocularly maps: A technique for computer vision (*Restrepo*)
- IMSE-077 Bayer pattern and image quality (*Kunze*)
- IPAS-205 Water region extraction in thermal and RGB sequences using spatiotemporally-oriented energy features (*Ghahremani*)
- IRIACV-258 Efficient visual loop closure detection via moment based global image descriptors (*Erhan*)
- MOBMU-292 Introduction to WLAN-fingerprinting based indoor localization (*Akopian*)
- MWSF-331 Videos versus still images: Asymmetric sensor pattern noise comparison on mobile phones (*Galdi*)
- SD&A-340 Sharpness mismatch and 6 other stereoscopic artifacts measured on 10 Chinese S3D movies (*Vatolin*)

**9:10 am**

- COLOR-042 Color halftoning based on multi-stage, multi-pass, clustered-DBS (*Xi*)
- ERVR-089 Oculus rift with stereo camera for augmented reality medical intubation training (*Lim*)
- HVEI-133 Evaluation of color prediction methods in terms of least dissimilar asymmetric matching (*Roshan*)
- IMAWM-157 The internet on things: Delivering augmented reality experiences in context (*Gormish*)
- IPAS-206 Cloud and shadow detection using sequential characteristics on multi-spectral satellite images (*Groot*)
- IQSP-238 Feature ranking and selection used in a machine learning framework for predicting uniformity of printed pages (*Nguyen*)
- IRIACV-259 Real-time mobile robot navigation based on stereo vision and low-cost GPS (*Hong*)
- MOBMU-299 Android door and window image based measurements (*Mohammad*)
- SD&A-370 Bringing 3DMap to the 21<sup>st</sup> century (*Keith*)

**9:15 am**

- MWSF-332 Linear filter kernel estimation based on digital camera sensor noise (*Liu*)

**9:30 am**

- COLOR-43 On large local error accumulation in multilevel error diffusion (IJST-First) (*Eschbach*)
- ERVR-090 Virtual reality instructional modules in education based on gaming metaphor (*Sharma*)

## Paper Schedule by Day/Time

HVEI-134	Characterization of spatiotemporal fluctuation in absorbed light energy by an array of interleaved photosensitive elements ( <i>Peyvandi</i> )	ERVR-093	The Destiny-class CyberCANOE- a surround screen, stereoscopic, cyber-enabled collaboration analysis navigation and observation environment ( <i>Kawano</i> )
IMSE-078	Accurate joint geometric camera calibration of visible and far-infrared cameras ( <i>Shibata</i> )	IMAWM-158	MS-Celeb-1M: A review of large-scale face recognition (Invited) ( <i>Guo</i> )
IPAS-207	Thermal facial signatures for state assessment during deception ( <i>Powar</i> )	IPAS-209	Real-time estimation of the 3D transformation between images with large viewpoint differences in cluttered environments ( <i>van de Vouw</i> )
IQSP-239	Real-time print quality diagnostics ( <i>Xiao</i> )	IQSP-240	UHD quality analyses at various viewing conditions ( <i>Lee</i> )
IRIACV-260	The acceleration effect to the perception of velocity difference in passive elbow flexion movement ( <i>Akatsuka</i> )	IRIACV-262	Application of big data analytics for recognition of microbial colonies from hyperspectral images ( <i>Yoon</i> )
MOBMU-293	Usability of smart mobile micro photonic sensor systems for industrial and non-industrial quality assurance ( <i>Dittrich</i> )	SD&A-374	Stereo rendering of photorealistic precipitation ( <i>Hussain</i> )
SD&A-371	Subjective and objective study of the relation between 3D and 2D views based on depth and bit rate ( <i>Appina</i> )	<b>10:55 am</b>	
<b>9:40 am</b>		MWSF-336	Scalable processing history detector for JPEG images ( <i>Boroumand</i> )
MWSF-333	PRNU-based forgery detection with discriminative random fields ( <i>Chakraborty</i> )	<b>11:00 am</b>	
<b>9:50 am</b>		HVEI-137	A neurally-inspired algorithm for detecting ordinal depth from motion signals in video streams (Invited) ( <i>Livitz</i> )
COLOR-044	Edge-preserving error diffusion for multi-toning based on dual quantization ( <i>Kiyotomo</i> )	MOBMU-296	High quality virtual lighting using image-based-lighting and projection onto meshes generated from Lidar and SfM Point Clouds ( <i>Hasche</i> )
DPMI-079	Interferometric measurement of sensor MTF and crosstalk ( <i>Georgiev</i> )	<b>11:10 am</b>	
ERVR-092	Drawing towards virtual reality ( <i>Dolinsky</i> )	COLOR-046	Page classification for print imaging pipeline ( <i>Xu</i> )
HVEI-135	Robust dynamic range computation for high dynamic range content ( <i>Hulusic</i> )	ERVR-094	CAVE versus head-mounted displays: On-going thoughts ( <i>Mestre</i> )
IPAS-208	Face spoofing detection based on local binary descriptors ( <i>Tsai</i> )	IPAS-210	Camera-to-model back-raycasting for extraction of RGBD images from pointclouds ( <i>Javan Hemmat</i> )
IRIACV-261	Targeted intelligent autonomous robotics contest: The European Roboathon ( <i>Röning</i> )	IQSP-241	Image quality assessment for holographic display ( <i>Seo</i> )
MOBMU-294	Blackmagic production camera raw color investigation by spectral analysis of Macbeth color charts ( <i>Hasche</i> )	IRIACV-263	Weaving pattern recognition of ancient Chinese textiles by regular bands analysis ( <i>Chan</i> )
SD&A-373	Improved depth of field analysis of multilayer displays ( <i>Gotoda</i> )	SD&A-372	Utilization of stereoscopic 3D images in elementary school social studies classes ( <i>Shibata</i> )
<b>10:10 am</b>		<b>11:20 am</b>	
MOBMU-295	Liquid crystal lens characterization for integrated depth sensing and all in focus imaging application ( <i>Emberger</i> )	MOBMU-297	A billion words to remember ( <i>Nagy</i> )
<b>10:30 am</b>		MWSF-337	Deciphering severely degraded license plates ( <i>Agarwal</i> )
HVEI-136	GPU-accelerated vision modeling with the HPE cognitive computing toolkit (Invited) ( <i>Chandler</i> )	<b>11:30 am</b>	
MWSF-335	Sensitivity of different correlation measures to print-and-scan process ( <i>Tkachenko</i> )	COLOR-047	Indirect periodic disturbance compensator using feedforward control for image noises ( <i>Kaneko</i> )
<b>10:50 am</b>		DPMI-081	TIK: A time domain continuous imaging testbed using conventional still images and video ( <i>Dietz</i> )
COLOR-045	Selecting best ink color for sparse watermark ( <i>Reed</i> )	ERVR-095	Distributed rendering using NVIDIA OptiX ( <i>McCarthy</i> )
DPMI-080	Silicon retina technology (Invited) ( <i>Delbruck</i> )	HVEI-138	Computational estimation of scene structure through texture gradient cues (Invited) ( <i>Tyler</i> )

## Paper Schedule by Day/Time

- IMAWM-159 Evaluation of Hadoop and HPC for multimedia big data analysis (*Chinta*)
- IPAS-212 Depth image object extraction approach based on improved fractal dimension (*Cao*)
- IQSP-242 Subjective viewer preference model for automatic HDR down conversion (*Lenzen*)
- IRIACV-264 Finding a needle in a haystack: Recognizing surgical instruments through vision and manipulation (*Zhou*)
- SD&A-375 360° 3D capture: Meeting the need in VR (*Macmillan*)

### 11:40 am

- MOBMU-298 Demographic prediction based on mobile user data (*Podoyntsina*)

### 11:45 am

- MWSF-338 PCB surface fingerprints based counterfeit detection of electronic devices (*Iqbal*)

### 11:50 am

- COLOR-048 3D halftoning (*Mao*)
- ERVR-096 Laser illuminated projectors and the technological advancements brought forth to immersive environments (*Rains*)
- IMAWM-160 Creating the world's largest real-time camera network (*Dailey*)
- IMSE-082 CMOS image sensor pixel design and optimization (*Fowler*)
- IQSP-243 A foveated just noticeable difference model for virtual reality (*Deng*)
- IRIACV-265 Automatic detection of plant roots in multispectral images (*Srinivas*)

### 12:00 pm

- HVEI-139 Learning visual representations for active perception (Invited) (*Olshausen*)
- MOBMU-300 Optimizing video transmission for mobile devices (*Lee*)

### 12:10 pm

- ERVR-097 New VR navigation techniques to reduce cybersickness (*Kemeny*)
- IMAWM-161 Multimedia instant messaging with real-time attribute-based encryption (*Pan*)
- IRIACV-266 Education in industrial machine vision in Upper Austria University of Applied Sciences (bachelor/master) with respect to the needs by the European industry and automation engineering (*Niel*)

### 12:20 pm

- MOBMU-308 Comparative visualization of the geometry of a hollow box girder using 3D-LiDAR – Part 2: Reconstruction of a 3D geometric model (*Maack*)

### 2:00 pm

- PLENARY Designing VR video camera systems (*Cabral*)

### 3:30 pm

- COLOR-049 What makes hue special? (*Farup*)
- HVEI-140 Simulation of the biological information available for relative position acuity (*Jiang*)
- IMAWM-162 Distracted driver detection: Deep learning vs handcrafted features (*Hssayeni*)
- IMSE-178 High sensitivity and high readout speed electron beam detector using steep pn Junction Si diode for low acceleration voltage (*Koda*)
- IQSP-244 A framework for auto-exposure subjective comparison (*Oh*)
- IRIACV-267 Unsupervised video segmentation and its application to region-based local contrast enhancement (*Park*)
- MOBMU-301 Investigation of three security relevant aspects of Android eHealth Apps - permissions, storage properties, and data transmission (*Knackmuss*)
- SD&A-105 Designing a cloud-based 3D visualization engine for smart cities (*Holliman*)
- VDA-383 Topological analysis at the extreme scale: Finding features in large data sets (*Weber*)

### 3:50 pm

- COLOR-050 Revealing the Dark Ages – Imaging erased manuscripts (*Knox*)
- HVEI-141 Can 'crispening' be explained by contrast gain? (*Kane*)
- IMAWM-163 Logo recognition using data augmentation techniques (*Mas Montserrat*)
- IMSE-179 A full-resolution 8K single-chip portable camera system (*Nakamura*)
- IQSP-245 Autofocus measurement for imaging devices (*Robisson*)
- IRIACV-268 High-precision 3D sensing with hybrid light field & photometric stereo approach in multi-line scan framework (*Antensteiner*)
- MOBMU-302 Privacy issues in mobile health applications - Assessment of current Android Health Apps (*Hoppe*)
- SD&A-106 Interactive computer graphics, stereo and VR practice at the Electronic Visualization Laboratory University of Illinois at Chicago (*Brown*)

### 4:10 pm

- COLOR-051 Image quality for visually impaired? (*Triantaphillidou*)
- ERVR-107 Designing at the Advanced Visualization Lab at Indiana University (*Dolinsky*)
- HVEI-142 Defining self-similarity of images using features learned by convolutional neural networks (*Brachmann*)
- IMAWM-164 Detection and characterization of Coordinate Measuring Machine (CMM) probes using deep networks for improved quality assurance of machine parts (*Nair*)

## Paper Schedule by Day/Time

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- IMSE-180 Filter selection for multispectral imaging optimizing spectral, colorimetric and image quality (*Wang*)
- IQSP-246 Auto Focus Performance – What can we expect from today's cameras? (*Artmann*)
- IRIACV-269 Line-scan stereo using binary descriptor matching and regularization (*Štolc*)
- MOBMU-303 A forensic mobile application designed for both steganalysis and steganography in digital images (*Li*)

### 4:30 pm

- COLOR-052 Lights, camera, metamer failure (*Pines*)
- ERVR-108 Exploring Calit2 (*Schulze*)
- HVEI-143 Determining the influence of image-based cues on human skin gloss perception (*Wang*)
- IMAWM-165 Robust head detection with CNN (*Chen*)
- IMSE-181 The challenge of shot-noise limited speckle patterns statistical analysis (*Tualle*)
- IQSP-247 Autofocus analysis: Latency and sharpness (*Passarella*)
- IRIACV-270 Traffic Camera Dangerous Driver Detection (TCD3™): Contextually aware heuristic feature & OFA density-based computer vision with movement machine learning analysis of live streaming traffic camera footage to identify anomalous & dangerous driving (*Prasad*)
- MOBMU-304 Pokemon Go – A forensic analysis (*Creutzburg*)
- VDA-384 An interactive tool for Analyzing the Correlation, Uncertainty, and Clustering (ACUC) over ensembles in climate dataset (*Abedzadeh*)

### 4:36 pm

- VDA-385 Analysis enhanced particle-based flow visualization (*Shi*)

### 4:42 pm

- VDA-450 Constellations of movement: An interactive application to visualise research in motor imagery decoding (*Rogers*)

### 4:50 pm

- COLOR-053 What we see and what we know: Partners in human vision (*McCann*)
- HVEI-144 Writer identification in modern and historical documents via binary pixel patterns, Kolmogorov-Smirnov test and Fisher's method (JIST-first) (*Shaus*)
- IMSE-182 Overview of machine vision standards (*Darmont*)
- IRIACV-271 An in-situ defect detection system for Big Area Additive Manufacturing using laser profilometry (*Goin*)
- MOBMU-305 Computation of equidistant curve for the image with blurred contours (*Semenishchev*)
- SD&A-109 3D-Stereoscopic immersive analytics projects at Monash University and University of Konstanz (*Sommer*)

### 5:10 pm

- HVEI-145 CNN-based transfer learning for historical Chinese seal character recognition based on artificial random samples (*Shang*)
- IMSE-183 Hot pixel rate behavior as pixel sizes go to 1 micron (*Chapman*)
- IRIACV-272 Outlier detection in large-scale traffic data by naïve bayes method and Gaussian mixture model method (*Lam*)
- MOBMU-306 Prune the convolutional neural networks with Sparse Shrink (*Li*)
- SD&A-110 Image distortions in large-scale immersive display systems – Cylinder and wedge displays (*Woods*)

### 5:20 pm

- IMSE-184 Performance evaluation of the thick pinhole gamma rays diagnostic system (*Xie*)

### 5:30 pm

- COIMG-439 Non-iterative joint demosaicing and super resolution framework (*Petrova*)
- COIMG-440 Localized high dynamic range plenoptic image compression (*Chang*)
- COIMG-441 Image-based age estimation: Comparing hand crafted and deep features (*Dornaika*)
- COIMG-442 Compressive light field display using scattering polarizer (*Lee*)
- COIMG-443 High-resolution image reconstruction for PET using local and non-local regularizations (*Ren*)
- COIMG-444 3D reconstruction based multiple view depth generation using heterogeneous cameras (*Shin*)
- COIMG-445 Deep convolutional neural networks for the classification of snapshot mosaic hyperspectral imagery (*Fotiadou*)
- COIMG-446 Space-variant smoothing in median-regularized reconstruction for transmission tomography (*Jung*)
- COIMG-447 A viewing direction control camera without mechanical motion based on computational imaging (*Teraya*)
- COIMG-448 The human sclera and pupil as the calibration targets (*Choi*)
- DPMI-075 A Canon hack development kit implementation of time domain continuous imaging (*Long*)
- DPMI-076 Advanced HDR fusion method for image sensor with variable pixel exposure (*Uvarov*)
- IPAS-087 Search the optimal border for combination of image pairs using neural networks (*Semenishchev*)
- IPAS-211 Feature representation learning by rank ordered autoencoder for multi-camera person re-identification (*Makov*)
- IPAS-213 Change detection from remote sensing images based on fractional integral and improved FCM (*Wang*)

IPAS-214	Non-blind image deconvolution using a sampling without replacement ( <i>Han</i> )
IPAS-215	Alpha-rooting method of gray-scale image enhancement in the quaternion frequency domain ( <i>Grigoryan</i> )
IPAS-217	What makes HDR the contents more realistic? Peak-luminance enhancement using the loading effect for OLED displays ( <i>Woo</i> )
IQSP-236	Solid-mottle method for measuring in laser-printers ( <i>Ko</i> )
IQSP-248	Estimation and compensation of reconstructed image in digital holographic display ( <i>Kim</i> )
MOBMU-307	Automated segmentation of ophthalmological OCT images ( <i>Müller</i> )
MOBMU-309	Concept for software-based configuration of the organizational and technical security of a company of arbitrary size ( <i>Möller</i> )
MOBMU-310	Facilitated polling approach for SMS and IP messaging applications ( <i>Mahadik</i> )
MOBMU-311	A multi-platform characterization of delays inherent in Message Queue Telemetry Transport (MQTT) communications. ( <i>Bendele</i> )
MOBMU-312	Semi-automatic generation of multilingual lecture notes – Wikipedia books on different subjects in various languages ( <i>Creutzburg</i> )
MOBMU-313	The strange world of keyloggers – An overview ( <i>Creutzburg</i> )
MOBMU-314	The study of algorithms reducing the level of out-of-band radiation and inter carrier interference of the OFDM signal ( <i>Fedosov</i> )
MOBMU-315	Two-tier state-machine programming for messaging applications ( <i>Morales</i> )
SD&A-376	Analysis of retinal images for retinal projection type super multi-view 3D head-mounted display ( <i>Emoto</i> )
SD&A-377	A new design and algorithm for lenticular lenses display ( <i>de la Barré</i> )

## Thursday, February 2, 2017

### 8:50 am

COLOR-054	Extraordinary perceptual color stability in low cost, real time color image compression inspired by structure tensor analysis ( <i>Lebowski</i> )
HVEI-146	Comparison of visual discomfort and visual fatigue between HMD and smartphone ( <i>Suk</i> )
IMAWM-166	Analytics for body worn cameras (Invited) ( <i>Fan</i> )
IMSE-185	Octagonal CMOS image sensor for endoscopic applications ( <i>Reis</i> )
VDA-386	Declarative guide creation ( <i>Cottam</i> )

### 9:10 am

3DIPM-001	A 3D mesh image quality metric based on features fusion ( <i>Chetouani</i> )
COLOR-055	Sky color enhancement of photographic images ( <i>Zeng</i> )
ERVR-098	VR journeys from the dark ages to a bright future ( <i>Dawe</i> )
HVEI-147	Measuring visually induced motion sickness using wearable devices ( <i>Liu</i> )
IMSE-186	Optimization of CMOS image sensor utilizing variable temporal multi-sampling partial transfer technique to achieve full-frame high dynamic range with superior low light and stop motion capability ( <i>Kabir</i> )
VDA-387	Visual-interactive semi-supervised labeling of human motion capture data ( <i>Bernard</i> )

### 9:30 am

3DIPM-002	3D blind mesh quality assessment index ( <i>Nouri</i> )
COLOR-056	A novel colour hessian and its applications ( <i>Tahery</i> )
HVEI-148	Developmental changes in ambient and focal visual processing strategies. ( <i>Krishna</i> )
IMAWM-167	Click-based interactive segmentation with graph cut ( <i>Tai</i> )
IMSE-187	A lateral electric field charge modulator with bipolar-gates for time-resolved imaging ( <i>Morikawa</i> )
VDA-388	Visual-interactive creation and validation of text clustering workflows to explore document collections ( <i>Ruppert</i> )

### 9:50 am

3DIPM-003	A magnifier on accurate depth jumps ( <i>Hach</i> )
COLOR-057	A color image model with applications to denoising ( <i>Fuller</i> )
HVEI-149	Gaze-contingent centers-surround fusion of infrared images to facilitate visual search for human targets (IJST-first) ( <i>Glaholt</i> )
IMAWM-168	Drone Detection by acoustic signature identification ( <i>Bernardini</i> )

## Paper Schedule by Day/Time

IMSE-188	A 128x128, 34µm pitch, 8.9mW, 190mK NETD, TECless Uncooled IR bolometer image sensor with columnwise processing ( <i>Alacoque</i> )	<b>11:30 am</b>	3DIPM-006	Small scale surface profile recovery using a tunable lens based system ( <i>Angot-Petit</i> )
VDA-389	AssisTag: Seamless integration of content-based and keyword-based image exploration for category search (IJST-first) ( <i>Mizuno</i> )		COLOR-060	Illumination and reflectance spectra separation of hyperspectral image data under multiple illumination conditions ( <i>Chen</i> )
<b>10:10 am</b>				
ERVR-099	The Qlik Environment ( <i>Margolis</i> )		ERVR-100	A survey: Tools for human motion synthesis ( <i>Yan</i> )
HVEI-150	Evaluation and prediction of evoked emotions induced by image manipulations ( <i>Yuan</i> )		HVEI-152	The gist of beauty: An investigation of aesthetic perception in rapidly presented images (Invited) ( <i>Mullin</i> )
IMAWM-169	Aesthetics of fashion photographs: Effect on user preferences ( <i>Li</i> )		IMAWM-172	Chromatic domain phase features with gradient and texture for efficient human detection ( <i>Ragb</i> )
<b>10:50 am</b>				
3DIPM-004	3D microscopic image construction using high dynamic range imaging ( <i>Zheng</i> )		IMSE-191	Linearity analysis of a CMOS image sensor ( <i>Wang</i> )
COLOR-058	Addressing the colorimetric redundancy in 11-ink color separation ( <i>Nyström</i> )		VDA-392	Ray traced volume clipping using multi-hit BVH Traversal ( <i>Zellmann</i> )
ERVR-103	The Reality Wall: The aesthetics of reality disambiguation in AR/VR ( <i>Lichy</i> )		<b>11:50 am</b>	
IMAWM-170	Local boosted features for illumination invariant face recognition ( <i>Essa</i> )		COLOR-061	Multispectral face recognition using hybrid feature ( <i>Gouton</i> )
IMSE-189	Residual bulk image characterization using photon transfer techniques ( <i>Crisp</i> )		ERVR-101	Exploring body gestures as natural user interface for flying in a virtual reality game with Kinect ( <i>Tong</i> )
VDA-390	Megacity: A collaborative virtual reality environment for emergency response, training, and decision making ( <i>Sharma</i> )		IMAWM-173	A real-time smile elegance detection system: A feature-level fusion and ranking SVM based approach ( <i>Lin</i> )
<b>11:00 am</b>				
HVEI-151	Measurement problems and measurement strategies for capturing the rich experience of art (Invited) ( <i>Carbon</i> )		IMSE-196	Automotive imaging ( <i>Denny</i> )
<b>11:10 am</b>				
3DIPM-005	Digitized 3D mesh segmentation based on curvature analysis ( <i>Gauthier</i> )		VDA-393	Effectiveness of feature-driven storytelling in 3D time-varying data visualization (IJST-first) ( <i>Lu</i> )
COLOR-059	Spectral band selection using a genetic algorithm based wiener filter estimation method for reconstruction of munsell spectral data ( <i>Gouton</i> )		<b>12:00 pm</b>	
ERVR-104	Decoupling of real and digital content in projection based augmented reality systems using time multiplexed image capture (IJST-first) ( <i>Soomro</i> )		HVEI-153	Gaze patterns in art viewing and their dependency on expertise and image characteristics (Invited) ( <i>Fedorovskaya</i> )
IMAWM-171	High precision 3D reconstruction of the human face ( <i>Wang</i> )		<b>12:10 pm</b>	
IMSE-190	RTS and photon shot noise reduction based on maximum likelihood estimate with multi-aperture optics and semi-photon-counting-level CMOS image sensors ( <i>Ishida</i> )		ERVR-102	Soft robotic glove for kinesthetic haptic feedback in virtual reality environments ( <i>adhav</i> )
VDA-391	Display systems for visualization and simulation in virtual environments ( <i>Wischgoll</i> )		<b>2:00 pm</b>	
			3DIPM007	A comparison of stereo matching algorithms on multi-core digital signal processor platform ( <i>Menant</i> )
			COLOR-062	Interactive Workshop: How can color imaging provide us with powerful insights? ( <i>Lebowski</i> )
			HVEI-154	Imaging human vision: An artistic perspective (Invited) ( <i>Pepperell</i> )
			IMAWM-174	MU, the ultra mobile visual analytic sensor for toys and IOTs ( <i>Yu</i> )
			IMSE-192	FPGA platform for testing a real-time tone-mapping algorithm based on a Mantissa-exponent representation ( <i>Shahnovich</i> )
			VDA-394	A visual and statistical benchmark of graph sampling methods ( <i>Zhang</i> )

## Paper Schedule by Day/Time

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### 2:20 pm

- 3DIPM-008 Viewing angle enhancement of a real-time integral imaging system using multi-directional projections and GPU parallel processing (*Alam*)
- IMAWM-175 An imaging approach to online progressive addition lens retrieval (*Li*)
- IMSE-194 Fast, low-complex, non-contact motion encoder based on the NSIP concept (*Astrom*)
- VDA-395 Inferring partial orders of nodes for hierarchical network layout (JIST-first) (*Wu*)

### 2:30 pm

- HVEI-155 Art training matters: Enhancement of spatial cognition and brain connectivity (Invited) (*Likova*)

### 2:40 pm

- IMAWM-176 Are mobile phones changing the order behavior and content for printed photo products? (*Fageth*)
- IMSE-195 In the quest of vision-sensors-on-chip: Pre-processing sensors for data reduction (*Rodríguez-Vázquez*)
- VDA-396 Closest point sparse octree for surface flow visualization (*Kim*)

### 3:00 pm

- HVEI-156 Trading conversations between science and art: When musical improvisation enters the dialogue on stage (Invited) (*Lopez-Gonzalez*)
- IMAWM-177 Texture re-rendering tool for re-mixing indoor scene images (*Liu*)
- VDA-397 Accelerating advection via approximate block exterior flow maps (*Bleile*)



## 3D Image Processing, Measurement (3DIPM), and Applications 2017

### Conference overview

Scientific and technological advances during the last decade in the fields of image acquisition, processing, telecommunications, and computer graphics have contributed to the emergence of new multimedia, especially 3D digital data. Nowadays, the acquisition, processing, transmission, and visualization of 3D objects are a part of possible and realistic functionalities over the internet. Confirmed 3D processing techniques exist and a large scientific community works hard on open problems and new challenges, including 3D data processing, transmission, fast access to huge 3D databases, or content security management.

The emergence of 3D media is directly related to the emergence of 3D acquisition technologies. Indeed, recent advances in 3D scanner acquisition and 3D graphics rendering technologies boost the creation of 3D model archives for several application domains. These include archaeology, cultural heritage, computer assisted design (CAD), medicine, face recognition, video games, and bioinformatics. New devices such as time-of-flight cameras open challenging new perspectives on 3D scene analysis and reconstruction.

Three-dimensional objects are more complex to handle than other multimedia data, such as audio signals, images, or videos. Indeed, only a unique and simple 2D grid representation is associated to a 2D image. All the 2D acquisition devices generate this same representation (digital cameras, scanners, 2D medical systems). Unfortunately (for the users), but fortunately (for scientists), there exist different 3D representations for a 3D object. For example, an object can be represented on a 3D grid (digital image) or in 3D Euclidian space. In the latter, the object can be expressed by a single equation (like algebraic implicit surfaces), by a set of facets representing its boundary surface, or by a set of mathematical surfaces. One can easily imagine the numerous open problems related to these different representations and their processing, a new challenge for the image processing community.

**Awards:** Best Paper Award and Best Student Paper given to the author(s) of two full papers presented at the conference, selected by the Organizing Committee.

**Conference Chairs:** William Puech, Lab. d'Informatique de Robotique et de Microelectronique de Montpellier (France), and Robert Sitnik, Warsaw Univ. of Technology (Poland);

**Program Committee:** Atilla M. Baskurt, Univ. de Lyon (France); Hugues Benoit-Cattin, Institut National des Sciences Appliquées de Lyon (France); Silvia Biasotti, Consiglio Nazionale delle Ricerche (Italy); Adrian G. Bors, The Univ. of York (United Kingdom); Saida Bouakaz, Univ. Claude Bernard Lyon 1 (France); Mohamed Daoudi, Télécom Lille 1 (France); Florent Dupont, Univ. Claude Bernard Lyon 1 (France); Gilles Gesquière, Lab. des Sciences de l'Information et des Systèmes (France); Afzal Godil, National Institute of Standards and Technology (United States); Serge Miguet, Univ. Lumière Lyon 2 (France); Eric Paquet, National Research Council Canada (Canada); Frédéric Payan, Univ. of Nice Sophia Antipolis - I3S Laboratory, CNRS (France); Tobias Schreck, Graz Univ. of Technology (Austria); Frédéric Truchetet, Univ. de Bourgogne (France); and Stefano Tubaro, Politecnico di Milano (Italy)



## 3D Image Processing, Measurement (3DIPM), and Applications 2017

Tuesday, January 31, 2017

### Surface Appearance Assessment and Digital Methods I JOINT SESSION

Session Chair: Greg Ward, Dolby Laboratories (United States)

**9:10 – 10:10 am**

Grand Peninsula Ballroom C

This session is jointly sponsored by: Material Appearance 2017 and 3D Image Processing, Measurement (3DIPM), and Applications 2017.

9:10 MAAP-282

**Graininess appearance of goniochromatic samples in lighting cabinets,** Paola Iacomussi, Michela Radis, and Giuseppe Rossi, INRIM (Italy)

9:30 MAAP-283

**Measurement and evaluation method of orange peel,** Takuroh Sone and Shuhei Watanabe, Ricoh Company, Ltd. (Japan)

9:50 MAAP-284

**Enhanced RTI for gloss reproduction,** Peter Fornaro, Andrea Bianco, and Lukas Rosenthaler, University of Basel (Switzerland)

10:00 am – 7:30 pm Industry Exhibition

10:10 – 10:50 am Coffee Break

### Surface Appearance Assessment and Digital Methods II JOINT SESSION

Session Chair: Mathieu Hebert, Université Jean Monnet de Saint Etienne (France)

**10:50 – 11:50 am**

Grand Peninsula Ballroom C

This session is jointly sponsored by: Material Appearance 2017 and 3D Image Processing, Measurement (3DIPM), and Applications 2017.

10:50 MAAP-285

**Consistent tool-independent virtual material appearance,** Dar'ya Guarnera<sup>1</sup>, Giuseppe Claudio Guarnera<sup>1</sup>, Cornelia Denk<sup>2</sup>, and Mashhuda Glencross<sup>1,3</sup>; <sup>1</sup>Loughborough University (United Kingdom), <sup>2</sup>BMW Research (Germany), and <sup>3</sup>Switch That Limited (United Kingdom)

11:10 MAAP-286

**Interactive object surface retexturing using perceptual quality indexes,** Keita Hirai, Wataru Suzuki, Yoshimitsu Yamada, and Takahiko Horiuchi, Chiba University (Japan)

Thursday, February 2, 2017

### 3D Image Quality

Session Chair: Aladine Chetouani, University of Orléans (France)

**9:10 – 10:10 am**

Regency Ballroom A

9:10 3DIPM-001

**A 3D mesh image quality metric based on features fusion,** Aladine Chetouani, University of Orleans (France)

3:20 – 4:00 pm Coffee Break

9:30 3DIPM-002

**3D blind mesh quality assessment index,** Anass Nouri, Christophe Charrier, and Olivier Lézoray, Normandie University (France)

9:50 3DIPM-003

**A magnifier on accurate depth jumps,** Thomas Hach and Sascha Knob, Arnold & Richter Cine Technik (Germany)

10:10 – 10:50 am Coffee Break

### 3D Image Analysis

Session Chair: Olivier Strauss, University of Montpellier (France)

**10:50 – 11:50 am**

Regency Ballroom A

10:50 3DIPM-004

**3D microscopic image construction using high dynamic range imaging,** Chi Zheng<sup>1</sup>, Salvador Bernal Garcia<sup>2</sup>, and Guoping Qiu<sup>1,2</sup>; <sup>1</sup>University of Nottingham, Ningbo (China) and <sup>2</sup>University of Nottingham (United Kingdom)

11:10 3DIPM-005

**Digitized 3D mesh segmentation based on curvature analysis,** Silvère Gauthier<sup>1,2</sup>, William Puech<sup>1</sup>, Roseline Bénéière<sup>2</sup>, and Gérard Subsol<sup>1</sup>; <sup>1</sup>University of Montpellier and <sup>2</sup>C4W (France)

11:30 3DIPM-006

**Small scale surface profile recovery using a tunable lens based system,** Ludovic Angot-Petit, Industrial Technology Research Institute (Taiwan)

11:50 am – 2:00 pm Lunch Break

### 3D Imaging Systems

Session Chair: William Puech, University of Montpellier (France)

**2:00 – 2:40 PM**

Regency Ballroom A

2:00 3DIPM-007

**A comparison of stereo matching algorithms on multi-core digital signal processor platform,** Judicaël Menant, Jean-François Nezan, Muriel Pressigout, and Luce Morin, IETR - INSA de Rennes (France)

2:20 3DIPM-008

**Viewing angle enhancement of a real-time integral imaging system using multi-directional projections and GPU parallel processing,** Md. Ashraful Alam<sup>1,2</sup>, Md. Sifatul Islam<sup>1</sup>, Mohd. Zishan Tareque<sup>1</sup>, Mahfuze Subhani Protik<sup>1</sup>, M. Rashidur Rahman Rafi<sup>1</sup>, Md. Shahinur Alam<sup>2</sup>, and Nam Kim<sup>2</sup>; <sup>1</sup>BRAC University (Bangladesh) and <sup>2</sup>Chungbuk National University (Republic of Korea)

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

Research

**3:00 – 5:00 pm**

Atrium

## Autonomous Vehicles and Machines 2017

### Conference overview

Joint advancements in sensing, computing, imaging processing, and vision are enabling unprecedented growth and interest in autonomous vehicles and intelligent machines, from self-driving cars to unmanned drones to personal service robots. These new capabilities have the potential to fundamentally change the way people live, work, commute, and connect with each other and will undoubtedly provoke entirely new applications and commercial opportunities for generations to come.

The inaugural focus of Autonomous Vehicles and Machines (AVM) will consider a broad range of topics as it relates to equipping vehicles and machines with the capacity to perceive dynamic environments, inform human participants, demonstrate situational awareness, and make unsupervised decisions on self-navigating. The conference seeks high-quality papers featuring novel research in areas intersecting sensing, imaging, vision, and perception with applications including, but not limited to, autonomous cars, ADAS (advanced driver assistance system), drones, robots, and industrial automation. In addition to the main technical program, AVM will include demonstrations and exhibits.

### Conference Sponsor



**Conference Chairs:** Patrick Denny, Valeo (Ireland); Darnell Moore, Texas Instruments (United States); and Buyue Zhang, Intel Corporation (United States)

**Program Committee:** Umit Batur, Faraday Future (United States); Zhigang Fan, Apple Inc. (United States); Ching Hung, NVIDIA Corporation (United States); Mustafa I. Jaber, NanVision (United States); Pavan Shastry, Continental (Germany); Markus Vill, Intel Corporation (Germany); Yuqiong (Joan) Wang, Uber Advanced Technologies Center (United States); Xinzhou Wu, Qualcomm Technologies, Inc. (United States); and Yi Zhang, Ford Research and Innovation Center (United States)

# Autonomous Vehicles and Machines 2017

## Monday, January 30, 2017

### Keynote: Key Learnings from Automated Vehicle Development

Session Chair: Buyue Zhang, Intel Corporation (United States)

**8:50 – 9:50 pm**

Grand Peninsula Ballroom B

AVM-009

**Architectures for automated driving**, Jack Weast, Intel Corporation (United States)

Jack Weast is a Principal Engineer and the Chief Systems Engineer for Autonomous Driving Solutions at Intel Corporation. In his 17 year career at Intel, Weast has built a reputation as a change agent in new industries with significant technical and architectural contributions to a wide range of industry-first products and standards that range from one the world's first Digital Media Adapters to complex heterogeneous high performance compute solutions in markets that are embracing high performance computing for the first time. With an End to End Systems perspective, he combines a unique blend of embedded product experience with a knack for elegant Software and Systems design that will accelerate the adoption of Autonomous Driving. Weast is the co-author of "UPnP: Design By Example", an Associate Professor at Portland State University, and the holder of numerous patents with dozens pending.

### Multi-Camera and Embedded Systems for Autonomous Machines

Session Chair: Buyue Zhang, Intel Corporation (United States)

**9:50 – 10:30 am**

Grand Peninsula Ballroom B

9:50 AVM-010

**3D Perception: Multi-camera embedded structure-from-motion prototype for real-time mapping**, Martin Mueller<sup>1</sup>, Vikram Appia<sup>1</sup>, and Umit Batur<sup>2</sup>; <sup>1</sup>Texas Instruments Inc. and <sup>2</sup>Faraday Future (United States)

10:10 AVM-451

**Measuring MTF with wedges: Pitfalls and best practices**, Norman Koren, Robert Sumner, and Henry Koren, Imatest LLC (United States)

10:30 – 10:50 am Coffee Break

### Multi-Camera and Embedded Systems for Autonomous Machines (cont.)

Session Chairs: Darnell Moore, Texas Instruments, and Yi Zhang, Ford Research and Innovation Center (United States)

**10:50 AM – 12:30 pm**

Grand Peninsula Ballroom B

10:50 AVM-012

**Free-view multi-camera visualization and harmonization for automotive systems**, Vladimir Zlokalica, Brian Deegan, Patrick Denny, Mark Griffin, and Barry Dever, Valeo (Ireland)

11:10 AVM-013

**Accelerated stereo matching for autonomous vehicles using upright pinhole camera model**, Chen Chen<sup>1</sup>, Jiangbo Lu<sup>2</sup>, Minh Do<sup>1</sup>, Do-Kyoung Kwon<sup>3</sup>, and Darnell Moore<sup>4</sup>; <sup>1</sup>University of Illinois at Urbana-Champaign (United States), <sup>2</sup>Advanced Digital Sciences Center (Singapore), and <sup>3</sup>Texas Instruments (United States)

11:30 AVM-014

**Perspectively correct bird's views using stereo vision**, Christian Fuchs and Dietrich Paulus, University of Koblenz-Landau (Germany)

11:50 AVM-015

**A sense and avoid algorithm using surround stereo vision for drones**, G.M. Dilshan Godaliyadda<sup>1,2</sup>, Do-Kyoung Kwon<sup>2</sup>, Victor Cheng<sup>2</sup>, and Darnell Moore<sup>2</sup>; <sup>1</sup>Purdue University and <sup>2</sup>Texas Instruments (United States)

12:10 AVM-011

**Real-time flight altitude estimation using phase correlation with gram polynomial decimation**, Amir Badshah<sup>1</sup>, Aadil Choudhry<sup>2</sup>, and Saadullah Amin<sup>2</sup>; <sup>1</sup>International Islamic University Islamabad and <sup>2</sup>National University of Sciences and Technology (Pakistan)

12:30 – 2:00 pm Lunch Break

### EI 2017 Opening Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**Giga-scale 3D computational microscopy**, Laura Waller, University of California, Berkeley (United States)

Laura Waller is the Ted Van Duzer Endowed Assistant Professor of Electrical Engineering and Computer Sciences (EECS) at UC Berkeley. She is a Senior Fellow at the Berkeley Institute of Data Science, and received her BS (2004), MEng (2005), and PhD (2010) in EECS from the Massachusetts Institute of Technology (MIT). Waller's talk is on computational imaging methods for fast capture of gigapixel-scale 3D intensity and phase images in a commercial microscope that employs illumination-side and detection-side coding of angle (Fourier) space with simple hardware and fast acquisition. The result is high-resolution reconstructions across a large field-of-view, achieving high space-bandwidth-time product.

3:00 – 3:30 pm Coffee Break

**Keynote: Functional Safety and Security in Autonomous System Design**

Session Chair: Umit Batur, Faraday Future (United States)

**3:30 – 4:30 pm**

Grand Peninsula Ballroom B

AVM-016

**Needs and challenges analysis for reference architectures in autonomous systems**, *Justyna Zander, Intel Corporation (United States)*

*Justyna Zander is Software Architect and Technology Lead in autonomous driving at Intel Corporation. Before joining Intel, she spent over a year working on self-driving cars, ADAS, and functional safety as a senior consultant in Germany. She engaged with Fortune 500 companies including most prestigious automotive OEMs. Prior to that, Zander was a postdoctoral research scientist at Harvard University and a senior scientist at the Fraunhofer Institute in Germany. She holds PhD, MSc, and two BSc degrees in computer science and electrical engineering. Her expertise includes modeling, simulation, deep learning, validation, and verification, functional safety, computing platforms, and rapid prototyping with worldwide operations focus. A frequent public speaker, she holds 6 patents, has 8 patent applications at USPTO, and has co-authored more than 40 publications and 3 books. Her publications have been cited more than 550 times. Zander is recognized internationally with countless awards (IEEE, European Union, NIST, etc). She regularly serves as a technical committee member for more than 50 journals and conferences, and is invited by NSF, EU Commission, and national councils to advise on government strategy and research roadmaps.*

**Functional Safety**

Session Chair: Umit Batur, Faraday Future (United States)

**4:30 – 4:50 pm**

Grand Peninsula Ballroom B

4:30

AVM-017

**Enabling functional safety ASIL compliance for autonomous driving software systems**, *Kedar Chitnis, Mihir Mody, Biju Mg, Sivaraj R, Chaitanya Ghone, Badri Narayanan, Yashwant Dutt, Aish Dubey, and Pramod Swami, Texas Instruments India Ltd. (India)*

**Symposium Welcome Reception**

**5:00 – 6:00 pm**

Atrium

**Tuesday, January 31, 2017**

**Keynote: Autonomous Vehicle Navigation in Planetary Exploration**

Session Chair: Darnell Moore, Texas Instruments (United States)

**8:50 – 9:50 am**

Grand Peninsula Ballroom B

AVM-018

**Common themes in autonomous navigation on earth and in space**, *Larry Matthies, Jet Propulsion Laboratory (United States)*

*Larry Matthies received his PhD in computer science from Carnegie Mellon University in 1989, then moved to the Jet Propulsion Laboratory, where he is a Senior Research Scientist and supervisor of the Computer Vision Group. His research interests include 3-D perception, state estimation, terrain classification, and dynamic scene analysis for autonomous navigation of unmanned vehicles on Earth and in space. He has been a principal investigator in many programs involving robot vision funded by NASA, Army, Navy, DARPA, and commercial sponsors. He and his group have achieved several firsts in computer vision for space exploration, including development of vision algorithms used by rovers and landers in the 2003 Mars Exploration Rover mission. He is an Adjunct Professor of Computer Science at the University of Southern California, a lecturer in computer vision at Caltech, and a member of the editorial boards of the Autonomous Robots journal and the Journal of Field Robotics. He is a Fellow of the IEEE and was a joint winner in 2008 of the IEEE's Robotics and Automation Award for his contributions to robotic space exploration.*

**Computer Vision, Machine Learning, and Image Processing**

Session Chair: Darnell Moore, Texas Instruments (United States)

**9:50 – 10:10 am**

Grand Peninsula Ballroom B

9:50

AVM-019

**Milpet – The self-driving wheelchair**, *Samuel Echefu, Jacob Lauzon, Suvam Bag, Rasika Kangukar, Amar Bhatt, and Raymond Ptucha, Rochester Institute of Technology (United States)*

10:00 am – 7:30 pm      Industry Exhibition

10:10 – 10:40 am      Coffee Break

**Computer Vision, Machine Learning, and Image Processing (continued)**

Session Chairs: Markus Vill, Intel Corporation (Germany), and Buyue Zhang, Intel Corporation (United States)

**10:40 am – 12:40 pm**  
Grand Peninsula Ballroom B

10:40 AVM-020  
**Efficient pre-processor for CNN**, Mihir Mody, Manu Mathew, and Shyam Jagannathan, Texas Instruments India Ltd. (India)

11:00 AVM-021  
**Free-space detection with self-supervised and online trained fully convolutional networks**, Willem Sanberg, Gijs Dubbelman, and Peter De With, Eindhoven University of Technology (the Netherlands)

11:20 AVM-022  
**Motion estimation using visual odometry and deep learning localization**, Suvam Bag, Vishwas Venkatachalapathy, and Raymond Pucha, Rochester Institute of Technology (United States)

11:40 AVM-023  
**Deep reinforcement learning framework for autonomous driving**, Ahmad El Sallab, Mohammed Abdou, Etienne Perot, and Senthil Yogamani, Valeo (Ireland)

12:00 AVM-024  
**Automatic glare detection via photometric, geometric, and global positioning information**, Mehran Andalibi<sup>1</sup> and Damon Chandler<sup>2</sup>; <sup>1</sup>Embry-Riddle Aeronautical University (United States) and <sup>2</sup>Shizuoka University (Japan)

12:20 AVM-025  
**Pose estimation from rigid face landmarks for driver monitoring systems**, Bhawani Shankar, Jayachandra Dakala, and Kalyan Kumar Hati, Path Partner Technology Pvt Ltd. (India)

12:40 – 2:00 pm Lunch Break

**El 2017 Tuesday Plenary and Symposium Awards**

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**  
Grand Peninsula Ballroom D

**VR 2.0: Making virtual reality better than reality**, Gordon Wetzstein, Stanford University (United States)

*Gordon Wetzstein is an Assistant Professor of Electrical Engineering and, by courtesy, of Computer Science, at Stanford University, and leads the Stanford Computational Imaging Group. He received a PhD in computer science from the University of British Columbia (2011) where his doctoral dissertation focused on computational light modulation for image acquisition and display. In his talk, Wetzstein explores the frontiers of VR systems engineering. Eventually, VR/AR systems will redefine communication, entertainment, education, collaborative work, simulation, training, telesurgery, and basic vision research, as next-generation computational near-eye displays evolve to deliver visual experiences that are better than the real world.*

3:00 – 3:30 pm Coffee Break

**Symposium Demonstration Session**  
**5:30 – 7:30 pm**  
Grand Peninsula Ballroom E

**Thursday, February 2, 2017**

**Keynote: History and Standards for Automotive Vision Systems Performance** JOINT SESSION

Session Chairs: Arnaud Darmont, APHESA SPRL (Belgium); Ralf Widenhorn, Portland State University (United States); and Buyue Zhang, Intel Corporation (United States)

**11:50 am – 12:30 pm**  
Harbour

*This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Autonomous Vehicles and Machines 2017.*

IMSE-196

**Automotive imaging**, Patrick Denny, Valeo (Ireland)

*Patrick Denny is a Senior Research Engineer and a Valeo Senior Expert and has worked for the last 15 years at Valeo Vision Systems, Ireland. He received his PhD in physics (2000) from the National University of Ireland, Galway, where he is also Adjunct Professor of Automotive Electronics. Denny has in excess of 20 years experience in scientific and technological development internationally, designing, innovating and developing automotive imaging technologies for BMW, Jaguar Land Rover, Daimler, VW and other OEMs. His research interests include several aspects of automotive vision system image quality, sensor components, algorithmic design, systems, machine learning and data analytics.*

12:30 – 2:00 pm Lunch Break

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

**3:00 – 5:00 pm**  
Atrium

## Color Imaging XXII: Displaying, Processing, Hardcopy, and Applications

### Conference overview

Color imaging has historically been treated as a constant phenomenon well described by three independent parameters. Recent advances in computational resources and in the understanding of the human aspects are leading to new approaches that extend the purely metrological view towards a perceptual view of color in documents and displays. Part of this perceptual view is the incorporation of spatial aspects, adaptive color processing based on image content, and the automation of color tasks, to name a few. This dynamic nature applies to all output modalities, e.g., hardcopy devices, but to an even larger extent to soft-copy displays.

Spatially adaptive gamut and tone mapping, dynamic contrast, and color management continue to support the unprecedented development of the display hardware spreading from mobile displays to large size screens and emerging technologies. This conference provides an opportunity for presenting, as well as getting acquainted, with the most recent developments in color imaging researches, technologies, and applications. Focus of the conference is on color basic research and testing, color image input, dynamic color image output and rendering, color image automation, emphasizing color in context and color in images, and reproduction of images across local and remote devices.

The conference covers also software, media, and systems related to color. Special attention is given to applications and requirements created by and for multidisciplinary fields involving color and/or vision. The Special Session entitled "The Dark Side of Color" will group challenging questions, open issues, alternative views, paradigm shifts, bottom up experimentation, re-addressing the current state of the color science, technology, and applications. For this session, we are looking for well-asked questions rather than tangible results.

### Interactive Workshop: How can COLOR imaging provide us with powerful INSIGHTS?

On Thursday afternoon we would very much like to have you participate in a special session in which we encourage asking questions and exchanging ideas that frequently trouble us during research and development projects. The presence of experts in COLOR imaging and perhaps Electronic Imaging at large will provide a unique opportunity of efficiently and lively sharing simple/stupefying ideas enabling fascinating engineering concepts which may also stimulate your own future research and development projects!

This workshop is jointly sponsored by: Color Imaging XXII: Displaying, Processing, Hardcopy, and Applications and Material Appearance 2017

**Conference Chairs:** Reiner Eschbach, Norwegian Univ. of Science and Technology (Norway) and Monroe Community College (United States); **Gabriel G. Marcu**, Apple Inc. (United States); and **Alessandro Rizzi**, Univ. degli Studi di Milano (Italy)

**Program Committee:** Jan P. Allebach, Purdue Univ. (United States); **Vien Cheung**, Univ. of Leeds (United Kingdom); **Scott J. Daly**, Dolby Labs., Inc. (United States); **Phil J. Green**, Norwegian Univ. of Science and Technology (Norway); **Roger D. Hersch**, École Polytechnique Fédérale de Lausanne (Switzerland); **Choon-Woo Kim**, Inha Univ. (Republic of Korea); **Michael A. Kriss**, MAK Consultants (United States); **Fritz Lebowsky**, STMicroelectronics (France); **Nathan Moroney**, HP Labs, HP Inc. (United States); **Carinna E. Parraman**, Univ. of the West of England (United Kingdom); **Marius Pedersen**, Norwegian Univ. of Science and Technology (Norway); **Shoji Tominaga**, Chiba Univ. (Japan); and **Stephen Westland**, Univ. of Leeds (United Kingdom)



Photo: San Francisco Travel Association-Scott Chernits

## Color Imaging XXII: Displaying, Processing, Hardcopy, and Applications

### Monday, January 30, 2017

#### El 2017 Opening Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**Giga-scale 3D computational microscopy**, *Laura Waller, University of California, Berkeley (United States)*

*Laura Waller is the Ted Van Duzer Endowed Assistant Professor of Electrical Engineering and Computer Sciences (EECS) at UC Berkeley. She is a Senior Fellow at the Berkeley Institute of Data Science, and received her BS (2004), MEng (2005), and PhD (2010) in EECS from the Massachusetts Institute of Technology (MIT). Waller's talk is on computational imaging methods for fast capture of gigapixel-scale 3D intensity and phase images in a commercial microscope that employs illumination-side and detection-side coding of angle (Fourier) space with simple hardware and fast acquisition. The result is high-resolution reconstructions across a large field-of-view, achieving high space-bandwidth-time product.*

3:00 – 3:30 pm Coffee Break

#### Surface Appearance Modeling and Reproduction Joint Session

Session Chair: Francisco Imai (United States)

**3:30 – 4:50 pm**

Regency Ballroom C

This session is jointly sponsored by: Material Appearance 2017 and Color Imaging XXII: Displaying, Processing, Hardcopy, and Applications.

3:30 MAAP-288

**Modeling and reproducing effect paints**, *Gary Meyer and Avery Musbach, University of Minnesota (United States)*

3:50 MAAP-289

**How to design a recto-verso print displaying different images in various everyday-life lighting conditions**, *Nicolas Dalloz<sup>1,2</sup>, Serge Mazauric<sup>1,3</sup>, Mathieu Hebert<sup>1</sup>, and Thierry Fournel<sup>1</sup>*; <sup>1</sup>University of Lyon, UJM-Saint-Etienne, CNRS, Institut d'Optique Graduate School, <sup>2</sup>Institut d'Optique Graduate School, and <sup>3</sup>CPE Lyon (France)

4:10 MAAP-290

**Appearance decomposition and reconstruction of textured fluorescent objects**, *Shoji Tominaga, Keiji Kato, Keita Hirai, and Takahiko Horiuchi, Chiba University (Japan)*

4:30 MAAP-291

**Assessing the proper color of translucent materials by an extended two-flux model from measurements based on an integrating sphere**, *Lionel Simonot<sup>1</sup>, Mathieu Hebert<sup>2</sup>, Serge Mazauric<sup>2,3</sup>, and Roger Hersch<sup>4</sup>*; <sup>1</sup>Université de Poitiers (France), <sup>2</sup>Université Jean Monnet de Saint Etienne (France), <sup>3</sup>CPE Lyon, Domaine Scientifique de la Doua (France), and <sup>4</sup>École Polytechnique Fédérale de Lausanne (Switzerland)

#### Symposium Welcome Reception

**5:00 – 6:00 pm**

Atrium

### Tuesday, January 31, 2017

7:15 – 8:45 am Women in Electronic Imaging Breakfast

#### Color Management

Session Chair: Sophie Triantaphillidou, University of Westminster (United Kingdom)

**8:50 – 9:50 am**

Regency Ballroom C

8:50 COLOR-026

**Wide-gamut mobile-device displays: Gamut-mapping and color enhancement challenges**, *Reza Safaee-Rad<sup>1</sup> and Jennifer Gille<sup>2</sup>*, <sup>1</sup>Qualcomm (Canada) and <sup>2</sup>Qualcomm Technologies, Inc. (United States)

9:10 COLOR-027

**Methods of defining a gamut boundary based on a face/vertex encoding**, *Phil Green<sup>1</sup>, Kiran Deshpande<sup>2</sup>, Frans Gaykema<sup>3</sup>, and William Revie<sup>4</sup>*; <sup>1</sup>Norwegian University of Science and Technology (Norway), <sup>2</sup>Multi Packaging Solutions (United Kingdom), <sup>3</sup>Océ Technologies (the Netherlands), and <sup>4</sup>FFEI (United Kingdom)

9:30 COLOR-028

**Gamut mapping in RGB colour spaces with the iterative ratios diffusion algorithm**, *Ivar Farup<sup>1</sup> and Carlo Gatta<sup>2</sup>*; <sup>1</sup>Norwegian University of Science and Technology (Norway) and <sup>2</sup>Computer Vision Center (Spain)

#### Color Vision and Deficiency

Session Chair: Sophie Triantaphillidou, University of Westminster (United Kingdom)

**9:50 – 10:30 am**

Regency Ballroom C

9:50 COLOR-029

**Checklist for daltonization methods: Requirements and characteristics of a good recoloring method**, *Joschua Simon-Liedtke<sup>1</sup>, David Flatla<sup>2</sup>, and Eskild Bakken<sup>1</sup>*; <sup>1</sup>Norwegian University of Science and Technology (Norway) and <sup>2</sup>University of Dundee (United Kingdom)

10:10 COLOR-030

**On the edge: A scalable daltonization method focusing on color contrasts and color edges**, *Joschua Simon-Liedtke<sup>1</sup>, Ivar Farup<sup>1</sup>, and Reiner Eschbach<sup>1,2</sup>*; <sup>1</sup>Norwegian University of Science and Technology (Norway) and <sup>2</sup>Monroe Community College (United States)

10:00 am – 7:30 pm Industry Exhibition

10:30 – 10:50 am Coffee Break



## Color Vision and Deficiency (continued)

Session Chair: Alessandro Rizzi, Università degli Studi di Milano (Italy)

**10:50 – 11:50 am**

Regency Ballroom C

10:50 COLOR-033

**Estimating appearance differences of 3D objects with an RGB camera,** Pei-Li Sun, National Taiwan University of Science and Technology (Taiwan)

11:10 COLOR-034

**A metric for the evaluation of color perceptual smoothness,** Cedric Marchessoux and Johan Rostang, Barco N.V. (Belgium)

11:30 COLOR-035

**Towards a perceptually-motivated color space for high dynamic range imaging,** Mekides Abebe<sup>1</sup>, Tania Pouli<sup>2</sup>, and Chaker Larabi<sup>1</sup>; <sup>1</sup>Université de Poitiers (France) and <sup>2</sup>Technicolor (United States)

11:50 am – 2:00 pm Lunch Break

## El 2017 Tuesday Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**VR 2.0: Making virtual reality better than reality,** Gordon Wetzstein, Stanford University (United States)

Gordon Wetzstein is an Assistant Professor of Electrical Engineering and, by courtesy, of Computer Science, at Stanford University, and leads the Stanford Computational Imaging Group. He received a PhD in computer science from the University of British Columbia (2011) where his doctoral dissertation focused on computational light modulation for image acquisition and display. In his talk, Wetzstein explores the frontiers of VR systems engineering. Eventually, VR/AR systems will redefine communication, entertainment, education, collaborative work, simulation, training, telesurgery, and basic vision research, as next-generation computational near-eye displays evolve to deliver visual experiences that are better than the real world.

3:00 – 3:30 pm Coffee Break

## Display and Display Appearance

Session Chair: Fritz Lebowsky, STMicroelectronics (France)

**3:30 – 5:10 pm**

Regency Ballroom C

3:30 COLOR-036

**Color discrimination threshold for medical test devices,** Nargess Hassani and Susan Farnand, Rochester Institute of Technology (United States)

3:50 COLOR-037

**Content-dependent adaptation in a soft proof matching experiment,** Gregory High, Phil Green, and Peter Nussbaum, Norwegian University of Science and Technology (Norway)

4:10 COLOR-038

**Comparisons of measures of blurriness in transparent displays,** Chang-Mo Yang, Dong-Hyeok Lee, Kyoung-Soo Park, Young-Tae Kim, and Choon-Woo Kim, Inha University (Republic of Korea)

4:30 COLOR-039

**The smallest projection optics for the vertical shaped ultra short throw projector,** Yohei Takano and Hibiki Tatsuno, Ricoh Co., Ltd. (Japan)

4:50 COLOR-040

**Pareto optimality in primary selection for multiprimary displays,** Hao Xie, Carlos Rodriguez-Pardo, and Gaurav Sharma, University of Rochester (United States)

## Symposium Demonstration Session

**5:30 – 7:30 pm**

Grand Peninsula Ballroom E

## Wednesday, February 1, 2017

### Halftoning and Printing I

Session Chair: Reiner Eschbach, Norwegian University of Science and Technology (Norway) and Monroe Community College (United States)

**8:50 – 10:10 am**

Regency Ballroom C

8:50 COLOR-041

**Color halftoning based on Neugebauer Primary Area Coverage,** Wanling Jiang<sup>1</sup>, Weijuan Xi<sup>1</sup>, Utpal Sarkar<sup>2</sup>, Robert Ulichney<sup>2</sup>, and Jan Allebach<sup>1</sup>; <sup>1</sup>Purdue University and <sup>2</sup>HP Labs, HP Inc. (United States)

9:10 COLOR-042

**Color halftoning based on multi-stage, multi-pass, clustered-DBS,** Weijuan Xi<sup>1</sup>, Tal Frank<sup>2</sup>, Utpal Sarkar<sup>2</sup>, Ben-Shoshan Yotam<sup>2</sup>, Robert Ulichney<sup>2</sup>, and Jan Allebach<sup>1</sup>; <sup>1</sup>Purdue University and <sup>2</sup>HP Labs, HP Inc. (United States)

9:30 COLOR-043

**On large local error accumulation in multilevel error diffusion (JIST-first),** Reiner Eschbach<sup>1,2</sup> and Marius Pedersen<sup>1</sup>; <sup>1</sup>Norwegian University of Science and Technology (Norway) and <sup>2</sup>Monroe Community College (United States)

9:50 COLOR-044

**Edge-preserving error diffusion for multi-toning based on dual quantization,** Takuma Kiyotomo<sup>1</sup>, Keisuke Hoshino<sup>2</sup>, Yuki Tsukano<sup>2</sup>, Hiroki Kibushi<sup>2</sup>, and Takahiko Horiuchi<sup>1</sup>; <sup>1</sup>Chiba University and <sup>2</sup>Tokyo Kikai Seisakusho, Ltd. (Japan)

10:00 am – 4:00 pm Industry Exhibition

10:10 – 10:50 am Coffee Break

### Halftoning and Printing II

Session Chair: Robert Ulichney, HP Labs, HP Inc. (United States)

**10:50 am – 12:10 pm**

Regency Ballroom C

10:50 COLOR-045

**Selecting best ink color for sparse watermark,** Alastair Reed<sup>1</sup>, Kristyn Falkenstern<sup>1</sup>, and Edward Hattenberger<sup>2</sup>; <sup>1</sup>Digimarc Corporation and <sup>2</sup>X-Rite Inc. (United States)

11:10 COLOR-046

**Page classification for print imaging pipeline,** Shaoyuan Xu<sup>1</sup>, Cheng Lu<sup>1</sup>, Peter Bauer<sup>2</sup>, Mark Shaw<sup>2</sup>, and Jan Allebach<sup>1</sup>; <sup>1</sup>Purdue University and <sup>2</sup>HP Inc. (United States)

11:30 COLOR-047  
**Indirect periodic disturbance compensator using feedforward control for image noises**, Satoshi Kaneko, Ricoh Company, Ltd. (Japan)

11:50 COLOR-048  
**3D halftoning**, Ruiyi Mao<sup>1</sup>, Utpal Sarkar<sup>2</sup>, Robert Ulichney<sup>3</sup>, and Jan Allebach<sup>1</sup>; <sup>1</sup>Purdue University (United States), <sup>2</sup>HP Inc. (Spain), and <sup>3</sup>HP Labs, HP Inc. (United States)

12:10 – 2:00 pm Lunch Break

**EI 2017 Wednesday Plenary and Symposium Awards**

Session Chairs: Joyce E. Farrell, Stanford University, and Nitiin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**  
 Grand Peninsula Ballroom D

**Designing VR video camera systems**, Brian Cabral, Facebook, Inc. (United States)

*Brian Cabral is Director of Engineering at Facebook, leading the Surround 360 VR camera team, specializing in computational photography, computer vision, and computer graphics. He has published a number of papers in the area of computer graphics and imaging including the pioneering Line Integral Convolution algorithm. Cabral discusses developing Facebook Surround 360, an open, high-quality 3D-360 video capture system. VR video capture systems are composed of multiple optical and digital components - all of which must operate as if they are one seamless optical system. The design of VR video cameras, optical choices, SNR, etc., require a new set of technologies and engineering approaches, with tight coupling to the computational system components.*

3:00 – 3:30 pm Coffee Break

**Dark Side of Color**

Session Chair: Alessandro Rizzi, Università degli Studi di Milano (Italy)

**3:30 – 5:10 pm**  
 Regency Ballroom C

3:30 COLOR-049  
**What makes hue special?**, Ivar Farup, Norwegian University of Science and Technology (Norway)

3:50 COLOR-050  
**Revealing the Dark Ages - Imaging erased manuscripts**, Keith Knox<sup>1</sup> and Roger Easton<sup>2</sup>; <sup>1</sup>Knox Consulting and <sup>2</sup>Rochester Institute of Technology (United States)

4:10 COLOR-051  
**Image quality for visually impaired?**, Sophie Triantaphillidou, University of Westminster (United Kingdom)

4:30 COLOR-052  
**Lights, camera, metamer failure**, Joshua Pines, Technicolor (United States)

4:50 COLOR-053  
**What we see and what we know: Partners in human vision**, John McCann, McCann Imaging (United States)

**Symposium Interactive Papers (Poster) Session**  
**5:30 – 7:00 pm**  
 Atrium

**Thursday, February 2, 2017**

**Color Image Processing**

Session Chair: Gabriel Marcu, Apple Inc. (United States)

**8:50 – 10:10 am**  
 Regency Ballroom C

8:50 COLOR-054  
**Extraordinary perceptual color stability in low cost, real time color image compression inspired by structure tensor analysis**, Fritz Lebowsky and Mariano Bona, STMicroelectronics (France)

9:10 COLOR-055  
**Sky color enhancement of photographic images**, Huanzhao Zeng, Google Inc. (United States)

9:30 COLOR-056  
**A novel colour hessian and its applications**, Saman Tahery and Mark Drew, Simon Fraser University (Canada)

9:50 COLOR-057  
**A color image model with applications to denoising**, Megan Fuller and Jae Lim, Massachusetts Institute of Technology (United States)

10:10 – 10:50 am Coffee Break

**Spectral Selection and Separation**

Session Chair: Marius Pedersen, Norwegian University of Science and Technology (Norway)

**10:50 am – 12:10 pm**  
 Regency Ballroom C

10:50 COLOR-058  
**Addressing the colorimetric redundancy in 11-ink color separation**, Daniel Nyström, Paula Zitinski Elias, and Sasan Gooran, Linköping University (Sweden)

11:10 COLOR-059  
**Spectral band selection using a genetic algorithm based wiener filter estimation method for reconstruction of munsell spectral data**, Pierre Gouton, Keivan Ansari, and Jean-Baptiste Thomas, University de Bourgogne (France)

11:30 COLOR-060  
**Illumination and reflectance spectra separation of hyperspectral image data under multiple illumination conditions**, Xiaochuan Chen, Mark Drew, and Ze-Nian Li, Simon Fraser University (Canada)

11:50 COLOR-061  
**Multispectral face recognition using hybrid feature**, Pierre Gouton<sup>1</sup>, Mamadou Diarra<sup>2</sup>, and Jerome Kablan Adou<sup>2</sup>; <sup>1</sup>University de Bourgogne (France) and <sup>2</sup>Université Félix Houphouët Boigny (Côte d'Ivoire)

12:10 – 2:00 pm Lunch Break

### Interactive Workshop: How can COLOR imaging provide US with powerful INSIGHTS? Joint Session

Moderator: Fritz Lebowsky, STMicroelectronics (France)

**2:00 – 3:30 pm**

Regency Ballroom C

*This session is jointly sponsored by: Color Imaging XXII: Displaying, Processing, Hardcopy, and Applications and Material Appearance 2017.*

*We would very much like to have you participate in a special session in which we encourage asking questions and exchange ideas that frequently trouble us during research and development projects. The presence of experts in COLOR imaging and perhaps Electronic Imaging at large will provide a unique opportunity of efficiently and lively sharing simple/stupefying ideas enabling fascinating engineering concepts which may also stimulate your own future research and development projects!*

COLOR-062

**Interactive Workshop: How can color imaging provide us with powerful insights?,** Fritz Lebowsky, STMicroelectronics (France)

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

**3:00 – 5:00 pm**

Atrium

3:20 – 4:00 pm Coffee Break

### Interactive Workshop: How can COLOR imaging provide US with powerful INSIGHTS? (continued) Joint Session

Moderator: Fritz Lebowsky, STMicroelectronics (France)

**4:00 – 5:00 pm**

Regency Ballroom C

*This continuing workshop session is jointly sponsored by: Color Imaging XXII: Displaying, Processing, Hardcopy, and Applications, and Material Appearance 2017.*

## Computational Imaging XIV

### Conference overview

More than ever before, computers and computation are critical to the image formation process. Across diverse applications and fields, remarkably similar imaging problems appear, requiring sophisticated mathematical, statistical, and algorithmic tools. This conference focuses on imaging as a marriage of computation with physical devices. It emphasizes the interplay between mathematical theory, physical models, and computational algorithms that enable effective current and future imaging systems. Contributions to the conference are solicited on topics ranging from fundamental theoretical advances to detailed system-level implementations and case studies.

**Conference Chairs and Program Committee:**  
Charles A. Bouman, Purdue Univ. (United States), and Robert Stevenson, Univ. of Notre Dame (United States)



## Computational Imaging XIV

Monday, January 30, 2017

## Scientific Imaging

Session Chair: Garth Simpson, Purdue University (United States)

8:50 – 10:30 am

Cypress C

8:50 COIMG-453

**Deep neural networks for synchrotron X-ray imaging,** Francesco De Carlo, Charudatta Phatak, Vincent De Andrade, and Doğa Gürsoy, Argonne National Laboratory (United States)

9:10 COIMG-415

**Synchrotron x-ray diffraction dynamic sampling for protein crystal centering,** Garth Simpson, Purdue University (United States)

9:30 COIMG-416

**An iterative method to estimate and recover systematic and random errors in grating based x-ray phase contrast imaging,** Teck-Yian Lim<sup>1</sup>, Minh Do<sup>1</sup>, and Amber Dage<sup>2</sup>; <sup>1</sup>University of Illinois at Urbana-Champaign and <sup>2</sup>Sandia National Laboratories (United States)

9:50 COIMG-417

**A model based neuron detection approach using sparse location priors,** Soumendu Majee<sup>1</sup>, Dong Hye Ye<sup>1</sup>, Gregory Buzzard<sup>2</sup>, and Charles Bouman<sup>1</sup>; <sup>1</sup>School of Electrical and Computer Engineering, Purdue University and <sup>2</sup>Dept. of Mathematics, Purdue University (United States)

10:10 COIMG-449

**Multi-resolution Data Fusion (MDF) for computational electron microscopy,** Suhas Sreehari<sup>1</sup>, Jeffrey Simmons<sup>2</sup>, Lawrence Drummy<sup>2</sup>, and Charles Bouman<sup>1</sup>; <sup>1</sup>Purdue University and <sup>2</sup>Air Force Research Laboratory (United States)

10:30 – 10:50 am Coffee Break

## Tomography

Session Chair: W. Clem Karl, Boston University (United States)

10:50 am – 12:30 PM

Cypress C

10:50 COIMG-418

**High spatial resolution detection method for point light source in scintillator,** Kai Xu<sup>1</sup>, Tetsuya Iizuka<sup>2</sup>, Toru Nakura<sup>2</sup>, and Kunihiro Asada<sup>2</sup>; <sup>1</sup>The University of Tokyo and <sup>2</sup>VLSI Design and Education Center, The University of Tokyo (Japan)

11:10 COIMG-419

**A randomized approach to reduce metal artifacts in x-ray computed tomography,** David Castañón and Parisa Babaheidarian, Boston University (United States)

11:30 COIMG-420

**Joint segmentation and material recognition in dual-energy CT images,** David Castañón and Parisa Babaheidarian, Boston University (United States)

11:50 COIMG-421

**MultiGPU acceleration of branchless distance driven projection and backprojection for Clinical Helical CT (JIST-first),** Ayan Mitra<sup>1</sup>, David Polite<sup>2</sup>, Bruce Whiting<sup>3</sup>, Jeffrey Williamson<sup>4</sup>, and Joseph O'Sullivan<sup>1</sup>; <sup>1</sup>Washington University, <sup>2</sup>Washington University School of Medicine, <sup>3</sup>University of Pittsburg, and <sup>4</sup>Virginia Commonwealth University (United States)

12:10 COIMG-422

**Fast and robust discrete computational imaging,** Ahmet Tuysuzoglu<sup>1</sup>, Yuehaw Khoo<sup>2</sup>, and W. Clem Karl<sup>3</sup>; <sup>1</sup>Siemens Healthcare, <sup>2</sup>Princeton University, and <sup>3</sup>Boston University (United States)

12:30 – 2:00 pm Lunch Break

## EI 2017 Opening Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

2:00 – 3:00 pm

Grand Peninsula Ballroom D

**Giga-scale 3D computational microscopy,** Laura Waller, University of California, Berkeley (United States)

Laura Waller is the Ted Van Duzer Endowed Assistant Professor of Electrical Engineering and Computer Sciences (EECS) at UC Berkeley. She is a Senior Fellow at the Berkeley Institute of Data Science, and received her BS (2004), MEng (2005), and PhD (2010) in EECS from the Massachusetts Institute of Technology (MIT). Waller's talk is on computational imaging methods for fast capture of gigapixel-scale 3D intensity and phase images in a commercial microscope that employs illumination-side and detection-side coding of angle (Fourier) space with simple hardware and fast acquisition. The result is high-resolution reconstructions across a large field-of-view, achieving high space-bandwidth-time product.

3:00 – 3:30 pm Coffee Break

## Computational Color

Session Chair: Charles Bouman, Purdue University (United States)

3:30 – 4:30 pm

Cypress C

3:30 COIMG-423

**Linear mapping based inverse tone mapping,** Dae Eun Kim and Munchul Kim, Korea Advanced Institute of Science and Technology (Republic of Korea)

3:50 COIMG-424

**Performance of the 14 skin-colored patches to accurately estimate the human skin,** Hayan Choi, Kyungah Choi, and Hyeon-jeong Suk, Korea Advanced Institute of Science and Technology (Republic of Korea)

4:10 COIMG-425

**Skin-representative region in a face for finding true skin color,** Hyeon-jeong Suk, Hayan Choi, and Kyungah Choi, Korea Advanced Institute of Science and Technology (Republic of Korea)

**Symposium Welcome Reception**  
**5:00 – 6:00 pm**  
 Atrium

**Tuesday, January 31, 2017**

**Computational Optics**

Session Chair: Stanley Chan, Purdue University (United States)

**8:50 – 10:10 am**  
 Cypress C

8:50 COIMG-454  
**Atomistic simulations of interface characteristics in materials systems,**  
*Jeffrey Rickman, Lehigh University (United States)*

9:10 COIMG-426  
**A phase-coded aperture camera with programmable optics,** *Jieen Chen<sup>1</sup>, Michael Hirsch<sup>2</sup>, Rainer Heintzmann<sup>3</sup>, Bernhard Eberhardt<sup>4</sup>, and Hendrik Lensch<sup>1</sup>; <sup>1</sup>University of Tuebingen, <sup>2</sup>Max Plank Institute for Intelligent Systems, <sup>3</sup>Leibniz Institute of Photonic Technology, and <sup>4</sup>Stuttgart Media University (Germany)*

9:30 COIMG-427  
**Wavefront correction using self-interference incoherent digital holography,** *Kiseung Bang<sup>1</sup>, Changwon Jang<sup>1</sup>, Jonghyun Kim<sup>1</sup>, Myung Kim<sup>2</sup>, and Byoungso Lee<sup>1</sup>; <sup>1</sup>Seoul National University (Republic of Korea) and <sup>2</sup>University of South Florida (United States)*

9:50 COIMG-428  
**Non-iterative image reconstruction for single photon image sensors,**  
*Stanley Chan, Purdue University (United States)*

10:00 am – 7:30 pm Industry Exhibition

10:10 – 10:50 am Coffee Break

**Computational Photography**

Session Chair: Henry Dietz, University of Kentucky (United States)

**10:50 am – 12:30 pm**  
 Cypress C

10:50 COIMG-429  
**Single image super-interpolation using adjusted self-exemplars,** *Hyun-Ho Kim, Jae-Seok Choi, and Munchul Kim, Korea Advanced Institute of Science and Technology (Republic of Korea)*

11:10 COIMG-430  
**Temporal super-resolution for time domain continuous imaging,** *Henry Dietz, John Fike, Paul Eberhart, Katie Long, and Clark Demaree, University of Kentucky (United States)*

11:30 COIMG-431  
**Edge-aware light-field flow for depth estimation and occlusion detection,** *Wenhui Zhou<sup>1</sup>, Andrew Lumsdaine<sup>2</sup>, Lili Lin<sup>3</sup>, Wei Zhang<sup>3</sup>, and Rong Wang<sup>3</sup>; <sup>1</sup>Hangzhou Dianzi University (China), <sup>2</sup>Indiana University (United States), and <sup>3</sup>Zhejiang Gongshang University (China)*

11:50 COIMG-432  
**Evaluating age estimation using deep convolutional neural nets,** *Carlos Belver, Ignacio Arganda-Carreras, and Fadi Dornaika, University of the Basque Country (Spain)*

12:10 COIMG-452  
**3-D Shape recovery from real images using a symmetry prior,** *Vijai Jayadevan, Aaron Michaux, Edward Delp, and Zygmunt Pizlo, Purdue University (United States)*

12:30 – 2:00 pm Lunch Break

**EI 2017 Tuesday Plenary and Symposium Awards**

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**  
 Grand Peninsula Ballroom D

**VR 2.0: Making virtual reality better than reality,** *Gordon Wetzstein, Stanford University (United States)*

*Gordon Wetzstein is an Assistant Professor of Electrical Engineering and, by courtesy, of Computer Science, at Stanford University, and leads the Stanford Computational Imaging Group. He received a PhD in computer science from the University of British Columbia (2011) where his doctoral dissertation focused on computational light modulation for image acquisition and display. In his talk, Wetzstein explores the frontiers of VR systems engineering. Eventually, VR/AR systems will redefine communication, entertainment, education, collaborative work, simulation, training, telesurgery, and basic vision research, as next-generation computational near-eye displays evolve to deliver visual experiences that are better than the real world.*

3:00 – 3:30 pm Coffee Break

**Image Analysis**

Session Chair: Avideh Zakhor, University of California, Berkeley (United States)

**3:30 – 5:30 pm**  
 Cypress C

3:30 COIMG-433  
**Augmenting salient foreground detection using Fiedler vector for multi-object segmentation,** *Michal Kucer<sup>1</sup>, Nathan Cahill<sup>1</sup>, Alexander Loui<sup>2</sup>, and David Messinger<sup>1</sup>; <sup>1</sup>Rochester Institute of Technology and <sup>2</sup>Kodak Alaris Inc. (United States)*

3:50 COIMG-434  
**Non-destructive localization of overpaintings in Byzantine miniature illuminations,** *Alexandra Psarrou<sup>1</sup>, Vassiliki Kokla<sup>1</sup>, Sophie Triantaphillidou<sup>1</sup>, and Lindsay MacDonald<sup>2</sup>; <sup>1</sup>University of Westminster and <sup>2</sup>University College London (United Kingdom)*

4:10 COIMG-435  
**Computing height and width of in situ sorghum plants using 2.5d infrared images,** *Tavor Baharav, Mohini Bariya, and Avideh Zakhor, University of California, Berkeley (United States)*

4:30 COIMG-436  
**Non-parametric texture synthesis using texture classification,** *Kyle Ziga<sup>1</sup>, Judy Bagchi<sup>2</sup>, Jan Allebach<sup>1</sup>, and Fengqing Zhu<sup>1</sup>; <sup>1</sup>Purdue University and <sup>2</sup>DZine Steps (United States)*

4:50 COIMG-437  
**On-the-fly performance evaluation of large-scale fiber tracking,** *Hongkai Yu<sup>1</sup>, Jeffrey Simmons<sup>2</sup>, Craig Przybyla<sup>2</sup>, and Song Wang<sup>1</sup>; <sup>1</sup>University of South Carolina and <sup>2</sup>Air Force Research Laboratory (United States)*

5:10

COIMG-438

**Point cloud based approach to biomass feature extraction**, Jihui Jin and Avidesh Zakhor, *University of California, Berkeley (United States)*

COIMG-440

**Localized high dynamic range plenoptic image compression**, Chuan-Chung Chang<sup>1</sup>, Hsin-Hsiang Lo<sup>1</sup>, Han-Hsuan Lin<sup>1</sup>, Zhi-Rong Fan<sup>2</sup>, Shao-Hsuan Cheng<sup>1</sup>, Chih-Hung Lu<sup>1</sup>, Fu-Ming Chuang<sup>1</sup>, and Jiun-In Guo<sup>2</sup>; <sup>1</sup>Coretronic Corp. and <sup>2</sup>National Chiao Tung University (Taiwan)

COIMG-441

**Image-based age estimation: Comparing hand crafted and deep features**, Fadi Dornaika<sup>1</sup>, Nada Moukaddem<sup>2</sup>, and Ammar Assoum<sup>2</sup>; <sup>1</sup>University of the Basque Country (Spain) and <sup>2</sup>Lebanese University (Lebanon)

COIMG-442

**Compressive light field display using scattering polarizer**, Dukho Lee<sup>1,2</sup>, Byoungho Lee<sup>1,2</sup>, Seokil Moon<sup>1,2</sup>, Chang-Kun Lee<sup>1,2</sup>, and Gang Li<sup>1,2</sup>; <sup>1</sup>Electrical and Computer Engineering, Seoul National University and <sup>2</sup>Optical Engineering and Quantum Electronics Laboratory, Seoul National University (Republic of Korea)

COIMG-443

**High-resolution image reconstruction for PET using local and non-local regularizations**, Xue Ren and SooJin Lee, *Pai Chai University (Republic of Korea)*

COIMG-444

**3D reconstruction based multiple view depth generation using heterogeneous cameras**, Dong-won Shin, *Gwangju Institute of Science and Technology (Republic of Korea)*

COIMG-445

**Deep convolutional neural networks for the classification of snapshot mosaic hyperspectral imagery**, Konstantina Fotiadou<sup>1,2</sup>, Grigorios Tsagakatakis<sup>1</sup>, and Panagiotis Tsakalides<sup>1,2</sup>; <sup>1</sup>FORTH and <sup>2</sup>University of Crete (Greece)

COIMG-446

**Space-variant smoothing in median-regularized reconstruction for transmission tomography**, Ji Eun Jung and SooJin Lee, *Pai Chai University (Republic of Korea)*

COIMG-447

**A viewing direction control camera without mechanical motion based on computational imaging**, Daiki Teraya and Tomohiro Yendo, *Nagaoka University of Technology (Japan)*

COIMG-448

**The human sclera and pupil as the calibration targets**, Hayan Choi, Kyungah Choi, and Hyeon-Jeong Suk, *Korea Advanced Institute of Science and Technology (Republic of Korea)*

**Symposium Demonstration Session**  
**5:30 – 7:30 pm**  
Grand Peninsula Ballroom E

## Wednesday, February 1, 2017

**EI 2017 Wednesday Plenary and Symposium Awards**  
Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)  
**2:00 – 3:00 pm**  
Grand Peninsula Ballroom D

**Designing VR video camera systems**, Brian Cabral, Facebook, Inc. (United States)

Brian Cabral is Director of Engineering at Facebook, leading the Surround 360 VR camera team, specializing in computational photography, computer vision, and computer graphics. He has published a number of papers in the area of computer graphics and imaging including the pioneering Line Integral Convolution algorithm. Cabral discusses developing Facebook Surround 360, an open, high-quality 3D-360 video capture system. VR video capture systems are composed of multiple optical and digital components - all of which must operate as if they are one seamless optical system. The design of VR video cameras, optical choices, SNR, etc., require a new set of technologies and engineering approaches, with tight coupling to the computational system components.

3:00 – 3:30 pm Coffee Break

### Computational Imaging XV Interactive Papers Session

**5:30 – 7:00 pm**  
Atrium

The following works will be presented at the EI 2017 Symposium Interactive Papers Session.

COIMG-439

**Non-iterative joint demosaicing and super resolution framework**, Xenya Petrova, Ivan Glazistov, Sergey Zavalishin, Vladimir Kurmanov, Kirill Lebedev, Alexander Malchanov, Andrey Shcherbinin, Gleb Milyukov, and Ilya Kurilin, *Samsung R&D Institute Rus (Russian Federation)*

## Computer Vision Applications in Sports 2017

### Overview

The advances in computer vision affect how we train, perform, watch, and interact with sports and sport events. For example, using a camera feed and computer vision algorithms, 1) players can enhance their skills, 2) coaches can assess individual and team performance, 3) injuries could be analyzed and avoided, 4) real-time statistics could be generated, and 5) enhanced engaging experience could be delivered to viewers. In the Special Session on Computer Vision Applications in Sports we are interested in understanding how computer vision algorithms can help players train more effectively and sharpen their skills via real-time feedback while training. We also are interested in helping coaches build better teams via monitoring gameplay, performing objective assessment, and avoiding fractions and injuries. For the sports fan, we are looking for systems to build a personalized viewer experience on TV, mobile phones, and wearable devices. Experiences of interest would include (but are not limited to) graphical effects rendering, augmented/virtual reality, and mobile app for off-screen engagement.

**Chairs:** Mustafa Jaber, NantVision (United States), and Grigorios Tsagkatakis, Institute of Computer Science, FORTH (Greece)



# Computer Vision Applications in Sports 2017

## Monday, January 30, 2017

### Sports Imaging

Session Chairs: Mustafa Jaber, NantVision Inc. (United States), and Grigorios Tsagkatakis, FORTH (Greece)

#### 9:30 – 10:20 am

Cypress B

9:30

#### Chair Opening Remarks

9:40

CVAS-342

**Virtual tracking shots for sports analysis**, Stuart Bennett<sup>1</sup>, Joan Lasenby<sup>1</sup>, and Tony Purnell<sup>1,2</sup>; <sup>1</sup>University of Cambridge and <sup>2</sup>British Cycling (United Kingdom)

10:00

CVAS-343

**Aerodynamic analysis via foreground segmentation**, Peter Carey<sup>1</sup>, Stuart Bennett<sup>1</sup>, Joan Lasenby<sup>1</sup>, and Tony Purnell<sup>1,2</sup>; <sup>1</sup>University of Cambridge and <sup>2</sup>British Cycling (United Kingdom)

10:20 – 10:50 am Coffee Break

### Sports Analysis

Session Chairs: Mustafa Jaber, NantVision Inc. (United States), and Grigorios Tsagkatakis, FORTH (Greece)

#### 10:50 am – 12:10 pm

Cypress B

10:50

CVAS-344

**Goal! Event detection in sports video**, Grigorios Tsagkatakis<sup>1</sup>, Mustafa Jaber<sup>2</sup>, and Panagiotis Tsakalides<sup>1</sup>; <sup>1</sup>FORTH (Greece) and <sup>2</sup>NantVision Inc. (United States)

11:10

CVAS-345

**Pose estimation for deriving kinematic parameters of competitive swimmers**, Dan Zecha, Christian Eggert, and Rainer Lienhart, University of Augsburg (Germany)

11:30

CVAS-346

**Comparison of a virtual game-day experience on varying devices**, Jack Miller, Holly Baiotto, Anastacia MacAllister, Gabriel Evans, Jonathan Schlueter, Melynda Hoover, Vijay Kalivarapu, and Eliot Winer, Iowa State University (United States)

11:50

CVAS-347

**Digital playbook – A teaching tool for American football**, Mario Vorstandlechner and Margrit Gelautz, Technische Universität Wien (Austria)

12:10 – 2:00 pm Lunch Break

### EI 2017 Opening Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

#### 2:00 – 3:00 pm

Grand Peninsula Ballroom D

**Giga-scale 3D computational microscopy**, Laura Waller, University of California, Berkeley (United States)

Laura Waller is the Ted Van Duzer Endowed Assistant Professor of Electrical Engineering and Computer Sciences (EECS) at UC Berkeley. She is a Senior Fellow at the Berkeley Institute of Data Science, and received her BS (2004), MEng (2005), and PhD (2010) in EECS from the Massachusetts Institute of Technology (MIT). Waller's talk is on computational imaging methods for fast capture of gigapixel-scale 3D intensity and phase images in a commercial microscope that employs illumination-side and detection-side coding of angle (Fourier) space with simple hardware and fast acquisition. The result is high-resolution reconstructions across a large field-of-view, achieving high space-bandwidth-time product.

3:00 – 3:30 pm Coffee Break

### Keynote: Computer Vision, Robotic Cameras, Sports Applications

Session Chairs: Mustafa Jaber, NantVision Inc. (United States), and Grigorios Tsagkatakis, FORTH (Greece)

#### 3:30 – 4:30 pm

Cypress B

CVAS-348

**Automated sports broadcasting**, Peter Carr, Disney Research (United States)

Peter Carr is a Senior Research Engineer at Disney Research, Pittsburgh. He received his PhD from the Australian National University (2010), under the supervision of Prof. Richard Hartley. His thesis, "Enhancing Surveillance Video Captured in Inclement Weather", explored single-view depth estimation using graph cuts, as well as real-time image processing on graphics hardware. As part of his earlier PhD work in sports analysis, Carr was a research intern at Mitsubishi Electric Research Labs. He received a Master's in physics from the Centre for Vision Research at York University in Toronto, Canada, and a Bachelor's of Applied Science (engineering physics) from Queen's University in Kingston, Canada.

### Symposium Welcome Reception

#### 5:00 – 6:00 pm

Atrium

## Digital Photography and Mobile Imaging XIII

### Conference overview

Digital photography has revolutionized the world we live in. Both the number of still images and videos taken each year and the capabilities of current imaging devices are unprecedented. The number of cell phones produced each year exceeds one billion and the quality of images produced by them is so high that many people are happy with a cell phone as their only camera. At the same time, other types of cameras also keep improving. Advances in hardware and processing of captured images help to push boundaries of what was previously possible in consumer and line art photography and in the huge range of applications of digital imaging in industry, science, health care, defense, and other areas. Despite the tremendous progress that has been already made, the future promises even more.

This conference serves to bring together researchers, scientists, and engineers working in the fields of traditional, mobile, and computational camera imaging to discuss recent progress in the development of digital cameras and camera modules, with all related areas like optics, sensors, in-camera still image and video processing (including traditional pipeline steps like demosaicing, color correction, and image compression, as well as high dynamic range processing, blur removal, and various other computational imaging techniques), applications of image and video processing, still image and video management and sharing applications, and methods and standards for evaluating the quality of produced images and video and of cameras used for their capture.

This conference includes paper presentations, presentation-only talks, and joint sessions with other Electronic Imaging conferences with overlapping interests.

**Awards:** Best Paper Award and Best Student Paper Award

### Conference Sponsors



**Conference Chairs:** Zhen He, Intel Corp. (United States); Feng Li, GoPro Inc. (United States); and Jon S. McElvain, Dolby Labs., Inc. (United States)

**Program Committee:** Sebastiano Battiato, Università degli Studi di Catania (Italy); Kathrin Berkner, Ricoh Innovations, Inc. (United States); Ajit Bopardikar, Samsung R&D Institute India Bangalore Pvt. Ltd. (India); Peter Catrysse, Stanford Univ. (United States); Henry Dietz, Univ. of Kentucky (United States); Giovanni Farinella, Università degli Studi di Catania (Italy); Joyce Farrell, Stanford Univ. (United States); Robert Fiete, Exelis (United States); Boyd Fowler, OminVision Technologies, Inc. (United States); Sergio Goma, Qualcomm Technologies, Inc. (United States); Mirko Guarnera, STMicroelectronics R&D Shenzhen Co. Ltd (China); Bahadır Gunturk, Istanbul Medipol Univ. (Turkey); Paul Hubel, Apple Inc. (United States); Francisco Imai (United States); Pramati Kalwad, National Institute of Technology Karnataka, Surathkal (India); Michael Kriss, MAK Consultants (United States); Jiangtao (Willy) Kuang, Qualcomm Technologies, Inc. (United States); Andrew Lumsdaine, Indiana Univ. (United States); Kevin Matherson, Microsoft Corporation (United States); Jon McElvain, Dolby Laboratories, Inc. (United States); Lingfei Meng, Ricoh Innovations, Inc. (United States); David Morgan-Mar, Canon Information Systems Research Australia Pty Ltd (CISRA) (Australia); Bo Mu, BAE Systems Imaging Solutions (United States); Barbara Pitts, Apple Inc. (United States); Kari Pulli, Intel Corporation (United States); John Reinert-Nash, Lifetouch, Inc. (United States); Jackson Roland, Apple Inc. (United States); Nitin Sampat, Rochester Institute of Technology (United States); Sabine Süssstrunk, École Polytechnique Fédérale de Lausanne (Switzerland); Touraj Tajbakhsh, Apple Inc. (United States); Radka Tezaur, Intel Corporation (United States); Ashok Veeraraghavan, Rice Univ. (United States); Thomas Vogelsang, Rambus Inc. (United States); Michael Wang, Intel Corporation (United States); Dietmar Wueller, Image Engineering GmbH & Co. KG (Germany); and Zhan Yu, Univ. of Delaware (United States)

## Digital Photography and Mobile Imaging XIII

Monday, January 30, 2017

### Camera Arrays and RGB-D Imaging Algorithms

Session Chairs: Francisco Imai (United States) and Kevin Matherson, Microsoft Corporation (United States)

8:50 – 10:10 am

Grand Peninsula Ballroom A

8:50 DPMI-063

**Stabilized high-speed video from camera arrays**, Maha El Choubassi and Oscar Nestares, Intel Corporation (United States)

9:10 DPMI-064

**Panoramic background estimation from RGB-D videos**, Christos Bampis<sup>1</sup>, Gowri Somanath<sup>2</sup>, Oscar Nestares<sup>2</sup>, and Jiajie Yao<sup>3</sup>; <sup>1</sup>The University of Texas at Austin (United States), <sup>2</sup>Intel Labs, Intel Corporation (United States), and <sup>3</sup>Intel Corporation (China)

9:30 DPMI-065

**Accurate measurement of point to point distances in 3D camera images**, Kalpana Seshadrinathan, Oscar Nestares, and Yi Wu, Intel Corporation (United States)

9:50 DPMI-066

**A novel framework for fast MRF optimization**, Gowri Somanath, Jiajie Yao, and Yong Jiang, Intel Corporation (United States)

10:10 – 10:50 am Coffee Break

#### Keynote: Accelerated Computational Tools

Session Chair: Michael Kriss, MAK Consultants (United States)

10:50 – 11:30 am

Grand Peninsula Ballroom A

DPMI-067

**Heterogeneous computational imaging**, Kari Pulli, Intel Corporation (United States)

Kari Pulli is a Senior Principal Engineer at Intel Corporation, working as the CTO of the Imaging and Camera Technologies Group. He has a long history in Computational Photography, Computer Vision, and Computer Graphics (earlier jobs include VP of Computational Imaging at Light, Sr. Director at NVIDIA Research, Nokia Fellow), with numerous publications (h-index = 30). Pulli has a PhD from the University of Washington, Seattle. He has also been a researcher / lecturer at Stanford, MIT, and University of Oulu. He has contributed to many multimedia standards at the Khronos Group, including OpenVX, and is a regular speaker and contributor at SIGGRAPH, CVPR, and many other conferences.

### Emerging Architectures and Systems

Session Chair: Michael Kriss, MAK Consultants (United States)

11:30 am – 12:30 pm

Grand Peninsula Ballroom A

11:30 DPMI-068

**Is there a multi-camera future? (Invited)**, Timothy Macmillan, Consultant (United States)

11:50 DPMI-069

**Capturing light field video for 6-DOF VR playback (Invited)**, William Jiang, Lytro Inc. (United States)

12:10 DPMI-070

**Representation and compression for cinematic VR (Invited)**, Hari Lakshman, Dolby Labs (United States)

12:30 – 2:00 pm Lunch Break

#### EI 2017 Opening Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

2:00 – 3:00 pm

Grand Peninsula Ballroom D

**Giga-scale 3D computational microscopy**, Laura Waller, University of California, Berkeley (United States)

Laura Waller is the Ted Van Duzer Endowed Assistant Professor of Electrical Engineering and Computer Sciences (EECS) at UC Berkeley. She is a Senior Fellow at the Berkeley Institute of Data Science, and received her BS (2004), MEng (2005), and PhD (2010) in EECS from the Massachusetts Institute of Technology (MIT). Waller's talk is on computational imaging methods for fast capture of gigapixel-scale 3D intensity and phase images in a commercial microscope that employs illumination-side and detection-side coding of angle (Fourier) space with simple hardware and fast acquisition. The result is high-resolution reconstructions across a large field-of-view, achieving high space-bandwidth-time product.

3:00 – 3:30 pm Coffee Break

### Imaging System Assessment

Session Chairs: Joyce Farrell, Stanford University, and Bo Mu, BAE Systems Imaging Solutions (United States)

3:30 – 4:50 pm

Grand Peninsula Ballroom A

3:30 DPMI-071

**Quantifying the luminance ratio of interior and exterior scenes: Challenges and tradeoffs in definitions, current standards, measurement methodologies and instrumentation, capturing capabilities of digital cameras, effects of veiling glare**, Fernando Voltolini de Azambuja, Nitin Sampat, and Stephen Viggiano, Rochester Institute of Technology (United States)

3:50 DPMI-072

**Sensitivity analysis applied to ISO recommended camera color calibration methods to determine how much of an advantage, if any, does spectral characterization of the camera offer over the chart-based approach**, Nitin Sampat, Stephen Viggiano, and Keith Borrino, Rochester Institute of Technology (United States)

4:10 DPMI-073

**Perceptual optimization driven by image quality metrics (Invited)**, Zhou Wang, University of Waterloo (Canada)

4:30 DPMI-074

**Looming challenges in mobile imaging quality: New technologies and new markets (Invited)**, David Cardinal, Cardinal Photo & Extremetech.com (United States)

**Symposium Welcome Reception**  
**5:00 – 6:00 pm**

Atrium

**Tuesday, January 31, 2017**

**Keynote: Mobile Device Camera IQ** Joint Session

Session Chairs: Susan Farnand, Rochester Institute of Technology, and Jackson Roland, Apple Inc. (United States)

**8:50 – 9:20 am**

Grand Peninsula Ballroom A

*This session is jointly sponsored by: Image Quality and System Performance XIV and Digital Photography and Mobile Imaging XIII.*

IQSP-249

**Towards the development of the IEEE P1858 CPIQ standard – A validation study**, Elaine Jin<sup>1</sup>, Jonathan Phillips<sup>1</sup>, Susan Farnand<sup>2</sup>, Margaret Belska<sup>3</sup>, Vinh Tran<sup>3</sup>, Ed Chang<sup>1</sup>, Yixuan Wang<sup>3</sup>, and Benjamin Tseng<sup>4</sup>; <sup>1</sup>Google Inc. (United States), <sup>2</sup>Rochester Institute of Technology (United States), <sup>3</sup>NVIDIA (United States), and <sup>4</sup>Apkudo (Australia)

*Elaine W. Jin holds a PhD in optical engineering from Zhejiang University in China, and a PhD in psychology from the University of Chicago. She has worked in the imaging industry for 15+ years including employment at Polaroid Corporation, Eastman Kodak Company, Micron Technologies, Aptina Imaging, Marvell Semiconductors, and Intel Corporation. She currently is a staff image scientist at Google, working on developing cutting-edge consumer hardware products. Her primary research interests include imaging systems design and analysis, color imaging, and psychophysics. She has published 22 journal and conference papers, and authored 14 US patents / patent applications. She joined the CPIQ initiative (Camera Phone Image Quality) in 2006, and since then has made major contributions in the development of the softcopy quality ruler method, and the CPIQ metrics for visual noise, texture blur, spatial frequency responses, chroma level, and color uniformity. She currently leads the Color/Tone Subgroup of the IEEE CPIQ Standard Working Group.*

**Mobile Device Camera IQ** Joint Session

Session Chairs: Susan Farnand, Rochester Institute of Technology, and Jackson Roland, Apple Inc. (United States)

**9:20 – 10:20 am**

Grand Peninsula Ballroom A

*This session is jointly sponsored by: Image Quality and System Performance XIV and Digital Photography and Mobile Imaging XIII.*

9:20

IQSP-250

**A methodology for perceptual image quality assessment of smartphone cameras – Color quality**, Susan Farnand, Rochester Institute of Technology (United States)

9:40

IQSP-251

**Assessing the ability of simulated laboratory scenes to predict the image quality performance of HDR captures (and rendering) of exterior scenes using mobile phone cameras**, Amelia Spooner<sup>1</sup>, Ashley Solter<sup>1</sup>, Fernando Voltolini de Azambuja<sup>1</sup>, Nitin Sampat<sup>1</sup>, Stephen Viggiano<sup>1</sup>, Brian Rodricks<sup>2</sup>, and Cheng Lu<sup>3</sup>; <sup>1</sup>Rochester Institute of Technology, <sup>2</sup>SensorSpace, LLC, and <sup>3</sup>Intel Corporation (United States)

10:00

DPMI-252

**Cell phone rankings!**, Dietmar Wueller, Image Engineering GmbH & Co. KG (Germany)

10:00 am – 7:30 pm

Industry Exhibition

10:20 – 10:50 am

Coffee Break

**MTF** Joint Session

Session Chairs: Peter Burns, Burns Digital Imaging, and Feng Li, GoPro Inc. (United States)

**10:50 am – 12:30 pm**

Grand Peninsula Ballroom A

*This session is jointly sponsored by: Image Quality and System Performance XIV and Digital Photography and Mobile Imaging XIII.*

10:50

IQSP-253

**Characterization of entire imaging plane spatial frequency response**, Victor Lenchenkov, Orit Skorka, Stan Micinski, and Radu Ispasoiu, ON Semiconductor (United States)

11:10

IQSP-254

**Reverse-projection method for measuring camera MTF**, Stan Birchfield, Microsoft Corporation (United States)

11:30

IQSP-255

**Texture MTF from images of natural scenes**, Riccardo Branca<sup>1</sup>, Sophie Triantaphillidou<sup>1</sup>, and Peter Burns<sup>2</sup>; <sup>1</sup>University of Westminster (United Kingdom) and <sup>2</sup>Burns Digital Imaging (United States)

11:50

DPMI-256

**Camera phone texture preservation measurements with modulation transfer function: An alternative approach for noise estimation of random texture chart images**, Nitiin Suresh<sup>1,2</sup>, Joshua Pfefer<sup>1</sup>, and Quanzeng Wang<sup>1</sup>; <sup>1</sup>U.S. Food and Drug Administration and <sup>2</sup>University of Maryland (United States)

12:10

IQSP-257

**The effects of misregistration on the dead leaves cross-correlation texture blur analysis**, Ranga Burada<sup>1</sup>, Robert Sumner<sup>1</sup>, and Noah Kram<sup>2</sup>; <sup>1</sup>Imatest, LLC and <sup>2</sup>Rochester Institute of Technology (United States)

12:30 – 2:00 pm

Lunch Break

**EI 2017 Tuesday Plenary and Symposium Awards**

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**VR 2.0: Making virtual reality better than reality**, Gordon Wetzstein, Stanford University (United States)

*Gordon Wetzstein is an Assistant Professor of Electrical Engineering and, by courtesy, of Computer Science, at Stanford University, and leads the Stanford Computational Imaging Group. He received a PhD in computer science from the University of British Columbia (2011) where his doctoral dissertation focused on computational light modulation for image acquisition and display. In his talk, Wetzstein explores the frontiers of VR systems engineering. Eventually, VR/AR systems will redefine communication, entertainment, education, collaborative work, simulation, training, telesurgery, and basic vision research, as next-generation computational near-eye displays evolve to deliver visual experiences that are better than the real world.*

3:00 – 3:30 pm

Coffee Break

**Image Interpolation, Restoration, and Denoising** Joint Session

Session Chairs: Karen Egiazarian, Tampere University of Technology (Finland), and Radka Tezaur, Intel Corporation (United States)

**3:30 – 5:30 pm**  
Grand Peninsula Ballroom A

*This session is jointly sponsored by: Digital Photography and Mobile Imaging XIII and Image Processing: Algorithms and Systems XV.*

3:30 DPMI-083  
**BM3D-HVS: Content-adaptive denoising for improved visual quality (Invited)**, Karen Egiazarian<sup>1,2</sup>, Aram Danielyan<sup>2</sup>, Nikolay Ponomarenko<sup>1,2</sup>, Alessandro Foi<sup>1,2</sup>, Oleg Ieremeiev<sup>3</sup>, and Vladimir Lukin<sup>3</sup>; <sup>1</sup>Tampere University of Technology (Finland), <sup>2</sup>Noiseless Imaging Oy (Finland), and <sup>3</sup>National Aerospace University (Ukraine)

3:50 IPAS-084  
**Refining raw pixel values using a value error model to drive texture synthesis**, Henry Dietz, University of Kentucky (United States)

4:10 IPAS-085  
**Color interpolation based on colorization for RGB-white color filter array**, Paul Oh<sup>1</sup>, Sukho Lee<sup>2</sup>, and Moon Gi Kang<sup>1</sup>; <sup>1</sup>Yonsei University and <sup>2</sup>Dongseo University (Republic of Korea)

4:30 IPAS-086  
**Video frame synthesizing method for HDR video capturing system with four image sensors**, Takayuki Yamashita<sup>1,2</sup> and Yoshihiro Fujita<sup>1</sup>; <sup>1</sup>Ehime University and <sup>2</sup>NHK (Japan)

4:50 DPMI-088  
**Robust defect pixel detection and correction for Bayer Imaging Systems**, Noha El-Yamany, Intel Corporation (Finland)

**Symposium Demonstration Session**  
**5:30 – 7:30 pm**  
Grand Peninsula Ballroom E

**Wednesday, February 1, 2017**

**Keynote: Sharp High-quality Color Interpolation** Joint Session

Session Chairs: Kevin Matherson, Microsoft Corporation (United States), and Dietmar Wueller, Image Engineering GmbH & Co. KG (Germany)

**8:50 – 9:30 am**  
Grand Peninsula Ballroom A

*This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.*

**Conference Chair Opening Remarks**

IMSE-077  
**Bayer pattern and image quality**, Jörg Kunze, Basler AG (Germany)

*Jörg Kunze has 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. Kunze serves as an expert for image sensors, camera hardware, noise, color fidelity, 3D- and computational imaging and develops new algorithms for color image signal processing. The majority of the Basler patents name him as inventor.*

**Input Signal Quality & Characterization** Joint Session

Session Chairs: Kevin Matherson, Microsoft Corporation (United States), and Dietmar Wueller, Image Engineering GmbH & Co. KG (Germany)

**9:30 – 10:10 am**  
Grand Peninsula Ballroom A

*This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.*

9:30 IMSE-078  
**Accurate joint geometric camera calibration of visible and far-infrared cameras**, Takashi Shibata<sup>1,2</sup>, Masayuki Tanaka<sup>1</sup>, and Masatoshi Okutomi<sup>1</sup>; <sup>1</sup>Tokyo Institute of Technology and <sup>2</sup>NEC Corporation (Japan)

9:50 DPMI-079  
**Interferometric measurement of sensor MTF and crosstalk**, Todor Georgiev, Jennifer Gille, Amber Sun, Lyubomir Baev, and Tharun Battula, Qualcomm Technologies, Inc. (United States)

10:00 am – 4:00 pm Industry Exhibition

10:10 – 10:50 am Coffee Break

**Keynote: Machine Vision Retina Improvement** Joint Session

Session Chairs: Thomas Vogelsang, Rambus Inc., and Ralf Widenhorn, Portland State University (United States)

**10:50 – 11:30 am**  
Grand Peninsula Ballroom A

*This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.*

DPMI-080  
**Silicon retina technology (Invited)**, Tobi Delbruck, Institute for Neuroinformatics (INI) (Switzerland)

*Tobi Delbruck received a PhD from Caltech (1993). He is currently a professor of physics and electrical engineering at ETH Zurich in the Institute of Neuroinformatics, University of Zurich and ETH Zurich, Switzerland, where he has been since 1998. His group, which he coordinates together with Shih-Chii Liu, focuses on neuromorphic event-based sensors and sensory processing. He has co-organized the Telluride Neuromorphic Cognition Engineering summer workshop and the live demonstration sessions at ISCAS and NIPS. Delbruck is past Chair of the IEEE CAS Sensory Systems Technical Committee. He worked on electronic imaging at Arithmos, Synaptics, National Semiconductor, and Foveon and has founded 3 spin-off companies, including inilabs.com, a non-for-profit organization that has distributed hundreds of R&D prototype neuromorphic sensors to more than a hundred organizations around the world. He has been awarded 9 IEEE awards.*

**Emerging Imaging Sensor & Hardware** Joint Session

Session Chairs: Thomas Vogelsang, Rambus Inc., and Ralf Widenhorn, Portland State University (United States)

**11:30 – 11:50 am**  
Grand Peninsula Ballroom A

*This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.*

11:30

DPMI-081

**TIK: A time domain continuous imaging testbed using conventional still images and video**, Henry Dietz, John Fike, Paul Eberhart, Katie Long, Clark Demaree, and Jong Wu, University of Kentucky (United States)

**Keynote: Comparing CMOS Image Sensor Architectures** Joint Session

Session Chairs: Thomas Vogelsang, Rambus Inc., and Ralf Widenhorn, Portland State University (United States)

**11:50 am – 12:40 pm**

Grand Peninsula Ballroom A

This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.

IMSE-082

**CMOS image sensor pixel design and optimization**, Boyd Fowler, OmniVision Technologies (United States)

Boyd Fowler's research interests include CMOS image sensors, low noise image sensors, noise analysis, data compression, and machine learning and vision. He received his MSEE (1990) and PhD (1995) from Stanford University. After finishing his PhD he stayed at Stanford University as a research associate in the Electrical Engineering Information Systems Laboratory until 1998. In 1998, Fowler founded Pixel Devices International in Sunnyvale California. Between 2005 and 2013, Fowler was CTO and VP of Technology at Fairchild Imaging. He is currently at OmniVision Technologies leading the marketing department. Fowler has authored numerous technical papers, book chapters and patents.

**Image Sensors and Imaging Systems 2017 Awards**

12:40 – 2:00 pm Lunch Break

**EI 2017 Wednesday Plenary and Symposium Awards**

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**Designing VR video camera systems**, Brian Cabral, Facebook, Inc. (United States)

Brian Cabral is Director of Engineering at Facebook, leading the Surround 360 VR camera team, specializing in computational photography, computer vision, and computer graphics. He has published a number of papers in the area of computer graphics and imaging including the pioneering Line Integral Convolution algorithm. Cabral discusses developing Facebook Surround 360, an open, high-quality 3D-360 video capture system. VR video capture systems are composed of multiple optical and digital components - all of which must operate as if they are one seamless optical system. The design of VR video cameras, optical choices, SNR, etc., require a new set of technologies and engineering approaches, with tight coupling to the computational system components.

3:00 – 3:30 pm Coffee Break

**Digital Photography and Mobile Imaging XIII Interactive Papers Session**

**5:30 – 7:00 pm**

Atrium

The following works will be presented at the EI 2017 Symposium Interactive Papers Session.

DPMI-075

**A Canon hack development kit implementation of time domain continuous imaging**, Katie Long, Clark Demaree, and Henry Dietz, University of Kentucky (United States)

DPMI-076

**Advanced HDR fusion method for image sensor with variable pixel exposure**, Timofey Uvarov, OmniVision Technologies, Inc. (United States)

## The Engineering Reality of Virtual Reality 2017

### Conference overview

Virtual and augmented reality systems are evolving. In addition to research, the trend toward content building continues and practitioners find that technologies and disciplines must be tailored and integrated for specific visualization and interactive applications. This conference serves as a forum where advances and practical advice toward both creative activity and scientific investigation are presented and discussed. Research results can be presented and applications can be demonstrated.

### Excursion

On Thursday afternoon, we have the **Qlik Field Trip: Showcase for VR, AR, and Visual Analytics Applications**. Todd Margolis will host the ERVR group at Qlik, located a five minute car ride or 30 min walk from the conference. Sign up in advance at the registration desk. Transportation on your own.

Conference Chairs and Program Committee:  
**Margaret Dolinsky**, Indiana Univ. (United States), and **Ian E. McDowall**, Fakespace Labs, Inc. (United States)



Photo: San Francisco Travel Association-Scott Clemis.

# The Engineering Reality of Virtual Reality 2017

## Wednesday, February 1, 2017

### The Real World Meets VR: Case Studies

Session Chairs: Margaret Dolinsky, Indiana University, and Ian McDowall, Intuitive Surgical / Fakespace Labs (United States)

#### 9:10 – 10:10 am

Sandpebble A

9:10 ERVR-089

**Oculus rift with stereo camera for augmented reality medical intubation training**, Kevin Lim, Preetham Suresh, and Jürgen Schulze, University of California, San Diego (United States)

9:30 ERVR-090

**Virtual reality instructional modules in education based on gaming metaphor**, Sharad Sharma and Emmanuel Ossueta, Bowie State University (United States)

9:50 ERVR-092

**Drawing towards virtual reality**, Margaret Dolinsky, Indiana University (United States)

10:00 am – 4:00 pm Industry Exhibition

10:10 – 10:50 am Coffee Break

### Positioning the Body in VR

Session Chairs: Margaret Dolinsky, Indiana University, and Ian McDowall, Intuitive Surgical / Fakespace Labs (United States)

#### 10:50 am – 12:30 pm

Sandpebble A

10:50 ERVR-093

**The Destiny-class CyberCANOE- a surround screen, stereoscopic, cyber-enabled collaboration analysis navigation and observation environment**, Noel Kawano, Alberto Gonzalez, Jack Lam, Ryan Theriot, Ken Uchida, Eric Wu, Andrew Guagliardo, Dylan Kobayashi, and Jason Leigh, University of Hawai'i at Manoa (United States)

11:10 ERVR-094

**CAVE versus head-mounted displays: On-going thoughts**, Daniel Mestre, CNRS (France)

11:30 ERVR-095

**Distributed rendering using NVIDIA OptiX**, Dylan McCarthy and Jürgen Schulze, University of California, San Diego (United States)

11:50 ERVR-096

**Laser illuminated projectors and the technological advancements brought forth to immersive environments**, Danielle Rains, Dirk Reiners, and Carolina Cruz-Neira, University of Arkansas at Little Rock (United States)

12:10

ERV-097

**New VR navigation techniques to reduce cybersickness**, Andras Kemeny<sup>1,2</sup>, Paul George<sup>1</sup>, Frédéric Mérienne<sup>1</sup>, and Florent Colombe<sup>2</sup>; <sup>1</sup>Arts et Métiers ParisTech and <sup>2</sup>Renault (France)

12:30 – 2:00 pm Lunch Break

### EI 2017 Wednesday Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

#### 2:00 – 3:00 pm

Grand Peninsula Ballroom D

**Designing VR video camera systems**, Brian Cabral, Facebook, Inc. (United States)

Brian Cabral is Director of Engineering at Facebook, leading the Surround 360 VR camera team, specializing in computational photography, computer vision, and computer graphics. He has published a number of papers in the area of computer graphics and imaging including the pioneering Line Integral Convolution algorithm. Cabral discusses developing Facebook Surround 360, an open, high-quality 3D-360 video capture system. VR video capture systems are composed of multiple optical and digital components - all of which must operate as if they are one seamless optical system. The design of VR video cameras, optical choices, SNR, etc., require a new set of technologies and engineering approaches, with tight coupling to the computational system components.

3:00 – 3:30 pm Coffee Break

### Visualization Facilities Joint Session

Session Chairs: Margaret Dolinsky, Indiana University (United States), and Andrew Woods, Curtin University (Australia)

#### 3:30 – 5:40 pm

Grand Peninsula Ballroom D

This session is jointly sponsored by: Stereoscopic Displays and Applications XXVIII and The Engineering Reality of Virtual Reality 2017.

3:30 SD&A-105

**Designing a cloud-based 3D visualization engine for smart cities**, Nicolas Holliman, Stephen Dowsland, Mark Turner, Richard Cloete, and Tom Picton, Newcastle University (United Kingdom)

3:50 SD&A-106

**Interactive computer graphics, stereo and VR practice at the Electronic Visualization Laboratory University of Illinois at Chicago**, Maxine Brown<sup>1</sup>, Jason Leigh<sup>2</sup>, Tom DeFanti<sup>3</sup>, and Daniel Sandin<sup>1</sup>; <sup>1</sup>The University of Illinois at Chicago, <sup>2</sup>University of Hawai'i at Manoa, and <sup>3</sup>University of California, San Diego (United States)



4:10 ERVR-107  
**Designing at the Advanced Visualization Lab at Indiana University,**  
Margaret Dolinsky<sup>1</sup>, Eric Wernert<sup>2</sup>, Michael Boyles<sup>2</sup>, and Chris Eller<sup>2</sup>;  
<sup>1</sup>School of Art and Design, Indiana University and <sup>2</sup>Advanced Visualization  
Lab, Indiana University (United States)

4:30 ERVR-108  
**Exploring Calit2,** Jürgen Schulze and Gregory Dawe, University of  
California, San Diego (United States)

4:50 SD&A-109  
**3D-Stereoscopic immersive analytics projects at Monash University  
and University of Konstanz,** Björn Sommer<sup>1,3</sup>, David G. Barnes<sup>1,4</sup>, Sarah  
Boyd<sup>1</sup>, Thomas Chandler<sup>1</sup>, Maxime Cordeil<sup>1</sup>, Karsten Klein<sup>1,3</sup>, Toan  
Nguyen<sup>4</sup>, Hieu Nim<sup>1,5</sup>, Kingsley Stephens<sup>1</sup>, Dany VohP, Elliott Wilson<sup>1</sup>,  
Jon McCormack<sup>1</sup>, Kim Marriott<sup>1</sup>, and Falk Schreiber<sup>1,3</sup>; <sup>1</sup>Monash University  
(Australia), <sup>2</sup>Swinburne University of Technology (Australia), <sup>3</sup>University of  
Konstanz (Germany), <sup>4</sup>Monash Immersive Visualization Platform at Monash  
University (Australia), and <sup>5</sup>Australian Regenerative Medicine Institute of  
Monash University (Australia)

5:10 SD&A-110  
**Image distortions in large-scale immersive display systems – Cylinder  
and wedge displays,** Andrew Woods<sup>1</sup>, Joshua Hollick<sup>1</sup>, Jesse Helliwell<sup>1</sup>,  
and Paul Bourke<sup>2</sup>; <sup>1</sup>Curtin University and <sup>2</sup>University of Western Australia  
(Australia)

5:30  
**SD&A Closing Remarks,** Nicolas Holliman, Newcastle University (United  
Kingdom)

**Symposium Interactive Papers (Poster) Session**  
**5:30 – 7:00 pm**  
Atrium

## Thursday, February 2, 2017

**Keynote: Immersive Visualization Room - Design and Build**  
Session Chairs: Margaret Dolinsky, Indiana University, and Ian  
McDowall, Intuitive Surgical / Fakespace Labs (United States)  
**9:10 – 10:10 am**  
Sandpebble A

ERVR-098  
**VR journeys from the dark ages to a bright future,** Gregory Dawe,  
University of California, San Diego (United States)

Gregory Dawe, the design engineer who made many iterations of  
CAVE systems possible, will share his perspective on the progression  
of virtual reality from the first CRT based CAVE system and how it was  
enhanced during the digital projector era to where we are now with  
present day flat panel systems. He will discuss the technological quest  
to improve brightness, resolution and contrast in the crusade to exceed  
human acuity.

### Qlik Introduction

Session Chair: Margaret Dolinsky, Indiana University (United States)

**10:10 – 10:30 am**  
Sandpebble A

**The Qlik Environment,** Todd Margolis, Qlik (United States)

ERVR-099

10:30 – 10:50 am Coffee Break

### Kit and Kaboodle: VR Gear

Session Chairs: Margaret Dolinsky, Indiana University, and Ian McDowall,  
Intuitive Surgical / Fakespace Labs (United States)

**10:50 am – 12:30 pm**  
Sandpebble A

10:50 ERVR-103  
**The Reality Wall: The aesthetics of reality disambiguation in AR/VR,**  
Patrick Lichty, Zayed University (United States)

11:10 ERVR-104  
**Decoupling of real and digital content in projection based augmented  
reality systems using time multiplexed image capture (JIST-first),** Shoaib  
Soomro<sup>1</sup>, Erdem Ulusoy<sup>1</sup>, and Hakan Urey<sup>2</sup>; <sup>1</sup>Optical Microsystems  
Laboratory, Koc University and <sup>2</sup>Koç University (Turkey)

11:30 ERVR-100  
**A survey: Tools for human motion synthesis,** Jie Yan, Bowie State  
University (United States)

11:50 ERVR-101  
**Exploring body gestures as natural user interface for flying in a virtual  
reality game with Kinect,** Xin Tong and Diane Gromala, Simon Fraser  
University (Canada)

12:10 ERVR-102  
**Soft robotic glove for kinesthetic haptic feedback in virtual reality  
environments,** Saurabh Jadhav, Vikas Kannanda, Bocheng Kang, Michael  
Tolley, and Jürgen Schulze, University of California, San Diego (United States)

12:30 – 2:00 pm Lunch Break

### Qlik Field Trip: Showcase for VR, AR, and Visual Analytics Applications

Host: Todd Margolis, Qlik (United States)

Session Chairs: Margaret Dolinsky, Indiana University, and Ian McDowall,  
Intuitive Surgical / Fakespace Labs (United States)

**2:00 – 5:00 pm**  
Offsite

Todd Margolis will host the ERVR group at Qlik, located a five minute  
car ride or 30 min walk from the conference. Sign up in advance at the  
registration desk. Transportation on your own.

## Human Vision and Electronic Imaging 2017

### Conference overview

The conference on Human Vision and Electronic Imaging explores the role of human perception and cognition in the design, analysis, and use of electronic media systems. Over the years, it has brought together researchers, technologists and artists, from all over the world, for a rich and lively exchange of ideas. We believe that understanding the human observer is fundamental to the advancement of electronic media systems, and that advances in these systems and applications drive new research into the perception and cognition of the human observer. Every year, we introduce new topics through our Special Sessions, centered on areas driving innovation at the intersection of perception and emerging media technologies. The HVEI website (<http://hvei.eecs.northwestern.edu>) includes additional information and updates.

### Awards

Student Best Paper Award  
Student Paper Honorary Mention Award

### Events

Monday evening HVEI Banquet and Talk  
Thursday evening Museum Field Trip to San Francisco Museum of Modern Art  
Daily End-of-Day Discussions

## Conference Sponsors



**DOLBY**



**Conference Chairs:** **Bernice E. Rogowitz**, Visual Perspectives (United States); **Thrasylvoulos N. Pappas**, Northwestern Univ. (United States); and **Huib de Ridder**, Technische Univ. Delft (the Netherlands)

**Program Committee:** **Albert J. Ahumada**, NASA Ames Research Center (United States); **Jan P. Allebach**, Purdue Univ. (United States); **Erhardt Barth**, Univ. zu Lubeck (Germany); **Walter R. Bender**, Sugar Labs (United States); **Michael H. Brill**, Datacolor (United States); **Kjell Brunnström**, ACREO (Sweden); **Claus-Christian Carbon**, Univ. of Bamberg (Germany); **Damon M. Chandler**, Shizuoka Univ. (Japan); **Scott J. Daly**, Dolby Labs., Inc. (United States); **Ulrich Engelke**, Commonwealth Scientific and Industrial Research Organisation (Australia); **Elena A. Fedorovskaya**, Rochester Institute of Technology (United States); **James A. Ferwerda**, Rochester Institute of Technology (United States); **Jennifer L. Gille**, Qualcomm Technologies, Inc. (United States); **Sergio R. Goma**, Qualcomm Technologies, Inc. (United States); **Hari Kalva**, Florida Atlantic Univ. (United States); **Stanley A. Klein**, Univ. of California, Berkeley (United States); **Patrick Le Callet**, Univ. de Nantes (France); **Lora T. Likova**, The Smith-Kettlewell Eye Research Institute (United States); **Monica Lopez-Gonzalez**, La Petite Noiseuse Productions (United States); **Mark E. McCourt**, North Dakota State Univ. (United States); **Jeffrey B. Mulligan**, NASA Ames Research Center (United States); **Karol Myszkowski**, Max-Planck-Institut für Informatik (Germany); **Adar Pelah**, Univ. of York (United Kingdom); **Eliezer Peli**, Schepens Eye Research Institute (United States); **Sylvia Pont**, Technische Univ. Delft (the Netherlands); **Judith A. Redi**, Technische Univ. Delft (the Netherlands); **Hawley K. Rising**, Consultant (United States); **Sabine Süsstrunk**, École Polytechnique Fédérale de Lausanne (Switzerland); **Christopher W. Tyler**, The Smith-Kettlewell Eye Research Institute (United States); **Andrew B. Watson**, NASA Ames Research Center (United States); and **Michael A. Webster**, Univ. of Nevada, Reno (United States)

# Human Vision and Electronic Imaging 2017

Monday, January 30, 2017

12:30 – 2:00 pm Lunch Break

## Chair Opening Remarks

Session Chairs: Bernice Rogowitz, Visual Perspectives (United States), Thrasyvoulos Pappas, Northwestern University (United States), and Huib de Ridder, Delft University of Technology (the Netherlands)

**9:00 – 9:10 am**

Regency Ballroom B

## Keynote 1: Human Vision - Unifying Theory from Peripheral Vision

Session Chair: Bernice Rogowitz, Visual Perspectives (United States)

**9:10 – 10:00 am**

Regency Ballroom B

HVEI-111

**Vision at a glance (Invited)**, Ruth Rosenholtz, MIT (United States)

Ruth Rosenholtz is a Principal Research Scientist in the Dept. of Brain and Cognitive Sciences at MIT. Her lab studies human vision, including visual search, peripheral vision, perceptual organization, and the impact of visual clutter on task performance. Rosenholtz earned her PhD in electrical engineering and computer science, University of California at Berkeley (1994). Prior to MIT, she held research positions with the (Xerox) Palo Alto Research Center, NASA Ames, and with Utrecht University.

10:00 – 10:30 am Coffee Break

## Special Session: Decoding Visual Semantics: Perceptual Modeling and Deep Learning

Session Chairs: Jan Koenderink, Katholieke University Leuven (Belgium), and Ruth Rosenholtz, MIT (United States)

**10:30 am – 12:30 pm**

Regency Ballroom B

10:30

HVEI-112

**Eidolons: Effects of capricious local sign (Invited)**, Jan Koenderink<sup>1</sup>, Andrea van Doorn<sup>2</sup>, Matteo Valsecchi<sup>3</sup>, and Karl Gegenfurtner<sup>3</sup>; <sup>1</sup>Katholieke University Leuven (the Netherlands), <sup>2</sup>Utrecht University (the Netherlands), and <sup>3</sup>Giessen University (Germany)

11:00

HVEI-113

**Careful methods and measurements for comparisons between men and machines (Invited)**, Felix Wichmann<sup>1,2</sup>, David Janssen<sup>1</sup>, Robert Geirhos<sup>1</sup>, Guillermo Aguilar<sup>3</sup>, Schütt Heiko<sup>1</sup>, Marianne Maertens<sup>3</sup>, and Matthias Bethge<sup>1</sup>; <sup>1</sup>Eberhard Karls Universität Tübingen, <sup>2</sup>Max-Planck-Institut für Intelligente Systeme, and <sup>3</sup>Technische Universität Berlin (Germany)

11:30

HVEI-114

**Perceptual and engineering implications of cascaded gain control models (Invited)**, Eero Simoncelli<sup>1</sup>, Valero Laparra<sup>1,2</sup>, Johannes Ballé<sup>1</sup>, and Alexander Bernardino<sup>1</sup>; <sup>1</sup>New York University (United States) and <sup>2</sup>University of Valencia (Spain)

12:00

HVEI-116

**Emerging visual representations in deep learning networks (Invited)**, Aude Oliva, MIT (United States)

## EI 2017 Opening Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**Giga-scale 3D computational microscopy**, Laura Waller, University of California, Berkeley (United States)

Laura Waller is the Ted Van Duzer Endowed Assistant Professor of Electrical Engineering and Computer Sciences (EECS) at UC Berkeley. She is a Senior Fellow at the Berkeley Institute of Data Science, and received her BS (2004), MEng (2005), and PhD (2010) in EECS from the Massachusetts Institute of Technology (MIT). Waller's talk is on computational imaging methods for fast capture of gigapixel-scale 3D intensity and phase images in a commercial microscope that employs illumination-side and detection-side coding of angle (Fourier) space with simple hardware and fast acquisition. The result is high-resolution reconstructions across a large field-of-view, achieving high space-bandwidth-time product.

3:00 – 3:30 pm Coffee Break

## Keynote 2: Media Content Semantics - Transmitting Meaning

Session Chair: Thrasyvoulos Pappas, Northwestern University (United States)

**3:30 – 4:20 pm**

Regency Ballroom B

HVEI-117

**Movies and meaning: From low-level features to mind reading (Invited)**, Sergio Benini, University of Brescia (Italy)

Sergio Benini received his MSc in electronic engineering (cum laude) at the University of Brescia (2000) with a thesis granted by Italian Academy of Science. Between '01 and '03 he was with Siemens Mobile Communications R&D. He received his PhD in information engineering from the University of Brescia (2006), working on video content analysis. During his PhD he spent one year in British Telecom Research, United Kingdom, working in the "Content & Coding Lab." Since 2005 he has been an Assistant Professor at the University of Brescia. In 2012, he co-founded Yonder, a spin-off company specialized in NLP, Machine Learning, and Cognitive Computing.

## High Level Vision

Session Chair: Bernice Rogowitz, Visual Perspectives (United States)

**4:20 – 4:40 pm**

Regency Ballroom B

4:20

HVEI-119

**On the role of color in visual saliency**, Sergio Echebehere<sup>1</sup> and Elena Fedorovskaya<sup>2</sup>; <sup>1</sup>University Jean Monnet Saint-Etienne (France) and <sup>2</sup>Rochester Institute of Technology (United States)

**DISCUSSION: From Low-Level Descriptors to Visual Semantics**

**4:40 – 5:40 pm**  
Regency Ballroom B

Every afternoon at HVEI, authors from the day's papers gather to participate in a dynamic discussion with the audience, moderated by the conference and session chairs. Since the papers and the participants represent diverse disciplines, these interactive sessions are exciting and provocative.

**Symposium Welcome Reception**  
**5:00 – 6:00 pm**  
Atrium

**Human Vision and Electronic Imaging 2017 Banquet**

**Hosts:** Bernice Rogowitz, Visual Perspectives (United States), Thrasyvoulos Pappas, Northwestern University (United States), and Huib de Ridder, Delft University of Technology (the Netherlands)

**7:15 – 10:00 pm**  
Sandpebble C,D

**Deep learning for gestalt and gestalt for deep learning** (Invited), Stella Yu, University of California, Berkeley (United States)

Please join us for an exciting banquet presentation and the opportunity to interact with fellow colleagues and speakers, in an informal atmosphere. You can sign up for the Banquet now, when you register.

**Tuesday, January 31, 2017**

**Human Vision and Stereoscopic Imaging** JOINT SESSION

Session Chairs: Nicolas Holliman, University of Newcastle (United Kingdom), and Thrasyvoulos Pappas, Northwestern University (United States)

**8:50 – 10:10 am**  
Grand Peninsula Ballroom D

This session is jointly sponsored by: Stereoscopic Displays and Applications XXVIII and Human Vision and Electronic Imaging 2017.

8:50 HVEI-378  
**Depth-compressed expression for providing natural, visual experiences with integral 3D displays**, Yasuhito Sawahata and Toshiya Morita, Japan Broadcasting Corporation (Japan)

9:10 HVEI-379  
**Blind quality prediction of stereoscopic 3D images**, Jiheng Wang<sup>1</sup>, Qingbo Wu<sup>2</sup>, Abdul Rehman<sup>1</sup>, Shiqi Wang<sup>1</sup>, and Zhou Wang<sup>1</sup>; <sup>1</sup>University of Waterloo (Canada) and <sup>2</sup>University of Electronic Science and Technology of China (China)

9:30 SD&A-380  
**Pseudo-haptic by stereoscopic images and effects on muscular activity**, Takashi Kawai<sup>1</sup>, Fumiya Ohta<sup>1</sup>, Sanghyun Kim<sup>1</sup>, and Hiroyuki Morikawa<sup>1,2</sup>; <sup>1</sup>Waseda University and <sup>2</sup>Aoyama Gakuin University (Japan)

9:50 SD&A-381  
**The effects of proximity cues on visual comfort when viewing stereoscopic contents (JIST-first)**, Yaohua Xie<sup>1</sup>, Danli Wang<sup>2</sup>, and Heng Qiao<sup>3</sup>; <sup>1</sup>Chinese Academy of Sciences, <sup>2</sup>Institute of Software, Chinese Academy of Sciences, and <sup>3</sup>Central University of Finance and Economics (China)

10:00 am – 7:30 pm Industry Exhibition  
10:10 – 10:40 am Coffee Break

**Emerging Issues in Perceptual Image Quality**

Session Chair: Huib de Ridder, Delft University of Technology (the Netherlands)

**10:40 am – 12:40 pm**  
Regency Ballroom B

10:40 HVEI-120  
**Interactions between saliency and utility**, Edward Scott and Sheila Hemami, Northeastern University (United States)

11:00 HVEI-121  
**Perceptual evaluation of psychovisual rate-distortion enhancement in video coding**, Zhengfang Duanmu, Kai Zeng, Zhou Wang, and Mahzar Eispour, University of Waterloo (Canada)

11:20 HVEI-122  
**Balancing Type I errors and statistical power in video quality assessment**, Kjell Brunnstrom<sup>1,2</sup> and Marcus Barkowsky<sup>3</sup>; <sup>1</sup>Acreo Swedish ICT AB (Sweden), <sup>2</sup>Mid Sweden University (Sweden), and <sup>3</sup>University of Nantes (France)

11:40 HVEI-123  
**On the perceptual factors underlying the quality of post-compression enhancement of textures**, Yusizwan Yaacob, Yi Zhang, and Damon Chandler, Shizuoka University (Japan)

12:00 HVEI-124  
**Do gaze disruptions indicate the perceived quality of non-uniformly coded natural scenes?**, Yashas Rai and Patrick Le Callet, University of Nantes (France)

12:20 HVEI-125  
**Subjective evaluation of distortions in first-person videos**, Chen Bai and Amy Reibman, Purdue University (United States)

12:40 – 2:00 pm Lunch Break

**EI 2017 Tuesday Plenary and Symposium Awards**

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**  
Grand Peninsula Ballroom D

**VR 2.0: Making virtual reality better than reality**, Gordon Wetzstein, Stanford University (United States)

Gordon Wetzstein is an Assistant Professor of Electrical Engineering and, by courtesy, of Computer Science, at Stanford University, and leads the Stanford Computational Imaging Group. He received a PhD in computer science from the University of British Columbia (2011) where his doctoral dissertation focused on computational light modulation for image acquisition and display. In his talk, Wetzstein explores the frontiers of VR systems engineering. Eventually, VR/AR systems will redefine communication, entertainment, education, collaborative work, simulation, training, telesurgery, and basic vision research, as next-generation computational near-eye displays evolve to deliver visual experiences that are better than the real world.

3:00 – 3:30 pm Coffee Break

**SPECIAL SESSION AND PANEL: Visually Lossless Video Quality for Modern Devices: Research and Industry Perspectives**

Panel Moderator: Kjell Brunnstrom, Acreo Swedish ICT AB (Sweden)  
 Panelists: Damon Chandler, Shizuoka University (Japan); Phil Corriveau, Intel Corporation (United States); Scott Daly, Dolby Laboratories (United States); Edward Delp, Purdue University (United States); and James Goel, Qualcomm Inc. (Canada)

**3:30 – 4:20 pm**  
 Regency Ballroom B

3:30 HVEI-126  
**Image and video compression for mobile: Is my screen small enough? (Invited)**, Edward Delp, Purdue University (United States)

3:40 HVEI-127  
**Business perspectives on perceptually lossless and lossy quality (Invited)**, Scott Daly, Dolby Laboratories (United States)

3:50 HVEI-128  
**Usage perspectives on perceptually lossless and lossy quality and assessment (Invited)**, Philip Corriveau<sup>1</sup>, Juliana Knopf<sup>1</sup>, Hannah Colett<sup>1</sup>, and Shun-nan Yang<sup>2</sup>; <sup>1</sup>Intel Corporation and <sup>2</sup>Pacific University (United States)

4:00 HVEI-129  
**Subjective assessment and the criteria for visually lossless compression (Invited)**, Laurie Wilcox<sup>1</sup>, Robert Allison<sup>1</sup>, and James Goel<sup>2</sup>; <sup>1</sup>York University and <sup>2</sup>Qualcomm Inc. (Canada)

4:10 HVEI-130  
**Masked detection of compression artifacts on laboratory, consumer, and mobile displays (Invited)**, Yi Zhang, Yusizwan Yaacob, and Damon Chandler, Shizuoka University (Japan)

**Moderated Discussion: Visually Lossless Video Quality for Modern Devices: Research and Industry Perspectives**

Panel Moderator: Kjell Brunnstrom, Acreo Swedish ICT AB (Sweden)  
 Panelists: Damon Chandler, Shizuoka University (Japan); Phil Corriveau, Intel Corporation (United States); Scott Daly, Dolby Laboratories (United States); Edward Delp, Purdue University (United States); and James Goel, Qualcomm Inc. (Canada)

**4:20 – 5:20 pm**  
 Regency Ballroom B

*The issues raised during this panel discussion, and a review of the resulting discussion, will be summarized in a proceedings manuscript, authored by all the contributing panelists:*

4:20 HVEI-131  
**Industry and business perspectives on the distinctions between visually lossless and lossy video quality: Mobile and large format displays (Invited)**, Kjell Brunnstrom<sup>1,2</sup>, Scott Daly<sup>3</sup>, Damon Chandler<sup>4</sup>, Phil Corriveau<sup>5</sup>, Yi Zhang<sup>4</sup>, Yusizwan Yaacob<sup>4</sup>, Laurie Wilcox<sup>6</sup>, Robert Allison<sup>6</sup>, James Goel<sup>7</sup>, Edward Delp<sup>8</sup>, and Shun-nan Yang<sup>9</sup>; <sup>1</sup>Acreo Swedish ICT AB (Sweden), <sup>2</sup>Mid Sweden University (Sweden), <sup>3</sup>Dolby Laboratories (United States), <sup>4</sup>Shizuoka University (Japan), <sup>5</sup>Intel Corporation (United States), <sup>6</sup>York University (Canada), <sup>7</sup>Qualcomm (Canada), <sup>8</sup>Purdue University (United States), and <sup>9</sup>Pacific University (United States)

**DISCUSSION: Perceptual, Cognitive, and Affective Issues in Image Representation, Compression, and Measurement**

**5:20 – 6:00 pm**  
 Regency Ballroom B

*In this session, authors from the day's papers will gather to participate in a dynamic discussion with the audience, moderated by the conference and session chairs. Since the papers and the participants represent diverse disciplines, interactive session promised to be exciting and provocative.*

**Symposium Demonstration Session**  
**5:30 – 7:30 pm**  
 Grand Peninsula Ballroom E

**Wednesday, February 1, 2017**

**Computational Models of Human Color, Stereo, and High Dynamic Range**

**8:50 – 10:10 am**  
 Regency Ballroom B

8:50 HVEI-132  
**Orientation-ocular maps: A technique for computer vision**, Alfredo Restrepo, Universidad de los Andes (Colombia)

9:10 HVEI-133  
**Evaluation of color prediction methods in terms of least dissimilar asymmetric matching**, Emitis Roshan and Brian Funt, Simon Fraser University (Canada)

9:30 HVEI-134  
**Characterization of spatiotemporal fluctuation in absorbed light energy by an array of interleaved photosensitive elements**, Shahram Peyvandi<sup>1</sup>, Vebjorn Ekroll<sup>2</sup>, and Alan Gilchrist<sup>1</sup>; <sup>1</sup>Rutgers, The State University of New Jersey (United States) and <sup>2</sup>University of Leuven (KU Leuven) (Belgium)

9:50 HVEI-135  
**Robust dynamic range computation for high dynamic range content**, Vedad Hulusic<sup>1</sup>, Giuseppe Valenzise<sup>1</sup>, Kurt Debattista<sup>2</sup>, and Frederic Dufaux<sup>1</sup>; <sup>1</sup>Télécom ParisTech, Université Paris-Saclay (France) and <sup>2</sup>University of Warwick (United Kingdom)

10:00 am – 4:00 pm Industry Exhibition

10:10 – 10:30 am Coffee Break



**Special Session: Computational Modeling Inspired by Human Vision**

Session Chair: Christopher Tyler, Smith-Kettlewell Eye Research Institute (United States)

**10:30 am – 12:30 pm**

Regency Ballroom B

10:30 HVEI-136

**GPU-accelerated vision modeling with the HPE cognitive computing toolkit (Invited)**, Benjamin Chandler, Hewlett Packard Enterprise (United States)

11:00 HVEI-137

**A neurally-inspired algorithm for detecting ordinal depth from motion signals in video streams (Invited)**, Gennady Livitz, Harald Ruda, and Ennio Mingolla, Northeastern University (United States)

11:30 HVEI-138

**Computational estimation of scene structure through texture gradient cues (Invited)**, Christopher Tyler<sup>1,2</sup> and Ajay Gopi<sup>3</sup>; <sup>1</sup>Smith-Kettlewell Eye Research Institute (United States), <sup>2</sup>City University of London (United Kingdom), and <sup>3</sup>University of California, Berkeley (United States)

12:00 HVEI-139

**Learning visual representations for active perception (Invited)**, Bruno Olshausen, Brian Cheung, and Eric Weiss, University of California, Berkeley (United States)

12:30 – 2:00 pm Lunch Break

**EI 2017 Wednesday Plenary and Symposium Awards**

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**Designing VR video camera systems**, Brian Cabral, Facebook, Inc. (United States)

Brian Cabral is Director of Engineering at Facebook, leading the Surround 360 VR camera team, specializing in computational photography, computer vision, and computer graphics. He has published a number of papers in the area of computer graphics and imaging including the pioneering Line Integral Convolution algorithm. Cabral discusses developing Facebook Surround 360, an open, high-quality 3D-360 video capture system. VR video capture systems are composed of multiple optical and digital components - all of which must operate as if they are one seamless optical system. The design of VR video cameras, optical choices, SNR, etc., require a new set of technologies and engineering approaches, with tight coupling to the computational system components.

3:00 – 3:30 pm Coffee Break

**Image Statistics and Perceptual Features**

Session Chairs: Bernice Rogowitz, Visual Perspectives (United States), and Huib de Ridder, Delft University of Technology (the Netherlands)

**3:30 – 4:50 pm**

Regency Ballroom B

3:30 HVEI-140

**Simulation of the biological information available for relative position acuity**, Haomiao Jiang<sup>1</sup>, Nicolas Cottaris<sup>2</sup>, James Golden<sup>1</sup>, David Brainard<sup>2</sup>, Joyce Farrell<sup>1</sup>, and Brian Wandell<sup>1</sup>; <sup>1</sup>Stanford University and <sup>2</sup>University of Pennsylvania (United States)

3:50 HVEI-141

**Can ‘crispening’ be explained by contrast gain?**, David Kane and Marcelo Bertalmio, Universitat Pompeu Fabra (Spain)

4:10 HVEI-142

**Defining self-similarity of images using features learned by convolutional neural networks**, Anselm Brachmann and Christoph Redies, Jena University Hospital (Germany)

4:30 HVEI-143

**Determining the influence of image-based cues on human skin gloss perception**, Jing Wang<sup>1</sup>, Jim Mayne<sup>2</sup>, Carla Kuesten<sup>2</sup>, Gopa Majmudar<sup>2</sup>, and Thrasyvoulos Pappas<sup>1</sup>; <sup>1</sup>Northwestern University and <sup>2</sup>Amway Corporation (United States)

**Digital Humanities: Humans and/vs. Machines**

Session Chair: Thrasyvoulos Pappas, Northwestern University (United States)

**4:50 – 5:30 pm**

Regency Ballroom B

4:50 HVEI-144

**Writer identification in modern and historical documents via binary pixel patterns, Kolmogorov-Smirnov test and Fisher’s method (JIST-first)**, Arie Shaus and Eli Turkel, Tel Aviv University (Israel)

5:10 HVEI-145

**CNN-based transfer learning for historical Chinese seal character recognition based on artificial random samples**, Hong Shang, Wei Fan, Jun Sun, and Satoshi Naoi, Fujitsu Research & Development Center (China)

**DISCUSSION: Computational Modeling, Perceptual Features, and Digital Humanities**

**5:30 – 6:20 pm**

Regency Ballroom B

In this session, authors from the day’s papers will gather to participate in a dynamic discussion with the audience, moderated by the conference and session chairs. Since the papers and the participants represent diverse disciplines, interactive session promised to be exciting and provocative.

**Symposium Interactive Papers (Poster) Session**

**5:30 – 7:00 pm**

Atrium

**Thursday, February 2, 2017**

**Measuring Fatigue and Discomfort**

Session Chair: Huib de Ridder, Delft University of Technology (the Netherlands)

**8:50 – 9:30 am**

Regency Ballroom B

8:50 HVEI-146

**Comparison of visual discomfort and visual fatigue between HMD and smartphone**, Hyeon-Jeong Suk<sup>1</sup>, Jungmin Han<sup>1</sup>, and Seon Hee Bae<sup>2</sup>; <sup>1</sup>Korea Advanced Institute of Science and Technology and <sup>2</sup>Hansol Eye Clinic (Republic of Korea)

9:10 HVEI-147  
**Measuring visually induced motion sickness using wearable devices,**  
*Ran Liu<sup>1,2</sup>, Eli Peli<sup>1</sup>, and Alex Hwang<sup>1</sup>; <sup>1</sup>Harvard University (United States)  
and <sup>2</sup>Chongqing University (China)*

**Attention, Individual Differences, and Emotion**

Session Chair: Bernice Rogowitz, Visual Perspectives (United States)

**9:30 – 10:30 am**  
Regency Ballroom B

9:30 HVEI-148  
**Developmental changes in ambient and focal visual processing strategies,**  
*Onkar Krishna<sup>1</sup>, Toshihiko Yamasaki<sup>1</sup>, Kiyoharu Aizawa<sup>1</sup>,  
Andrea Helo<sup>2</sup>, and Pia Rama<sup>2</sup>; <sup>1</sup>The University of Tokyo (Japan) and  
<sup>2</sup>Université Paris Descartes (France)*

9:50 HVEI-149  
**Gaze-contingent center-surround fusion of infrared images to facilitate visual search for human targets (JIST-first),**  
*Mackenzie Glaholt and Grace Sim, Defence Research and Development Canada (Canada)*

10:10 HVEI-150  
**Evaluation and prediction of evoked emotions induced by image manipulations,**  
*Lin Yuan and Touradj Ebrahimi, EPFL (Switzerland)*

10:30 – 11:00 am Coffee Break

**Special Session: Art and Aesthetics, Part I: Measuring Artistic and Aesthetic Judgments**

Session Chairs: Claus-Christian Carbon, University of Bamberg (Germany), Elena Fedorovskaya, Rochester Institute of Technology (United States), and Monica Lopez-Gonzalez, La Petite Noiseuse Productions (United States)

**11:00 am – 12:30 pm**  
Regency Ballroom B

11:00 HVEI-151  
**Measurement problems and measurement strategies for capturing the rich experience of art (Invited),**  
*Claus-Christian Carbon<sup>1,2</sup>;  
<sup>1</sup>University of Bamberg and <sup>2</sup>EPAEG (Germany)*

11:30 HVEI-152  
**The gist of beauty: An investigation of aesthetic perception in rapidly presented images (Invited),**  
*Caitlin Mullin<sup>1,2</sup>, Gregor Hayn-Leichsenring<sup>3</sup>, Christoph Redies<sup>3</sup>, and Johan Wagemans<sup>2</sup>;  
<sup>1</sup>Massachusetts Institute of Technology (United States), <sup>2</sup>University of Leuven (Belgium), and <sup>3</sup>University of Jena (Germany)*

12:00 HVEI-153  
**Gaze patterns in art viewing and their dependency on expertise and image characteristics (Invited),**  
*Elena Fedorovskaya, Sanjana Kapisthalam, and Yingtong Bu, Rochester Institute of Technology (United States)*

12:30 – 2:00 pm Lunch Break

**Special Session: Art and Aesthetics, Part II: Producing Art from the Artists' and Scientists' Perspectives**

Session Chairs: Claus-Christian Carbon, University of Bamberg (Germany), Elena Fedorovskaya, Rochester Institute of Technology (United States), and Monica Lopez-Gonzalez, La Petite Noiseuse Productions (United States)

**2:00 – 3:30 pm**  
Regency Ballroom B

2:00 HVEI-154  
**Imaging human vision: An artistic perspective (Invited),**  
*Robert Pepperell, Cardiff Metropolitan University (United Kingdom)*

2:30 HVEI-155  
**Art training matters: Enhancement of spatial cognition and brain connectivity (Invited),**  
*Lora Likova, Laura Cacciamani, and Spero Nicholas, Smith-Kettlewell Eye Research Institute (United States)*

3:00 HVEI-156  
**Trading conversations between science and art: When musical improvisation enters the dialogue on stage (Invited),**  
*Monica Lopez-Gonzalez, La Petite Noiseuse Productions (United States)*

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

**3:00 – 5:00 pm**  
Atrium

3:20 – 4:00 pm Coffee Break

**DISCUSSION: Embracing the Complexity of Human Experience**

**3:30 – 4:30 pm**  
Regency Ballroom B

*In this session, authors from the day's papers will gather to participate in a dynamic discussion with the audience, moderated by the conference and session chairs. Since the papers and the participants represent diverse disciplines, interactive session promised to be exciting and provocative.*

**Museum Visit: San Francisco Museum of Modern Art**

**5:30 – 7:30 pm**  
Offsite

*The San Francisco Museum of Modern Art is open again, after a significant multi-year renovation. To celebrate, we will be organizing a Museum Visit and informal dinner party for Friends of HVEI. Members of the HVEI community will provide perceptual and cognitive insights into pieces in the Museum Collection. Everyone is responsible for his or her own transportation, museum entrance fees and dinner. Anyone interested can meet in the Hotel Lobby at 5:00 to arrange shared cab rides or Ubers. The tour begins at 5:30 at the ticket booth in the museum lobby.*

**Friends of HVEI Casual Dinner**

**7:30 – 9:30 pm**  
Offsite

*This casual dinner follows immediately after the museum visit.*

## Image Processing: Algorithms and Systems XV

### Conference overview

Image Processing: Algorithms and Systems continues the tradition of the past conference Nonlinear Image Processing and Pattern Analysis in exploring new image processing algorithms. It also reverberates the growing call for integration of the theoretical research on image processing algorithms with the more applied research on image processing systems.

Specifically, the conference aims at highlighting the importance of the interaction between linear, nonlinear, and transform-based approaches for creating sophisticated algorithms and building modern imaging systems for new and emerging applications.

### Award

Best Paper

**Conference Chairs:** **Sos S. Agaian**, The Univ. of Texas at San Antonio (United States); **Karen O. Egiazarian**, Tampere Univ. of Technology (Finland); and **Atanas P. Gotchev**, Tampere Univ. of Technology (Finland)

**Program Committee:** **Gözde Bozdagi Akar**, Middle East Technical Univ. (Turkey); **Junior Barrera**, Univ. de São Paulo (Brazil); **Jenny Benois-Pineau**, Bordeaux Univ. (France); **Giacomo Boracchi**, Politecnico di Milano (Italy); **Reiner Creutzburg**, Fachhochschule Brandenburg (Germany); **Alessandro Foi**, Tampere Univ. of Technology (Finland); **Paul D. Gader**, Univ. of Florida (United States); **John C. Handley**, Xerox Corp. (United States); **Vladimir V. Lukin**, National Aerospace Univ. (Ukraine); **Vladimir Marchuk**, Don State Technical Univ. (Russian Federation); **Stephen Marshall**, Univ. of Strathclyde (United Kingdom); **Alessandro Neri**, Radiolabs (Italy); **Marek R. Ogiela**, AGH Univ. of Science and Technology (Poland); **Ljiljana Platisa**, Univ. Gent (Belgium); **Françoise Prêteux**, Mines ParisTech (France); **Giovanni Ramponi**, Univ. degli Studi di Trieste (Italy); **Ivan W. Selesnick**, Polytechnic Institute of New York Univ. (United States); and **Damir Sersic**, Univ. of Zagreb (Croatia)





# Image Processing: Algorithms and Systems XV

## Tuesday, January 31, 2017

### Transform-domain Image Processing

Session Chair: Karen Egiazarian, Tampere University of Technology (Finland)

**8:50 – 10:10 am**

Cypress B

8:50 IPAS-197

**Compressed sensing MRI using curvelet sparsity and nonlocal total variation**, Ali Pour Yazdanpanah, University of Nevada (United States)

9:10 IPAS-198

**Brand detection framework in LG wavelet domain**, Federica Mangiardi, Andrea Bernardini, Emiliano Pallotti, and Licia Capodiferro, Fondazione Ugo Bordoni (Italy)

9:30 IPAS-199

**Texture representations in different basis functions for image synthesis using system criteria analysis**, Viacheslav Voronin<sup>1</sup>, Vladimir Ryzhov<sup>2</sup>, Vladimir Marchuk<sup>1</sup>, and Karen Egiazarian<sup>3</sup>; <sup>1</sup>Don State Technical University (Russian Federation), <sup>2</sup>Southern Federal University (Russian Federation), and <sup>3</sup>Tampere University of Technology (Finland)

9:50 IPAS-200

**2-D octonion discrete fourier transform: Fast algorithms**, Artyom Grigoryan and Sos Agaian, University of Texas at San Antonio (United States)

10:00 AM – 7:30 pm Industry Exhibition

10:10 – 10:50 am Coffee Break

### Image Processing Algorithms

Session Chair: Karen Egiazarian, Tampere University of Technology (Finland)

**10:50 am – 12:10 pm**

Cypress B

10:50 IPAS-201

**Artifact suppression in compressed images using residual-based deep convolutional network**, Woo Hyun Nam, Kiheum Cho, Il Jun Ahn, Yongsup Park, and Tammy Lee, Samsung Electronics Co. Ltd. (Republic of Korea)

11:10 IPAS-202

**Full-reference metrics multidistortional analysis**, Oleg Ieremeiev<sup>1</sup>, Vladimir Lukin<sup>1</sup>, Nikolay Ponomarenko<sup>1</sup>, and Karen Egiazarian<sup>2</sup>; <sup>1</sup>National Aerospace University (Ukraine) and <sup>2</sup>Tampere University of Technology (Finland)

11:30 IPAS-203

**ICA-based background subtraction method for an FPGA-SoC**, Fernando Carrizosa-Corral, Alberto Vázquez-Cervantes, Josué Montes Martínez, Teresa Hernández-Díaz, Jorge Soto-Cajiga, and Hugo Jimenez; Centro de Ingeniería y Desarrollo Industrial (Mexico)

11:50 IPAS-204

**A robust line segmentation for Arabic printed text with diacritics**, Khader Mohammad, Birzeit University (Palestine)

12:10 – 2:00 pm Lunch Break

### EI 2017 Tuesday Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**VR 2.0: Making virtual reality better than reality**, Gordon Wetzstein, Stanford University (United States)

Gordon Wetzstein is an Assistant Professor of Electrical Engineering and, by courtesy, of Computer Science, at Stanford University, and leads the Stanford Computational Imaging Group. He received a PhD in computer science from the University of British Columbia (2011) where his doctoral dissertation focused on computational light modulation for image acquisition and display. In his talk, Wetzstein explores the frontiers of VR systems engineering. Eventually, VR/AR systems will redefine communication, entertainment, education, collaborative work, simulation, training, telesurgery, and basic vision research, as next-generation computational near-eye displays evolve to deliver visual experiences that are better than the real world.

3:00 – 3:30 pm Coffee Break

### Image Interpolation, Restoration, and Denoising Joint Session

Session Chairs: Karen Egiazarian, Tampere University of Technology (Finland), and Radka Tezaur, Intel Corporation (United States)

**3:30 – 5:30 pm**

Grand Peninsula Ballroom A

This session is jointly sponsored by: Digital Photography and Mobile Imaging XIII and Image Processing: Algorithms and Systems XV.

3:30 DPMI-083

**BM3D-HVS: Content-adaptive denoising for improved visual quality (Invited)**, Karen Egiazarian<sup>1,2</sup>, Aram Danielyan<sup>2</sup>, Nikolay Ponomarenko<sup>1,2</sup>, Alessandro Foi<sup>1,2</sup>, Oleg Ieremeiev<sup>3</sup>, and Vladimir Lukin<sup>3</sup>; <sup>1</sup>Tampere University of Technology (Finland), <sup>2</sup>Noiseless Imaging Oy (Finland), and <sup>3</sup>National Aerospace University (Ukraine)

3:50 IPAS-084

**Refining raw pixel values using a value error model to drive texture synthesis**, Henry Dietz, University of Kentucky (United States)

4:10 IPAS-085

**Color interpolation based on colorization for RGB-white color filter array**, Paul Oh<sup>1</sup>, Sukho Lee<sup>2</sup>, and Moon Gi Kang<sup>1</sup>; <sup>1</sup>Yonsei University and <sup>2</sup>Dongseo University (Republic of Korea)

4:30 IPAS-086

**Video frame synthesizing method for HDR video capturing system with four image sensors**, Takayuki Yamashita<sup>1,2</sup> and Yoshihiro Fujita<sup>1</sup>; <sup>1</sup>Ehime University and <sup>2</sup>NHK (Japan)

4:50 DPMI-088

**Robust defect pixel detection and correction for Bayer Imaging Systems**, Noha El-Yamany, Intel Corporation (Finland)

### Symposium Demonstration Session

**5:30 – 7:30 pm**

Grand Peninsula Ballroom E

## Wednesday, February 1, 2017

### Image Processing Applications

Session Chair: Sos Agaian, University of Texas at San Antonio (United States)

**8:50 – 10:10 am**

Cypress B

8:50 IPAS-205

**Water region extraction in thermal and RGB sequences using spatiotemporally-oriented energy features**, Amir Ghahremani, Egor Bondarev, and Peter De With, Eindhoven University of Technology (the Netherlands)

9:10 IPAS-206

**Cloud and shadow detection using sequential characteristics on multi-spectral satellite images**, Herman Groot<sup>1</sup>, Arjen Oostdijk<sup>2</sup>, Mark van Persie<sup>2</sup>, and Peter De With<sup>1</sup>; <sup>1</sup>Eindhoven University of Technology and <sup>2</sup>Netherlands Aerospace Centre (the Netherlands)

9:30 IPAS-207

**Thermal facial signatures for state assessment during deception**, Niles Powar<sup>1</sup>, Tamera Schneider<sup>2</sup>, Julie Skipper<sup>2</sup>, Douglas Petkie<sup>2</sup>, Vijayan Asari<sup>1</sup>, Rebecca Riffle<sup>2</sup>, Matthew Sherwood<sup>2</sup>, and Carl Cross<sup>2</sup>; <sup>1</sup>University of Dayton and <sup>2</sup>Wright State University (United States)

9:50 IPAS-208

**Face spoofing detection based on local binary descriptors**, Yao-Hong Tsai, Hsuan Chung University (Taiwan)

10:00 am – 4:00 pm Industry Exhibition

10:10 – 10:50 am Coffee Break

### 3D Sensing and Processing

Session Chair: Atanas Gotchev, Tampere University of Technology (Finland)

**10:50 – 11:50 am**

Cypress B

10:50 IPAS-209

**Real-time estimation of the 3D transformation between images with large viewpoint differences in cluttered environments**, Dennis van de Wouw<sup>1,2</sup>, Martin Pieck<sup>1</sup>, Gijs Dubbelman<sup>1</sup>, and Peter De With<sup>1</sup>; <sup>1</sup>Eindhoven University of Technology and <sup>2</sup>Vinotion B.V. (the Netherlands)

11:10 IPAS-210

**Camera-to-model back-raycasting for extraction of RGBD images from pointclouds**, Hani Javan Hemmat<sup>1</sup>, Egor Bondarev<sup>1</sup>, and Peter De With<sup>2</sup>; <sup>1</sup>Eindhoven University of Technology and <sup>2</sup>Fac EE, SPS-VCA, Eindhoven University of Technology (the Netherlands)

11:30 IPAS-212

**Depth image object extraction approach based on improved fractal dimension**, Ting Cao and Weixing Wang, Chang'an University (China)

11:50 am – 2:00 pm Lunch Break

### EI 2017 Wednesday Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**Designing VR video camera systems**, Brian Cabral, Facebook, Inc. (United States)

Brian Cabral is Director of Engineering at Facebook, leading the Surround 360 VR camera team, specializing in computational photography, computer vision, and computer graphics. He has published a number of papers in the area of computer graphics and imaging including the pioneering Line Integral Convolution algorithm. Cabral discusses developing Facebook Surround 360, an open, high-quality 3D-360 video capture system. VR video capture systems are composed of multiple optical and digital components - all of which must operate as if they are one seamless optical system. The design of VR video cameras, optical choices, SNR, etc., require a new set of technologies and engineering approaches, with tight coupling to the computational system components.

3:00 – 3:30 pm Coffee Break

### Image Processing: Algorithms and Systems Interactive Papers Session

**5:30 – 7:00 pm**

Atrium

The following works will be presented at the EI 2017 Symposium Interactive Papers Session.

IPAS-213

**Change detection from remote sensing images based on fractional integral and improved FCM**, Fengping Wang and Weixing Wang, Chang'an University (China)

IPAS-214

**Non-blind image deconvolution using a sampling without replacement**, Jaeduk Han, Jonghyun Kim, and Moon Gi Kang, Yonsei University (Republic of Korea)

IPAS-215

**Alpha-rooting method of gray-scale image enhancement in the quaternion frequency domain**, Artyom Grigoryan, John Aparna, and Sos Agaian, University of Texas at San Antonio (United States)

IPAS-217

**What makes HDR the contents more realistic? Peak-luminance enhancement using the loading effect for OLED displays**, Jihwan Woo and Seoyoung Lee, Samsung Electronics (Republic of Korea)

IPAS-211

**Feature representation learning by rank ordered autoencoder for multi-camera person re-identification**, Sergey Makov, Vladimir Frantc, Viacheslav Voronin, and Vladimir Marchuk, Don State Technical University (Russian Federation)

IPAS-087

**Search the optimal border for combination of image pairs using neural networks**, Evgeny Semenishchev, Don State Technical University (Russian Federation)

## Image Quality and System Performance XIV

### Conference overview

We live in a visual world. The perceived quality of images is of crucial importance in industrial, medical, and entertaining application environments. Developments in camera sensors, image processing, 3D imaging, display technology, and digital printing are enabling new or enhanced possibilities for creating and conveying visual content that informs or entertains. Wireless networks and mobile devices expand the ways to share imagery.

The power of imaging rests directly on the visual quality of the images and the systems that produce them. As the images are generally intended to be viewed by humans, consideration of the role of human visual perception is intrinsic to the effective assessment of image quality.

This conference brings together engineers and scientists from industry and academia who strive to understand what makes a high-quality image and how to assess the requirements and performance of modern imaging systems. It focuses on both objective and subjective methods for evaluating the perceptual quality of images and includes applications throughout the imaging chain from image capture, through processing, to output, printed or displayed, video or still, 2D or 3D, LDR or HDR.

**Awards:** Best Student Paper and Best Paper

### Conference Sponsors



Photo: San Francisco Travel Association

**Conference Chairs:** Robin Jenkin, ON Semiconductor Corp. (United States), and Elaine Jin, Google Inc. (United States)

**Program Committee:** Nicolas Bonnier, Apple Inc. (United States); Alan C. Bovik, Univ. of Texas at Austin (United States); Peter D. Burns, Burns Digital Imaging (United States); Luke C. Cui, Amazon (United States); Susan P. Farnand, Rochester Institute of Technology (United States); Robert D. Fiete, Exelis (United States); Frans Gaykema, Océ Technologies B.V. (the Netherlands); Jukka Häkkinen, Univ. of Helsinki (Finland); Dirk W. Hertel, E Ink Corp. (United States); Sang Ho Kim, SAMSUNG Electronics Co., Ltd. (Republic of Korea); Mohamed-Chaker Larabi, Univ. of Poitiers (France); Toshiya Nakaguchi, Chiba Univ. Japan); Göte S. Nyman, Univ. of Helsinki (Finland); Stuart W. Perry, University of Technology Sydney (Australia); Jonathan B. Phillips, Google Inc. (United States); Reza Safaee-Rad, Qualcomm Technologies Inc. (Canada); and Sophie Triantaphillidou, Univ. of Westminster (United Kingdom)

## Monday, January 30, 2017

### No Reference Quality Measurement

Session Chair: Robin Jenkin, ON Semiconductor (United States)

**8:50 – 10:10 am**

Harbour

8:50 IQSP-218  
**Blind image quality assessment using multiscale local binary patterns (JIST-first)**, Pedro Garcia Freitas, Wellington Akamine, and Mylène Farias, University of Brasilia (Brazil)

9:10 IQSP-219  
**Dimension reduction-based attributes selection in no-reference learning-based image quality algorithms**, Christophe Charrier<sup>1</sup>, Abdelhakim Saadane<sup>2</sup>, and Christine Fernandez Maloigne<sup>3</sup>; <sup>1</sup>Normandie University, <sup>2</sup>Université de Nantes, and <sup>3</sup>XLIM (France)

9:30 IQSP-220  
**GPGPU based implementation of a high performing No Reference (NR)- IQA algorithm, BLINDS-II**, Aman Yadav<sup>1</sup>, Sohun Sohoni<sup>1</sup>, and Damon Chandler<sup>2</sup>; <sup>1</sup>Arizona State University (United States) and <sup>2</sup>Shizuoka University (Japan)

9:50 IQSP-221  
**No-reference image contrast assessment based on just-noticeable-difference**, Minsub Kim, Ki Sun Song, and Moon Gi Kang, Yonsei University (Republic of Korea)

10:10 – 10:50 am Coffee Break

### Keynote: Automated Video Quality Measurement and Application

Session Chair: Elaine Jin, Google Inc. (United States)

**10:50 – 11:30 am**

Harbour

**How to use video quality metrics for something other than video compression**, Anil Kokaram, Google/YouTube (United States) IQSP-222

Anil Kokaram is the Engineering Manager for the media algorithms team in YouTube. The team is responsible for developing video processing algorithms for quality improvement in various pipelines. Kokaram is also a Professor at Trinity College Dublin, Ireland and continues to supervise a small number of students at [www.sigmedia.tv](http://www.sigmedia.tv) in the EE Dept there. His main expertise is in the broad areas of DSP for Video Processing, Bayesian Inference, and motion estimation. He has published more than 100 refereed papers in these areas. In 2007 he was awarded a Science and Engineering Academy Award for his work in video processing for post-production applications. He was founder of a company (GreenParrotPictures) producing video enhancement software that was acquired by Google in 2011. He is a former Associate Editor of the IEEE Transactions on CCIs and Systems for Video Technology and IEEE Transactions on Image Processing.

### Machine Learning and Implementation of Quality Metrics

Session Chair: Elaine Jin, Google Inc. (United States)

**11:30 am – 12:30 pm**

Harbour

11:30 IQSP-223  
**MS-UNIQUE: Multi-model and sharpness-weighted unsupervised image quality estimation**, Mohit Prabhushankar, Dogancan Temel, and Ghassan AlRegib, Georgia Institute of Technology (United States)

11:50 IQSP-224  
**Microarchitectural analysis of a GPU implementation of the most apparent distortion image quality assessment algorithm**, Vignesh Kannan<sup>1,2</sup>, Joshua Holloway<sup>1</sup>, Sohun Sohoni<sup>1</sup>, and Damon Chandler<sup>2</sup>; <sup>1</sup>Arizona State University (India) and <sup>2</sup>Shizuoka University (Japan)

12:10 IQSP-225  
**Image quality assessment by comparing CNN features between images (JIST-first)**, Seyed Ali Amirshahi<sup>1</sup>, Marius Pedersen<sup>2</sup>, and Stella Yu<sup>1</sup>; <sup>1</sup>University of California, Berkeley (United States) and <sup>2</sup>Norwegian University of Science and Technology (Norway)

12:30 – 2:00 pm Lunch Break

### EI 2017 Opening Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**Giga-scale 3D computational microscopy**, Laura Waller, University of California, Berkeley (United States)

Laura Waller is the Ted Van Duzer Endowed Assistant Professor of Electrical Engineering and Computer Sciences (EECS) at UC Berkeley. She is a Senior Fellow at the Berkeley Institute of Data Science, and received her BS (2004), MEng (2005), and PhD (2010) in EECS from the Massachusetts Institute of Technology (MIT). Waller's talk is on computational imaging methods for fast capture of gigapixel-scale 3D intensity and phase images in a commercial microscope that employs illumination-side and detection-side coding of angle (Fourier) space with simple hardware and fast acquisition. The result is high-resolution reconstructions across a large field-of-view, achieving high space-bandwidth-time product.

3:00 – 3:30 pm Coffee Break

### Novel Tools

Session Chair: Luke Cui, Amazon (United States)

**3:30 – 4:50 pm**

Harbour

3:30 IQSP-226  
**Potential contrast - A new image quality measure**, Arie Shaus, Shira Faigenbaum-Golovin, Barak Sober, Eli Turkel, and Eli Piasezky, Tel Aviv University (Israel)

3:50 IQSP-227  
**Observer calibrator for color vision research**, Zhen Zhou, Anthony DoVale, Ben Grotton, Kevin Kruse, Alex Skinner, Susan Farnand, and Mark Fairchild, Rochester Institute of Technology (United States)

4:10 IQSP-228  
**Knowledge based taxonomic scheme for full reference objective image quality measurement models (JIST-first)**, Atidel Lahoulou<sup>1</sup>, Chaker Larabi<sup>2</sup>, Azeddine Beghdadi<sup>3</sup>, Emmanuel Viennet<sup>3</sup>, and Ahmed Bouridane<sup>4</sup>; <sup>1</sup>University of Jijel (Algeria), <sup>2</sup>Université de Poitiers (France), <sup>3</sup>Université Paris 13 (France), and <sup>4</sup>Northumbria University (United Kingdom)

4:30 IQSP-229  
**A RGB-NIR data set for evaluating dehazing algorithms**, Julia Lüthen<sup>1</sup>, Julian Wörmann<sup>2</sup>, Martin Kleinsteuber<sup>2</sup>, and Johannes Steurer<sup>1</sup>; <sup>1</sup>ARRI Cinetechnik and <sup>2</sup>Technische Universität München (Germany)

**Symposium Welcome Reception**  
**5:00 – 6:00 pm**  
 Atrium

9:20 IQSP-250  
**A methodology for perceptual image quality assessment of smartphone cameras – Color quality**, Susan Farnand, Rochester Institute of Technology (United States)

9:40 IQSP-251  
**Assessing the ability of simulated laboratory scenes to predict the image quality performance of HDR captures (and rendering) of exterior scenes using mobile phone cameras**, Amelia Spooner<sup>1</sup>, Ashley Solter<sup>1</sup>, Fernando Voltolini de Azambuja<sup>1</sup>, Nitin Sampat<sup>1</sup>, Stephen Viggiano<sup>1</sup>, Brian Rodricks<sup>2</sup>, and Cheng Lu<sup>3</sup>; <sup>1</sup>Rochester Institute of Technology, <sup>2</sup>SensorSpace, LLC, and <sup>3</sup>Intel Corporation (United States)

10:00 DPMI-252  
**Cell phone rankings!**, Dietmar Wueller, Image Engineering GmbH & Co. KG (Germany)

10:00 am – 7:30 pm Industry Exhibition  
 10:20 – 10:50 am Coffee Break

**Tuesday, January 31, 2017**

**Keynote: Mobile Device Camera IQ** Joint Session  
 Session Chairs: Susan Farnand, Rochester Institute of Technology, and Jackson Roland, Apple Inc. (United States)  
**8:50 – 9:20 am**  
 Grand Peninsula Ballroom A

*This session is jointly sponsored by: Image Quality and System Performance XIV and Digital Photography and Mobile Imaging XIII.*

IQSP-249  
**Towards the development of the IEEE P1858 CPIQ standard – A validation study**, Elaine Jin<sup>1</sup>, Jonathan Phillips<sup>1</sup>, Susan Farnand<sup>2</sup>, Margaret Belska<sup>3</sup>, Vinh Tran<sup>3</sup>, Ed Chang<sup>1</sup>, Yixuan Wang<sup>3</sup>, and Benjamin Tseng<sup>4</sup>; <sup>1</sup>Google Inc. (United States), <sup>2</sup>Rochester Institute of Technology (United States), <sup>3</sup>NVIDIA (United States), and <sup>4</sup>Apkudo (Australia)

*Elaine W. Jin holds a PhD in optical engineering from Zhejiang University in China, and a PhD in psychology from the University of Chicago. She has worked in the imaging industry for 151 years including employment at Polaroid Corporation, Eastman Kodak Company, Micron Technologies, Aptina Imaging, Marvell Semiconductors, and Intel Corporation. She currently is a staff image scientist at Google, working on developing cutting-edge consumer hardware products. Her primary research interests include imaging systems design and analysis, color imaging, and psychophysics. She has published 22 journal and conference papers, and authored 14 US patents / patent applications. She joined the CPIQ initiative (Camera Phone Image Quality) in 2006, and since then has made major contributions in the development of the softcopy quality ruler method, and the CPIQ metrics for visual noise, texture blur, spatial frequency responses, chroma level, and color uniformity. She currently leads the Color/Tone Subgroup of the IEEE CPIQ Standard Working Group.*

**Mobile Device Camera IQ** Joint Session

Session Chairs: Susan Farnand, Rochester Institute of Technology, and Jackson Roland, Apple Inc. (United States)

**9:20 – 10:20 am**  
 Grand Peninsula Ballroom A

*This session is jointly sponsored by: Image Quality and System Performance XIV and Digital Photography and Mobile Imaging XIII.*

**MTF** Joint Session

Session Chairs: Peter Burns, Burns Digital Imaging, and Feng Li, GoPro Inc. (United States)

**10:50 am – 12:30 pm**  
 Grand Peninsula Ballroom A

*This session is jointly sponsored by: Image Quality and System Performance XIV and Digital Photography and Mobile Imaging XIII.*

10:50 IQSP-253  
**Characterization of entire imaging plane spatial frequency response**, Victor Lenchenkov, Orit Skorka, Stan Micinski, and Radu Ispasoiu, ON Semiconductor (United States)

11:10 IQSP-254  
**Reverse-projection method for measuring camera MTF**, Stan Birchfield, Microsoft Corporation (United States)

11:30 IQSP-255  
**Texture MTF from images of natural scenes**, Riccardo Branca<sup>1</sup>, Sophie Triantaphillidou<sup>1</sup>, and Peter Burns<sup>2</sup>; <sup>1</sup>University of Westminster (United Kingdom) and <sup>2</sup>Burns Digital Imaging (United States)

11:50 DPMI-256  
**Camera phone texture preservation measurements with modulation transfer function: An alternative approach for noise estimation of random texture chart images**, Nitiin Suresh<sup>1,2</sup>, Joshua Pfefer<sup>1</sup>, and Quanzeng Wang<sup>1</sup>; <sup>1</sup>U.S. Food and Drug Administration and <sup>2</sup>University of Maryland (United States)

12:10 IQSP-257  
**The effects of misregistration on the dead leaves cross-correlation texture blur analysis**, Ranga Burada<sup>1</sup>, Robert Sumner<sup>1</sup>, and Noah Kram<sup>2</sup>; <sup>1</sup>Imatest, LLC and <sup>2</sup>Rochester Institute of Technology (United States)

12:30 – 2:00 pm Lunch Break

**EI 2017 Tuesday Plenary and Symposium Awards**

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**VR 2.0: Making virtual reality better than reality**, Gordon Wetzstein, Stanford University (United States)

Gordon Wetzstein is an Assistant Professor of Electrical Engineering and, by courtesy, of Computer Science, at Stanford University, and leads the Stanford Computational Imaging Group. He received a PhD in computer science from the University of British Columbia (2011) where his doctoral dissertation focused on computational light modulation for image acquisition and display. In his talk, Wetzstein explores the frontiers of VR systems engineering. Eventually, VR/AR systems will redefine communication, entertainment, education, collaborative work, simulation, training, telesurgery, and basic vision research, as next-generation computational near-eye displays evolve to deliver visual experiences that are better than the real world.

3:00 – 3:30 pm Coffee Break

**Systems Measurements**

Session Chair: Frans Gaykema, Océ Technologies (the Netherlands)

**3:30 – 5:30 pm**

Harbour

3:30 IQSP-230  
**Towards a quantitative evaluation of multi-imaging systems**, Anna-Cecilia Vlachomitrou, DxO (France)

3:50 IQSP-231  
**Resolution enhancement through superimposition of projected images: An evaluation of the image quality**, Svein Arne Hansen<sup>1</sup>, Muhammad Nadeem Akram<sup>1</sup>, Jon Yngve Hardeberg<sup>2</sup>, and Oyvind Svensen<sup>3</sup>; <sup>1</sup>University College of Southeast Norway, <sup>2</sup>Norwegian University of Science and Technology, and <sup>3</sup>Barco (Norway)

4:10 IQSP-232  
**Evaluation of major factors affecting spatial resolution of gamma-rays camera**, Hongwei Xie, Institute of Nuclear Physics and Chemistry (China)

4:30 IQSP-233  
**Development and image quality evaluation of 8K high dynamic range cameras with hybrid log-gamma**, Ryohei Funatsu, Kazuya Kitamura, Toshio Yasue, Daiichi Koide, and Hiroshi Shimamoto, NHK (Japan Broadcasting Corporation) (Japan)

4:50 IQSP-234  
**Detection of streaks caused by dust in the sheetfed scanners**, Daulet Kenzhebalin<sup>1</sup>, Xing Liu<sup>1</sup>, Ni Yan<sup>1</sup>, Peter Bauer<sup>2</sup>, and Jan Allebach<sup>1</sup>; <sup>1</sup>Purdue University and <sup>2</sup>HP Inc. (United States)

5:10 IQSP-235  
**Effect of dark current distribution on image quality**, Orit Skorka, Pulla Reddy Ailuri, Leo Anzagira, and Radu Ispasoiu, ON Semiconductor (United States)

**Symposium Demonstration Session**

**5:30 – 7:30 pm**

Grand Peninsula Ballroom E

**Wednesday, February 1, 2017****Print Quality**

Session Chair: Chaker Larabi, Université de Poitiers (France)

**9:10 – 9:50 am**

Harbour

9:10 IQSP-238  
**Feature ranking and selection used in a machine learning framework for predicting uniformity of printed pages**, Minh Nguyen and Jan Allebach, Purdue University (United States)

9:30 IQSP-239  
**Real-time print quality diagnostics**, Zuguang Xiao<sup>1</sup>, Minh Nguyen<sup>1,2</sup>, Eric Maggard<sup>3</sup>, Mark Shaw<sup>3</sup>, Jan Allebach<sup>1</sup>, and Amy Reibman<sup>1</sup>; <sup>1</sup>Purdue University, <sup>2</sup>Duos Technologies, and <sup>3</sup>HP Inc. (United States)

10:00 am – 4:00 pm Industry Exhibition

10:10 – 10:50 am Coffee Break

**Display**

Session Chair: Sophie Triantaphillidou, University of Westminster (United Kingdom)

**10:50 am – 12:10 pm**

Harbour

10:50 IQSP-240  
**UHD quality analyses at various viewing conditions**, Chulhee Lee, Sangwook Baek, Sungwook Youn, Seongyoun Woo, and Jeongyeol Baek, Yonsei University (Republic of Korea)

11:10 IQSP-241  
**Image quality assessment for holographic display**, Wontaek Seo, Hoon Song, Jungkwon An, Juwon Seo, Geeyoung Sung, Yun-Tae Kim, Chil-Sung Choi, Sunil Kim, Hojung Kim, Yongkyu Kim, Young Kim, Yunhee Kim, Hong-Seok Lee, and Sungwoo Hwang, Samsung Advanced Institute of Technology (Republic of Korea)

11:30 IQSP-242  
**Subjective viewer preference model for automatic HDR down conversion**, Lucien Lenzen and Mike Christmann, Hochschule RheinMain (Germany)

11:50 IQSP-243  
**A foveated just noticeable difference model for virtual reality**, Yuqiao Deng, Yingxue Zhang, Daiqin Yang, and Zhenzhong Chen, Wuhan University (China)

12:10 – 2:00 pm Lunch Break

## El 2017 Wednesday Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**Designing VR video camera systems**, Brian Cabral, Facebook, Inc. (United States)

Brian Cabral is Director of Engineering at Facebook, leading the Surround 360 VR camera team, specializing in computational photography, computer vision, and computer graphics. He has published a number of papers in the area of computer graphics and imaging including the pioneering Line Integral Convolution algorithm. Cabral discusses developing Facebook Surround 360, an open, high-quality 3D-360 video capture system. VR video capture systems are composed of multiple optical and digital components - all of which must operate as if they are one seamless optical system. The design of VR video cameras, optical choices, SNR, etc., require a new set of technologies and engineering approaches, with tight coupling to the computational system components.

3:00 – 3:30 pm Coffee Break

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## Camera 3A

Session Chair: Jonathan Phillips, Google Inc. (United States)

**3:30 – 4:50 pm**

Harbour

3:30 IQSP-244  
**A framework for auto-exposure subjective comparison**, Seungseok Oh<sup>1</sup>, Clayton Passmore<sup>1,2</sup>, Bobby Gold<sup>1</sup>, Taylor Skilling<sup>1,3</sup>, Sean Pieper<sup>1</sup>, Taek Kim<sup>1</sup>, and Margaret Belska<sup>1</sup>; <sup>1</sup>NVIDIA (United States), <sup>2</sup>University of Waterloo (Canada), and <sup>3</sup>Northeastern University (United States)

3:50 IQSP-245  
**Autofocus measurement for imaging devices**, Pierre Robisson, DxO (France)

4:10 IQSP-246  
**Auto Focus Performance - What can we expect from today's cameras?**, Uwe Artmann, Image Engineering GmbH & Co KG (Germany)

4:30 IQSP-247  
**Autofocus analysis: Latency and sharpness**, Katrina Passarella, Brett Frymire, and Ed Chang, Google, Inc (United States)

### Panel: Image Quality Discussion

Panel Moderators: Robin Jenkin, ON Semiconductor, and Elaine Jin, Google Inc. (United States)

**4:50 – 5:30 pm**

Harbour

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## Image Quality and System Performance XIV Interactive Papers Session

**5:30 – 7:00 pm**

Atrium

The following works will be presented at the El 2017 Symposium Interactive Papers Session.

IQSP-248  
**Estimation and compensation of reconstructed image in digital holographic display**, Hyun-Eui Kim, Electronics and Telecommunications Research Institute (Republic of Korea)

IQSP-236  
**Solid-mottle method for measuring in laser-printers**, Daegun Ko, Samsung Electronics (Republic of Korea)

## Image Sensors and Imaging Systems 2017

### Conference overview

Solid state optical sensors and solid state cameras have established themselves as the imaging systems of choice for many demanding professional applications such as scientific and industrial applications. The advantages of low-power, low-noise, high-resolution, high-geometric fidelity, broad spectral sensitivity, and extremely high quantum efficiency have led to a number of revolutionary uses.

This conference aims at being a place of exchanges and at giving the opportunity to a quick publication of new works in the areas of solid state detectors, solid state cameras, new optical concepts, and novel applications. To encourage young talent, a best student paper contest is organized.

**Awards:** Best Paper, Best Student Paper

### Conference Sponsors



**Conference Chairs:** Arnaud Darmont, APHESA SPRL (Belgium), and Ralf Widenhorn, Portland State Univ. (United States);

**Program Committee:** Morley M. Blouke, Portland State Univ. (retired) (United States); Erik Bodegom, Portland State Univ. (United States); Nick Bulitka, Lumenaera Corp. (Canada); Calvin Chao, Taiwan Semiconductor Manufacturing Company (Taiwan); Glenn H. Chapman, Simon Fraser Univ. (Canada); James A. DiBella, Imperx (United States); Antoine Dupret, Commissariat à l'Énergie Atomique (France); Boyd A. Fowler, OminVision Technologies, Inc. (United States); Bumsuk Kim, Samsung Electronics Co., Ltd (Republic of Korea); Rihito Kuroda, Tohoku Univ. (Japan); Kevin J. Matherson, Microsoft Corp. (United States); Arnaud Peizerat, Commissariat à l'Énergie Atomique (France); 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); and Xinyang Wang, GPiXEL (China)



# Image Sensors and Imaging Systems 2017

## Wednesday, February 1, 2017

### Keynote: History and Standards for Automotive Vision Systems Performance Joint Session

Session Chairs: Kevin Matherson, Microsoft Corporation (United States), and Dietmar Wueller, Image Engineering GmbH & Co. KG (Germany)

**8:50 – 9:30 am**

Grand Peninsula Ballroom A

*This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.*

### Conference Chair Opening Remarks

IMSE-077

#### Bayer pattern and image quality, Jörg Kunze, Basler AG (Germany)

Jörg Kunze has 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. Kunze serves as an expert for image sensors, camera hardware, noise, color fidelity, 3D- and computational imaging and develops new algorithms for color image signal processing. The majority of the Basler patents name him as inventor.

### Input Signal Quality & Characterization Joint Session

Session Chairs: Kevin Matherson, Microsoft Corporation (United States), and Dietmar Wueller, Image Engineering GmbH & Co. KG (Germany)

**9:30 – 10:10 am**

Grand Peninsula Ballroom A

*This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.*

9:30

IMSE-078

**Accurate joint geometric camera calibration of visible and far-infrared cameras, Takashi Shibata<sup>1,2</sup>, Masayuki Tanaka<sup>1</sup>, and Masatoshi Okutomi<sup>1</sup>;** <sup>1</sup>Tokyo Institute of Technology and <sup>2</sup>NEC Corporation (Japan)

9:50

DPMI-079

**Interferometric measurement of sensor MTF and crosstalk, Todor Georgiev, Jennifer Gille, Amber Sun, Lyubomir Baev, and Tharun Battula, Qualcomm Technologies, Inc. (United States)**

10:00 am – 4:00 pm Industry Exhibition

10:10 – 10:50 am Coffee Break

### Keynote: Machine Vision Retina Improvement Joint Session

Session Chairs: Thomas Vogelsang, Rambus Inc., and Ralf Widenhorn, Portland State University (United States)

**10:50 – 11:30 am**

Grand Peninsula Ballroom A

*This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.*

DPMI-080

#### Silicon retina technology (Invited), Tobi Delbruck, Institute for Neuroinformatics (INI) (Switzerland)

Tobi Delbruck (IEEE M'99-SM'06-F'13) received a PhD from Caltech (1993). He is currently a professor of physics and electrical engineering at ETH Zurich in the Institute of Neuroinformatics, University of Zurich and ETH Zurich, Switzerland, where he has been since 1998. His group, which he coordinates together with Shih-Chii Liu, focuses on neuromorphic event-based sensors and sensory processing. He has co-organized the Telluride Neuromorphic Cognition Engineering summer workshop and the live demonstration sessions at ISCAS and NIPS. Delbruck is past Chair of the IEEE CAS Sensory Systems Technical Committee. He worked on electronic imaging at Arithmos, Synaptics, National Semiconductor, and Foveon and has founded 3 spin-off companies, including inilabs.com, a non-for-profit organization that has distributed hundreds of R&D prototype neuromorphic sensors to more than a hundred organizations around the world. He has been awarded 9 IEEE awards.

### Emerging Imaging Sensor & Hardware Joint Session

Session Chairs: Thomas Vogelsang, Rambus Inc., and Ralf Widenhorn, Portland State University (United States)

**11:30 – 11:50 am**

Grand Peninsula Ballroom A

*This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.*

11:30

DPMI-081

**TIK: A time domain continuous imaging testbed using conventional still images and video, Henry Dietz, John Fike, Paul Eberhart, Katie Long, Clark Demaree, and Jong Wu, University of Kentucky (United States)**

**Keynote: Comparing CMOS Image Sensor Architectures** Joint Session

Session Chairs: Thomas Vogelsang, Rambus Inc., and Ralf Widenhorn, Portland State University (United States)

**11:50 am – 12:40 pm**

Grand Peninsula Ballroom A

*This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Digital Photography and Mobile Imaging XIII.*

IMSE-082

**CMOS image sensor pixel design and optimization**, Boyd Fowler, OmniVision Technologies (United States)

*Boyd Fowler's research interests include CMOS image sensors, low noise image sensors, noise analysis, data compression, and machine learning and vision. He received his MSEE (1990) and PhD (1995) from Stanford University. After finishing his PhD he stayed at Stanford University as a research associate in the Electrical Engineering Information Systems Laboratory until 1998. In 1998, Fowler founded Pixel Devices International in Sunnyvale California. Between 2005 and 2013, Fowler was CTO and VP of Technology at Fairchild Imaging. He is currently at OmniVision Technologies leading the marketing department. Fowler has authored numerous technical papers, book chapters and patents.*

**Image Sensors and Imaging Systems 2017 Awards**

12:40 – 2:00 pm Lunch Break

**EI 2017 Wednesday Plenary and Symposium Awards**

Session Chairs: Joyce E. Farrell, Stanford University, and Nitiin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**Designing VR video camera systems**, Brian Cabral, Facebook, Inc. (United States)

*Brian Cabral is Director of Engineering at Facebook, leading the Surround 360 VR camera team, specializing in computational photography, computer vision, and computer graphics. He has published a number of papers in the area of computer graphics and imaging including the pioneering Line Integral Convolution algorithm. Cabral discusses developing Facebook Surround 360, an open, high-quality 3D-360 video capture system. VR video capture systems are composed of multiple optical and digital components - all of which must operate as if they are one seamless optical system. The design of VR video cameras, optical choices, SNR, etc., require a new set of technologies and engineering approaches, with tight coupling to the computational system components.*

3:00 – 3:30 pm Coffee Break

**High Performance Imaging**

Session Chairs: Rihito Kuroda, Tohoku University (Japan), and Alice Reinheimer, e2v (United States)

**3:30 – 5:00 pm**

Grand Peninsula Ballroom A

3:30

IMSE-178

**High sensitivity and high readout speed electron beam detector using steep pn Junction Si diode for low acceleration voltage**, Yasumasa Koda, Rihito Kuroda, Masaya Hara, Hiroyuki Tsunoda, and Shigetoshi Sugawa, Tohoku University (Japan)

3:50

IMSE-179

**A full-resolution 8K single-chip portable camera system**, Tomohiro Nakamura, Takahiro Yamasaki, Ryohei Funatsu, and Hiroshi Shimamoto, NHK Science and Technology Research Laboratories (Japan)

4:10

IMSE-180

**Filter selection for multispectral imaging optimizing spectral, colorimetric and image quality**, Yixuan Wang, Rochester Institute of Technology (United States)

4:30

IMSE-181

**The challenge of shot-noise limited speckle patterns statistical analysis**, Jean-Michel Tualle, Kinia Barjean, Eric Tinet, and Dominique Ettori, University Paris 13 (France)

4:50

IMSE-182

**Overview of machine vision standards**, Arnaud Darmont, APHESA SPRL (Belgium)

**Image Sensors and Imaging Systems 2017 Interactive Papers Oral Previews**

Session Chairs: Arnaud Darmont, APHESA SPRL (Belgium), and Ralf Widenhorn, Portland State University (United States)

**5:00 – 5:30 pm**

Grand Peninsula Ballroom 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 2017 portion of the Symposium Interactive Papers Session at 5:30 pm on Wednesday.*

5:00

**Session Chair Remarks**

5:10

IMSE-183

**Hot pixel rate behavior as pixel sizes go to 1 micron**, Glenn Chapman<sup>1</sup>, Rahul Thomas<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)

5:20

IMSE-184

**Performance evaluation of the thick pinhole gamma rays diagnostic system**, Hongwei Xie, Institute of Nuclear Physics and Chemistry (China)

**Symposium Interactive Papers (Poster) Session**  
**5:30 – 7:30 pm**

Atrium

## Thursday, February 2, 2017

### Sensor Design and Technology

Session Chairs: Arnaud Peizerat, CEA, and Jean-Michel Tualle, University Paris 13 (France)

#### 8:50 – 9:50 am

Harbour

8:50 IMSE-185  
**Octagonal CMOS image sensor for endoscopic applications**, *Elena Reis, Alice Andrade, Martin Wány, Pedro Santos, Ricardo M. Sousa, and Natércia Sousa, Awaiba, Lda (Portugal)*

9:10 IMSE-186  
**Optimization of CMOS image sensor utilizing variable temporal multi-sampling partial transfer technique to achieve full-frame high dynamic range with superior low light and stop motion capability**, *Salman Kabir, Craig Smith, Gerrit Barnard, Alex Schneider, Frank Armstrong, Michael Guidash, Thomas Vogelsang, and Jay Endsley, Rambus Inc. (United States)*

9:30 IMSE-187  
**A lateral electric field charge modulator with bipolar-gates for time-resolved imaging**, *Yuki Morikawa, Keita Yasutomi, Shoma Imanishi, Taishi Takasawa, Keiichiro Kagawa, Nobukazu Teranishi, and Shoji Kawahito, Shizuoka University (Japan)*

#### Keynote: Sensor design and technology

Session Chairs: Arnaud Peizerat, CEA, and Jean-Michel Tualle, University Paris 13 (France)

#### 9:50 – 10:20 am

Harbour

IMSE-188  
**A 128x128, 34 $\mu$ m pitch, 8.9mW, 190mK NETD, TECless Uncooled IR bolometer image sensor with columnwise processing**, *Laurent Alacoque<sup>1</sup>, Sébastien Martin<sup>1</sup>, Wilfried Rabaud<sup>1</sup>, Édith Beigné<sup>1</sup>, and Antoine Dupret<sup>2</sup>; <sup>1</sup>Minatoc Campus and <sup>2</sup>CEA (France)*

*Laurent Alacoque was born in Lyon, France in 1974. He received the engineering degree in electronics and information processing from the Ecole Supérieure de Chimie Physique et Electronique of Lyon (ESCPE) (1998). In the same year, he joined the Institut National de Sciences Appliquées (INSA) on Villeurbanne Campus for a PhD on the application of Asynchronous Logic to Analogue-Digital Conversion. He received his PhD (2002), and joined the CEA-Leti in 2003, first as a postdoctoral student and then as a member of the smart-imaging laboratory. Since then, his work focuses on the imaging chain, from pixel level design, imager-specific Analogue-Digital Conversion, to Image Signal Processing algorithms.*

10:20 – 10:50 am Coffee Break

### Noise and Performance

Session Chairs: Boyd Fowler, OmniVision Technologies (United States), and Gilles Sicard, CEA (France)

#### 10:50 – 11:50 am

Harbour

10:50 IMSE-189  
**Residual bulk image characterization using photon transfer techniques, CMOS image sensors**, *Richard Crisp, Etron Technology America (United States)*

11:10 IMSE-190  
**RTS and photon shot noise reduction based on maximum likelihood estimate with multi-aperture optics and semi-photon-counting-level CMOS image sensors**, *Haruki Ishida<sup>1</sup>, Keiichiro Kagawa<sup>1</sup>, Min Seo<sup>1</sup>, Takashi Komuro<sup>2</sup>, Bo Zhang<sup>1</sup>, Taishi Takasawa<sup>1</sup>, Keita Yasutomi<sup>1</sup>, and Shoji Kawahito<sup>1</sup>; <sup>1</sup>Shizuoka University and <sup>2</sup>Saitama University (Japan)*

11:30 IMSE-191  
**Linearity analysis of a CMOS image sensor**, *Fei Wang<sup>1</sup> and Albert Theuwissen<sup>1,2</sup>; <sup>1</sup>Technische University Delft (the Netherlands) and <sup>2</sup>Harvest Imaging (Belgium)*

#### Keynote: History and Standards for Automotive Vision Systems Performance Joint Session

Session Chairs: Arnaud Darmont, APHESA SPRL (Belgium), Ralf Widenhorn, Portland State University (United States), and Buyue Zhang, Intel Corp. (United States)

#### 11:50 am – 12:30 pm

Harbour

*This session is jointly sponsored by: Image Sensors and Imaging Systems 2017 and Autonomous Vehicles and Machines 2017.*

IMSE-196  
**Automotive imaging**, *Patrick Denny, Valeo (Ireland)*

*Patrick Denny is a Senior Research Engineer and a Valeo Senior Expert and has worked for the last 15 years at Valeo Vision Systems, Ireland. He received his PhD in physics (2000) from the National University of Ireland, Galway, where he is also Adjunct Professor of Automotive Electronics. Denny has in excess of 20 years experience in scientific and technological development internationally, designing, innovating and developing automotive imaging technologies for BMWV, Jaguar Land Rover, Daimler, VW, and other OEMs. His research interests include several aspects of automotive vision system image quality, sensor components, algorithmic design, systems, machine learning and data analytics.*

12:30 – 2:00 pm Lunch Break

**Image and Sensor Applications**

Session Chairs: Glenn Chapman, Simon Fraser University (Canada), and Xinyang Wang, Gpixel Inc. (China)

**2:00 – 2:40 pm**

Harbour

2:00 IMSE-192  
**FPGA platform for testing a real-time tone-mapping algorithm based on a Mantissa-exponent representation**, Ulian Shahnovich and Orly Yadid-Pecht, University of Calgary (Canada)

2:20 IMSE-194  
**Fast, low-complex, non-contact motion encoder based on the NSIP concept**, Anders Astrom<sup>1</sup> and Robert Forchheimer<sup>2</sup>; <sup>1</sup>Combitech AB and <sup>2</sup>Linköping University (Sweden)

**Keynote: Image Sensors for Devices of Internet of Things**

Session Chairs: Arnaud Darmont, APHESA SPRL (Belgium), and Ralf Widenhorn, Portland State University (United States)

**2:40 – 3:20 PM**

Harbour

**In the quest of vision-sensors-on-chip: Pre-processing sensors for data reduction**, Angel Rodriguez-Vázquez, Universidad de Sevilla (Spain) IMSE-195

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.

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

**3:00 – 5:00 pm**

Atrium

3:20 – 4:00 pm Coffee Break

## Imaging and Multimedia Analytics in a Web and Mobile World 2017

### Conference overview

The recent progress in web, social networks, and mobile capture and presentation technologies has created a new wave of interest in imaging and multimedia topics, from multimedia analytics to content creation and repurposing, from engineering challenges to aesthetics and legal issues, from content sharing on social networks to content access from Smart Phones with cloud-based content repositories and services. Compared to many subjects in traditional imaging, these topics are more multi-disciplinary in nature. This conference provides a forum for researchers and engineers from various related areas, both academic and industrial to exchange ideas and share research results in this rapidly evolving field.

**Conference Chairs:** Jan P. Allebach, Purdue Univ. (United States); Zhigang Fan, Apple Inc. (United States); and Qian Lin, Hp Labs, Hp Inc. (United States);

**Program Committee:** Gady Agam, Illinois Institute of Technology (United States); Vijayan K. Asari, Univ. of Dayton (United States); Reiner Fageth, CEWE Stiftung & Co. KGaA (Germany); Yi Fang, New York Univ. Abu Dhabi (United States); Michael J. Gormish, Ricoh Innovations, Inc. (United States); Yandong Guo, Microsoft Corp. (United States); Ali Jahanian, MIT CSAIL Lab (United States); Ramakrishna Kakarola, Picartio Inc. (United States); Xiaofan Lin, A9.com, Inc. (United States); Changsong Liu, Tsinghua Univ. (China); Yung-Hsiang Lu, Purdue Univ. (United States); Binu Nair, Univ. of Dayton Research Institute (United States); Mu Qiao, Shutterfly, Inc. (United States); Alastair M. Reed, Digimarc Corp. (United States); Andreas Savakis, RIT (United States); Bin Shen, Google Inc. (United States); Wiley H. Wang, Ditto.com (United States); Jane You, The Hong Kong Polytechnic Univ. (Hong Kong, China); and Buyue Zhang, Intel Corporation (United States)



# Imaging and Multimedia Analytics in a Web and Mobile World 2017

Wednesday, February 1, 2017

IMAWM

## Keynote: Web Scale Multimedia Analysis I

Session Chair: Jan Allebach, Purdue University (United States)

9:10 – 10:10 am

Cypress A

IMAWM-157

**The internet on things: Delivering augmented reality experiences in context,** Michael Gormish, Blippar (United States)

Michael Gormish is Principal Scientist at Blippar on the infrastructure team working on image retrieval and multiple computer vision products. Gormish is an image processing and computer vision scientist and engineer who invented algorithms used in products including video games, digital cinema, satellite and medical image acquisition and transport. He earned a PhD in electrical engineering dealing with image and data compression from Stanford University. In his twenty year career at Ricoh, he led several aspects of the JPEG 2000 standardization and provided key inventions used in photocopiers, digital cameras, tablets and imaging services. He was awarded the status of Ricoh Patent Master for being a co-inventor on more than 100 US patents. He has served the research community as an Associate Editor of the IEEE Signal Processing Magazine, Associate Editor of the Journal of Electronic Imaging, Program Chair of the Document Engineering Conference, and technical committee member and reviewer for numerous conferences and journals. Currently he is interested changing the world via mobile image understanding.

10:00 am – 4:00 pm Industry Exhibition

10:10 – 10:50 am Coffee Break

## Web Scale Multimedia Analysis II

Session Chair: Binu Nair, University of Dayton Research Institute (United States)

10:50 am – 12:30 pm

Cypress A

10:50 IMAWM-158

**MS-Celeb-1M: A review of large-scale face recognition (Invited),**

Yandong Guo and Lei Zhang, Microsoft Research (United States)

11:30 IMAWM-159

**Evaluation of Hadoop and HPCC for multimedia big data analysis,**

Vishnu Chinta, Hari Kalva, and Borko Furht, Florida Atlantic University (United States)

11:50 IMAWM-160

**Creating the world's largest real-time camera network,** Ryan Dailey,

Shengli Sui, Chan Wengyan, Thomas Norling, Sanghyun Joo, and Yung-Hsiang Lu, Purdue University (United States)

12:10 IMAWM-161

**Multimedia instant messaging with real-time attribute-based encryption,**

Xunyu Pan and Christopher Gill, Frostburg State University (United States)

12:30 – 2:00 pm Lunch Break

## EI 2017 Wednesday Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

2:00 – 3:00 pm

Grand Peninsula Ballroom D

**Designing VR video camera systems,** Brian Cabral, Facebook, Inc. (United States)

Brian Cabral is Director of Engineering at Facebook, leading the Surround 360 VR camera team, specializing in computational photography, computer vision, and computer graphics. He has published a number of papers in the area of computer graphics and imaging including the pioneering Line Integral Convolution algorithm. Cabral discusses developing Facebook Surround 360, an open, high-quality 3D-360 video capture system. VR video capture systems are composed of multiple optical and digital components - all of which must operate as if they are one seamless optical system. The design of VR video cameras, optical choices, SNR, etc., require a new set of technologies and engineering approaches, with tight coupling to the computational system components.

3:00 – 3:30 pm Coffee Break

## Deep Learning

Session Chair: Zhigang Fan, Apple Inc. (United States)

3:30 – 4:50 pm

Cypress A

3:30 IMAWM-162

**Distracted driver detection: Deep learning vs handcrafted features,**

Murtadha Hssayeni, Sagar Saxena, Raymond Pucha, and Andreas Savakis, Rochester Institute of Technology (United States)

3:50 IMAWM-163

**Logo recognition using data augmentation techniques,** Daniel Mas

Montserrat<sup>1</sup>, Qian Lin<sup>2</sup>, Jan Allebach<sup>1</sup>, and Edward Delp<sup>1</sup>; <sup>1</sup>Purdue University and <sup>2</sup>HP Labs, HP Inc. (United States)

4:10 IMAWM-164

**Detection and characterization of Coordinate Measuring Machine (CMM) probes using deep networks for improved quality assurance of machine parts,** Binu Nair<sup>1</sup>, Vidur Prasad<sup>2</sup>, and Nilesh Powar<sup>1</sup>;

<sup>1</sup>University of Dayton Research Institute and <sup>2</sup>University of Michigan (United States)

4:30 IMAWM-165

**Robust head detection with CNN,** Ming Chen<sup>1</sup>, Qian Lin<sup>2</sup>, Fengqing Zhu<sup>1</sup>, and Jan Allebach<sup>1</sup>; <sup>1</sup>Purdue University and <sup>2</sup>HP Labs, HP Inc. (United States)

## Symposium Interactive Papers (Poster) Session

5:30 – 7:00 pm

Atrium

## Thursday, February 2, 2017

### Multimedia Analysis

Session Chair: Reiner Fageth, CEWE Stiftung & Co. KGAA (Germany)

8:50 – 10:30 am

Cypress A

8:50 IMAWM-166

**Analytics for body worn cameras (Invited)**, Quanfu Fan, Thomas J. Watson Research Center (United States)

9:30 IMAWM-167

**Click-based interactive segmentation with graph cut**, ChunJung Tai<sup>1</sup>, Tongyang Liu<sup>1</sup>, Judy Bagchi<sup>2</sup>, Fengqing Zhu<sup>1</sup>, and Jan Allebach<sup>1</sup>; <sup>1</sup>Purdue University and <sup>2</sup>DzineSteps (United States)

9:50 IMAWM-168

**Drone Detection by acoustic signature identification**, Andrea Bernardini, Federica Mangiatordi, Emiliano Pallotti, and Licia Capodiferro, Fondazione Ugo Bordoni (Italy)

10:10 IMAWM-169

**Aesthetics of fashion photographs: Effect on user preferences**, Zhi Li<sup>1</sup>, Shuheng Lin<sup>1</sup>, Yang Cheng<sup>1</sup>, Gautam Golwala<sup>2</sup>, Sathya Sundaram<sup>2</sup>, and Jan Allebach<sup>1</sup>; <sup>1</sup>Purdue University and <sup>2</sup>Poshmark Inc. (United States)

10:30 – 10:50 am Coffee Break

### Face / Body Detection and Recognition

Session Chair: Andreas Savakis, Rochester Institute of Technology (United States)

10:50 am – 12:10 pm

Cypress A

10:50 IMAWM-170

**Local boosted features for illumination invariant face recognition**, Almatbrok Essa and Vijayan Asari, University of Dayton (United States)

11:10 IMAWM-171

**High precision 3D reconstruction of the human face**, Michael Wang, Daran He, Frankie Li, Wiley Wang, and Sergey Surkov, Ditto Technologies (United States)

11:30 IMAWM-172

**Chromatic domain phase features with gradient and texture for efficient human detection**, Hussin Ragb, University of Dayton (United States)

11:50 IMAWM-173

**A real-time smile elegance detection system: A feature-level fusion and ranking SVM based approach**, Lili Lin<sup>1</sup>, Yiwen Zhang<sup>1</sup>, Weini Zhang<sup>1</sup>, Xinxin Liu<sup>1</sup>, Yan Yan<sup>1</sup>, and Tianli Yu<sup>2</sup>; <sup>1</sup>Department of Computer Science, Xiamen University (China) and <sup>2</sup>Independent Consultant (United States)

12:10 – 2:00 pm Lunch Break

### Analytics for Mobile Applications

Session Chair: Qian Lin, HP Labs, HP Inc. (United States)

2:00 – 3:20 pm

Cypress A

2:00 IMAWM-174

**MU, the ultra mobile visual analytic sensor for toys and IOTs**, Tianli Yu, Morpx Inc. (United States)

2:20 IMAWM-175

**An imaging approach to online progressive addition lens retrieval**, Qin Li<sup>1</sup>, Ruohan Zhan<sup>2</sup>, Zhenhua Guo<sup>3</sup>, and Jane You<sup>2</sup>; <sup>1</sup>The Shenzhen Institute of Information Technology (China), <sup>2</sup>The Hong Kong Polytechnic University (Hong Kong), and <sup>3</sup>Graduate School at Shenzhen, Tsinghua University (China)

2:40 IMAWM-176

**Are mobile phones changing the order behavior and content for printed photo products?**, Reiner Fageth, CEWE Stiftung & Co. KGAA (Germany)

3:00 IMAWM-177

**Texture re-rendering tool for re-mixing indoor scene images**, Tongyang Liu<sup>1</sup>, ChunJung Tai<sup>1</sup>, Fengqing Zhu<sup>1</sup>, Judy Bagchi<sup>2</sup>, and Jan Allebach<sup>1</sup>; <sup>1</sup>Purdue University and <sup>2</sup>DzineSteps (United States)

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

3:00 – 5:00 pm

Atrium

3:20 – 4:00 pm Coffee Break

## Intelligent Robotics and Industrial Applications using Computer Vision 2017

### Conference overview

This conference brings together real-world practitioners and researchers in intelligent robots and computer vision to share recent applications and developments. Topics of interest include the integration of imaging sensors supporting hardware, computers, and algorithms for intelligent robots, manufacturing inspection, characterization, and/or control.

The decreased cost of computational power and vision sensors has motivated the rapid proliferation of machine vision technology in a variety of industries, including aluminum, automotive, forest products, textiles, glass, steel, metal casting, aircraft, chemicals, food, fishing, agriculture, archaeological products, medical products, artistic products, etc. Other industries, such as semiconductor and electronics manufacturing, have been employing machine vision technology for several decades. Machine vision supporting handling robots is another main topic. With respect to intelligent robotics another approach is sensor fusion – combining multi-modal sensors in audio, location, image and video data for signal processing, machine learning and computer vision, and additionally other 3D capturing devices.

There is a need of accurate, fast, and robust detection of objects and their position in space. Their surface, the background and illumination is uncontrolled, in most cases the objects of interest are within a bulk of many others. For both new and existing industrial users of machine vision, there are numerous innovative methods to improve productivity, quality, and compliance with product standards. There are several broad problem areas that have received significant attention in recent years. For example, some industries are collecting enormous amounts of image data from product monitoring systems. New and efficient methods are required to extract insight and to perform process diagnostics based on this historical record. Regarding the physical scale of the measurements, microscopy techniques are nearing resolution limits in fields such as semiconductors, biology, and other nano-scale technologies. Techniques such as resolution enhancement, model-based methods, and statistical imaging may provide the means to extend these systems beyond current capabilities. Furthermore, obtaining real-time and robust measurements in-line or at-line in harsh industrial environments is a challenge for machine vision researchers, especially when the manufacturer cannot make significant changes to their facility or process.

**Conference Chairs:** Henry Y.T. Ngan, Hong Kong Baptist Univ. (China); Kurt Niel, Upper Austria Univ. of Applied Sciences (Austria); and Juha Röning, Univ. of Oulu (Finland)

**Program Committee:** Philip Bingham, Oak Ridge National Laboratory (United States); Ewald Fauster, Montan Universität Leoben (Austria); Daniel Fecker, Technische Univ. Braunschweig (Germany); Steven Floeder, 3M Company (United States); David Fofi, Univ. de Bourgogne (France); Shaun Gleason, Oak Ridge National Lab (United States); B. Keith Jenkins, The Univ. of Southern California (United States); Olivier Laligant, Univ. de Bourgogne (France); Edmund Lam, The Univ. of Hong Kong (Hong Kong, China); Dah-Jye Lee, Brigham Young Univ. (United States); Junning Li, Keck School of Medicine, Univ. of Southern California (United States); Wei Liu, The Univ. of Sheffield (United Kingdom); Charles McPherson, Draper Laboratory (United States); Fabrice Meriaudeau, Univ. de Bourgogne (France); Yoshihiko Nomura, Mie Univ. (Japan); Lucas Paletta, JOANNEUM RESEARCH Forschungsgesellschaft mbH (Austria); Vincent Paquit, Oak Ridge National Laboratory (United States); Daniel Raviv, Florida Atlantic Univ. (United States); Hamed Sari-Sarraf, Texas Tech Univ. (United States); Ralph Seulin, Univ. de Bourgogne (France); Christophe Stolz, Univ. de Bourgogne (France); Svorad Štolc, AIT Austrian Institute of Technology GmbH (Austria); Bernard Theisen, U.S. Army Tank Automotive Research, Development and Engineering Center (United States); Seung-Chul Yoon, United States Department of Agriculture Agricultural Research Service (United States); Gerald Zauner, FH OÖ-Forschungs & Entwicklungs GmbH (Austria); and Dili Zhang, Monotype Imaging (United States)



# Intelligent Robotics and Industrial Applications using Computer Vision 2017

Wednesday, February 1, 2017

## Autonomous Robotics

Session Chair: Juha Röning, University of Oulu (Finland)

8:50 – 10:10 am

Cypress C

8:50 IRIACV-258  
**Efficient visual loop closure detection via moment based global image descriptors**, Can Erhan<sup>1</sup>, Evangelos Sariyanidi<sup>2</sup>, Onur Sencan<sup>1</sup>, and Hakan Temeltas<sup>1</sup>; <sup>1</sup>Istanbul Teknik Üniv. (Turkey) and <sup>2</sup>Queen Mary, University of London (United Kingdom)

9:10 IRIACV-259  
**Real-time mobile robot navigation based on stereo vision and low-cost GPS**, Soonhac Hong, Ming Li, Miao Liao, and Peter van Beek, Sharp Labs of America (United States)

9:30 IRIACV-260  
**The acceleration effect to the perception of velocity difference in passive elbow flexion movement**, Fumihiko Akatsuka and Yoshihiko Nomura, Mie University (Japan)

9:50 IRIACV-261  
**Targeted intelligent autonomous robotics contest: The European Roboathlon**, Juha Röning, University of Oulu (Finland)

10:00 am – 4:00 pm Industry Exhibition

10:10 – 10:50 am Coffee Break

## Machine Vision and Imaging

Session Chair: Kurt Niel, University of Applied Sciences Upper Austria (Austria)

10:50 am – 12:30 pm

Cypress C

10:50 IRIACV-262  
**Application of big data analytics for recognition of microbial colonies from hyperspectral images**, Seung-Chul Yoon, Kurt Lawrence, Bosoon Park, and Gary Gamble, US Department of Agriculture-Agricultural Research Service (United States)

11:10 IRIACV-263  
**Weaving pattern recognition of ancient Chinese textiles by regular bands analysis**, Connie C.W. Chan, K. S. (Sammy) Li, and Henry Ngan, Hong Kong Baptist University (Hong Kong)

11:30 IRIACV-264  
**Finding a needle in a haystack: Recognizing surgical instruments through vision and manipulation**, Tian Zhou and Juan Wachs, Purdue University (United States)

11:50 IRIACV-265  
**Automatic detection of plant roots in multispectral images**, Nisha Srinivas, Justin Baba, Colleen Iverson, Joanne Childs, Richard Norby, and Vincent Paquit, Oak Ridge National Laboratory (United States)

12:10

IRIACV-266

**Education in industrial machine vision in Upper Austria University of Applied Sciences (bachelor/master) with respect to the needs by the European industry and automation engineering**, Kurt Niel, University of Applied Sciences Upper Austria (Austria)

12:30 – 2:00 pm Lunch Break

## EI 2017 Wednesday Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

2:00 – 3:00 pm

Grand Peninsula Ballroom D

**Designing VR video camera systems**, Brian Cabral, Facebook, Inc. (United States)

Brian Cabral is Director of Engineering at Facebook, leading the Surround 360 VR camera team, specializing in computational photography, computer vision, and computer graphics. He has published a number of papers in the area of computer graphics and imaging including the pioneering Line Integral Convolution algorithm. Cabral discusses developing Facebook Surround 360, an open, high-quality 3D-360 video capture system. VR video capture systems are composed of multiple optical and digital components – all of which must operate as if they are one seamless optical system. The design of VR video cameras, optical choices, SNR, etc., require a new set of technologies and engineering approaches, with tight coupling to the computational system components.

3:00 – 3:30 pm Coffee Break

## Pattern Recognition and Inspection

Session Chair: Henry Ngan, Hong Kong Baptist University (Hong Kong)

3:30 – 5:30 pm

Cypress C

3:30 IRIACV-267  
**Unsupervised video segmentation and its application to region-based local contrast enhancement**, Sungbum Park<sup>1</sup>, Woo-sung Shim<sup>1</sup>, and Yong Seok Heo<sup>2</sup>; <sup>1</sup>Samsung and <sup>2</sup>Ajou University (Republic of Korea)

3:50 IRIACV-268  
**High-precision 3D sensing with hybrid light field & photometric stereo approach in multi-line scan framework**, Doris Antensteiner<sup>1</sup>, Svorad Štolc<sup>1</sup>, Kristián Valentín<sup>1</sup>, Bernhard Blaschitz<sup>1</sup>, Reinhold Huber-Mörk<sup>1</sup>, and Thomas Pock<sup>1,2</sup>; <sup>1</sup>AIT Austrian Institute of Technology GmbH and <sup>2</sup>Graz University of Technology (Austria)

4:10 IRIACV-269  
**Line-scan stereo using binary descriptor matching and regularization**, Svorad Štolc, Kristián Valentín, Bernhard Blaschitz, and Reinhold Huber-Mörk, AIT Austrian Institute of Technology GmbH (Austria)

4:30

IRIACV-270

**Traffic Camera Dangerous Driver Detection (TCD3™): Contextually aware heuristic feature & OFA density-based computer vision with movement machine learning analysis of live streaming traffic camera footage to identify anomalous & dangerous driving,** Vidur Prasad, University of Michigan (United States)

4:50

IRIACV-271

**An in-situ defect detection system for Big Area Additive Manufacturing using laser profilometry,** Michael Goin<sup>1</sup>, Vincent Paquit<sup>2</sup>, Andrzej Nycz<sup>2</sup>, Brian Post<sup>2</sup>, Peter Lloyd<sup>2</sup>, Randall Lind<sup>2</sup>, and Lonnie Love<sup>2</sup>; <sup>1</sup>University of Tennessee and <sup>2</sup>Oak Ridge National Laboratory (United States)

5:10

IRIACV-272

**Outlier detection in large-scale traffic data by naïve bayes method and Gaussian mixture model method,** Philip Lam<sup>1</sup>, Lili Wang<sup>1</sup>, Henry Ngan<sup>1</sup>, Nelson H.C. Yung<sup>2</sup>, and Anthony G. O. Yeh<sup>2</sup>; <sup>1</sup>Hong Kong Baptist University and <sup>2</sup>The University of Hong Kong (Hong Kong)

**Symposium Interactive Papers (Poster) Session**  
**5:30 – 7:30 pm**

Atrium

## Material Appearance 2017

### Conference overview

The rapid and continuous development of rendering devices such as displays and printers offers interesting challenges related to how materials are understood. Over the years, researchers from different disciplines have studied the interaction of incident light with the texture and surface geometry of a given object, as well as the optical properties of distinct materials. Thanks to those efforts, we have been able to render with high accuracy 2.5D and 3D objects and scenes.

Given the day-to-day technological improvements of materials and devices along with the advances in the areas of visual and tactile perception, modeling how light interacts with materials and techniques for measuring material properties, the field of material appearance is in constant evolution.

This conference offers the possibility to share research results and establish new collaborations among academic and industrial researchers from these related fields.

**Award:** Best Student Paper

### Conference Sponsor



**Conference Chairs:** Mathieu Hebert, Université Jean Monnet de Saint Etienne (France); Francisco H. Imai, (United States); and Ingeborg Tastl, HP Labs, HP Inc. (United States)

**Program Committee:** Jan P. Allebach, Purdue Univ. (United States); Susan P. Farnand, Rochester Institute of Technology (United States); Roland Fleming, Justus-Liebig-Universität Giessen (Germany); Jon Yngve Hardeberg, Norwegian Univ. of Science and Technology (Norway); Matthias B. Hullin, Univ. Bonn (Germany); Susanne Klein, Hewlett-Packard Ltd. (United Kingdom); Gary Meyer, Univ. of Minnesota (United States); Gael Obein, Conservatoire National des Arts et Metiers (France); Maria Ortiz Segovia, Océ Print Logic Technologies (France); Carinna Parraman, Univ. of the West of England (United Kingdom); Holly Rushmeier, Yale Univ. (United States); Sabine Süsstrunk, École Polytechnique Fédérale de Lausanne (Switzerland); Shoji Tominaga, Chiba Univ. (Japan); Philipp Urban, Fraunhofer Institute for Computer Graphics Research IGD (Germany); and Gregory Ward, Dolby Labs., Inc. (United States)

## Material Appearance 2017

### Monday, January 30, 2017

#### Surface Measurement and Lighting Systems

Session Chairs: Mathieu Hebert, Université Jean Monnet de Saint Etienne (France), Francisco Imai, (United States), and Ingeborg Tastl, HP Labs, HP Inc. (United States)

#### 10:50 am – 12:10 pm

Regency Ballroom C

10:50 MAAP-273

**Comparison between angularly and spectrally resolved gloss measurements with gloss measurements carried out on a national reference goniometer for gloss calibration**, *Renee Charriere<sup>1,2</sup> and Maria Nadal<sup>1</sup>*; <sup>1</sup>National Institute for Standards and Technology (United States) and <sup>2</sup>Ecole des Mines de Saint-Etienne (France)

11:10 MAAP-274

**A normal vector and BTF profile measurement system using a correlation camera and scanning dome illumination**, *Akira Kimachi, Motonori Doi, and Shogo Nishi, Osaka Electro-Communication University (Japan)*

11:30 MAAP-275

**Polarimetric multispectral bidirectional reflectance distribution function measurements using a Fourier transform instrument**, *Pierre Boher, Thierry Leroux, Ludivine Cave, Thibault Bignon, and Véronique Collomb-Patton, ELDIM (France)*

11:50 MAAP-276

**Optimal LED selection for multispectral lighting reproduction**, *Chloe LeGendre, Xueming Yu, and Paul Debevec, USC Institute for Creative Technologies (United States)*

12:10 – 2:00 pm Lunch Break

#### EI 2017 Opening Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

#### 2:00 – 3:00 pm

Grand Peninsula Ballroom D

**Giga-scale 3D computational microscopy**, *Laura Waller, University of California, Berkeley (United States)*

*Laura Waller is the Ted Van Duzer Endowed Assistant Professor of Electrical Engineering and Computer Sciences (EECS) at UC Berkeley. She is a Senior Fellow at the Berkeley Institute of Data Science, and received her BS (2004), MEng (2005), and PhD (2010) in EECS from the Massachusetts Institute of Technology (MIT). Waller's talk is on computational imaging methods for fast capture of gigapixel-scale 3D intensity and phase images in a commercial microscope that employs illumination-side and detection-side coding of angle (Fourier) space with simple hardware and fast acquisition. The result is high-resolution reconstructions across a large field-of-view, achieving high space-bandwidth-time product.*

3:00 – 3:30 pm Coffee Break

#### Surface Appearance Modeling and Reproduction Joint Session

Session Chair: Francisco Imai (United States)

#### 3:30 – 4:50 pm

Regency Ballroom C

*This session is jointly sponsored by: Material Appearance 2017 and Color Imaging XXII: Displaying, Processing, Hardcopy, and Applications.*

3:30 MAAP-288

**Modeling and reproducing effect paints**, *Gary Meyer and Avery Musbach, University of Minnesota (United States)*

3:50 MAAP-289

**How to design a recto-verso print displaying different images in various everyday-life lighting conditions**, *Nicolas Dalloz<sup>1,2</sup>, Serge Mazauric<sup>1,3</sup>, Mathieu Hebert<sup>1</sup>, and Thierry Fournel<sup>1</sup>*; <sup>1</sup>University of Lyon, UJM-Saint-Etienne, CNRS, Institut d'Optique Graduate School, <sup>2</sup>Institut d'Optique Graduate School, and <sup>3</sup>CPE Lyon (France)

4:10 MAAP-290

**Appearance decomposition and reconstruction of textured fluorescent objects**, *Shoji Tominaga, Keiji Kato, Keita Hirai, and Takahiko Horiuchi, Chiba University (Japan)*

4:30 MAAP-291

**Assessing the proper color of translucent materials by an extended two-flux model from measurements based on an integrating sphere**, *Lionel Simonot<sup>1</sup>, Mathieu Hebert<sup>2</sup>, Serge Mazauric<sup>2,3</sup>, and Roger Hersch<sup>4</sup>*; <sup>1</sup>Université de Poitiers (France), <sup>2</sup>Université Jean Monnet de Saint Etienne (France), <sup>3</sup>CPE Lyon, Domaine Scientifique de la Doua (France), and <sup>4</sup>École Polytechnique Fédérale de Lausanne (Switzerland)

#### Symposium Welcome Reception

#### 5:00 – 6:00 pm

Atrium

### Tuesday, January 31, 2017

#### Surface Appearance Assessment and Digital Methods I Joint Session

Session Chair: Greg Ward, Dolby Laboratories (United States)

#### 9:10 – 10:10 am

Grand Peninsula Ballroom C

*This session is jointly sponsored by: Material Appearance 2017 and 3D Image Processing, Measurement (3DIPM), and Applications 2017.*

9:10 MAAP-282

**Graininess appearance of goniochromatic samples in lighting cabinets**, *Paola Iacomussi, Michela Radis, and Giuseppe Rossi, INRIM (Italy)*

9:30 MAAP-283

**Measurement and evaluation method of orange peel**, *Takuroh Sone and Shuhei Watanabe, Ricoh Company, Ltd. (Japan)*

9:50

MAAP-284

**Enhanced RTI for gloss reproduction**, Peter Fornaro, Andrea Bianco, and Lukas Rosenthaler, University of Basel (Switzerland)

10:00 am – 7:30 pm Industry Exhibition

10:10 – 10:50 am Coffee Break

## Surface Appearance Assessment and Digital Methods II Joint Session

Session Chair: Mathieu Hebert, Université Jean Monnet de Saint Etienne (France)

**10:50 – 11:30 am**

Grand Peninsula Ballroom C

This session is jointly sponsored by: Material Appearance 2017 and 3D Image Processing, Measurement (3DIPM), and Applications 2017.

10:50

MAAP-285

**Consistent tool-independent virtual material appearance**, Dar'ya Guarnera<sup>1</sup>, Giuseppe Claudio Guarnera<sup>1</sup>, Cornelia Denk<sup>2</sup>, and Mashhuda Glencross<sup>1,3</sup>; <sup>1</sup>Loughborough University (United Kingdom), <sup>2</sup>BMW Research (Germany), and <sup>3</sup>Switch That Limited (United Kingdom)

11:10

MAAP-286

**Interactive object surface retexturing using perceptual quality indexes**, Keita Hirai, Wataru Suzuki, Yoshimitsu Yamada, and Takahiko Horiuchi, Chiba University (Japan)

11:30 am – 2:00 pm Lunch Break

### EI 2017 Tuesday Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Niitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**VR 2.0: Making virtual reality better than reality**, Gordon Wetzstein, Stanford University (United States)

Gordon Wetzstein is an Assistant Professor of Electrical Engineering and, by courtesy, of Computer Science, at Stanford University, and leads the Stanford Computational Imaging Group. He received a PhD in computer science from the University of British Columbia (2011) where his doctoral dissertation focused on computational light modulation for image acquisition and display. In his talk, Wetzstein explores the frontiers of VR systems engineering. Eventually, VR/AR systems will redefine communication, entertainment, education, collaborative work, simulation, training, telesurgery, and basic vision research, as next-generation computational near-eye displays evolve to deliver visual experiences that are better than the real world.

3:00 – 3:30 pm Coffee Break

### Keynote: Communicating Material Appearance

Session Chair: Ingeborg Tastl, HP Labs, HP Inc. (United States)

**3:30 – 4:10 pm**

Grand Peninsula Ballroom C

MAAP-277

**The future of material communication via the Appearance Exchange Format (AxF)**, Marc Ellens, Gero Mueller, and Francis Lamy, X-Rite, Inc. (United States)

Marc S. Ellens is a Senior Research Scientist with X-Rite-Pantone in Grand Rapids, MI. He received his BS in mathematics and computer science from Calvin College, and his PhD in computer aided geometric design from the University of Utah. In the past, Ellens has worked on CNC programming and at Lectra Systemes developing design applications for the textile industry. Now at X-Rite for more than 10 years, he has been involved in research and development efforts beyond color toward the capture and reproduction of appearance. Ellens has presented at the NVIDIA GPU Technology conference, Autodesk's Automotive Innovation Forums, and the IS&T Electronic Imaging Conference. He is named in three patents related to material visualization and reproduction.

### Material Characterization

Session Chair: Ingeborg Tastl, HP Labs, HP Inc. (United States)

**4:10 – 5:30 pm**

Grand Peninsula Ballroom C

4:10

MAAP-278

**Material with visual effects: Study of the gonioparency of the anodized titanium**, Quentin Cridling<sup>1,2</sup>, Renee Charriere<sup>1</sup>, Maria Pia Pedeferra<sup>2</sup>, Maria Vittoria Diamanti<sup>2</sup>, and David Delafosse<sup>1</sup>; <sup>1</sup>Ecole des Mines de Saint Etienne (France), and <sup>2</sup>Politecnico di Milano (Italy)

4:30

MAAP-279

**Adapted modulation transfer function method for characterization and improvement of 2.5D printing**, Marine Page<sup>1,2,3</sup>, Clotilde Bous<sup>2</sup>, Gaël Obein<sup>3</sup>, Annick Raze<sup>3</sup>, and Maria Ortiz Segovia<sup>1</sup>; <sup>1</sup>Océ - Canon Group, <sup>2</sup>Centre de Recherche et de Restauration des Musées de France, and <sup>3</sup>Conservatoire National des Arts et Métiers (France)

4:50

MAAP-280

**Evaluating an image based multi-angle measurement setup using different reflection models**, Aditya Sole, Ivar Farup, and Peter Nussbaum, Norwegian University of Science and Technology (Norway)

5:10

MAAP-281

**Model-based skin pigment cartography by high-resolution hyperspectral imaging (JIST-first)**, Pierre Seroul<sup>1</sup>, Mathieu Heber<sup>2</sup>, Marie Chereil<sup>1</sup>, Romain Vernet<sup>1</sup>, and Matthieu Jomier<sup>1</sup>; <sup>1</sup>Newton Technologies and <sup>2</sup>Université Jean Monnet de Saint Etienne (France)

### Symposium Demonstration Session

**5:30 – 7:30 pm**

Grand Peninsula Ballroom E

## Thursday, February 2, 2017

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### Interactive Workshop: How can COLOR imaging provide US with powerful INSIGHTS? Joint Session

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Moderator: Fritz Lebowsky, STMicroelectronics (France)

**2:00 – 3:30 pm**  
Regency Ballroom C

*This session is jointly sponsored by: Color Imaging XXII: Displaying, Processing, Hardcopy, and Applications and Material Appearance 2017.*

*We would very much like to have you participate in a special session in which we encourage asking questions and exchange ideas that frequently trouble us during research and development projects. The presence of experts in COLOR imaging and perhaps Electronic Imaging at large will provide a unique opportunity of efficiently and lively sharing simple/stupefying ideas enabling fascinating engineering concepts which may also stimulate your own future research and development projects!*

COLOR-062

**Interactive Workshop: How can color imaging provide us with powerful insights?**, Fritz Lebowsky, STMicroelectronics (France)

**Meet the Future: A Showcase of Student and Young Professionals Research**  
**3:00 – 5:00 pm**  
Atrium

3:20 – 4:00 pm      Coffee Break

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### Interactive Workshop: How can COLOR imaging provide US with powerful INSIGHTS? (continued) Joint Session

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Moderator: Fritz Lebowsky, STMicroelectronics (France)

**4:00 – 5:00 pm**  
Regency Ballroom C

*This continuation of the workshop session is jointly sponsored by: Color Imaging XXII: Displaying, Processing, Hardcopy, and Applications, and Material Appearance 2017.*

## Media Watermarking, Security, and Forensics 2017

### Conference overview

The ease of capturing, manipulating, distributing, and consuming digital media (e.g. images, audio, video, graphics, and text) has raised a number of important security challenges to the forefront. These issues have prompted significant research and development activities in the areas of digital watermarking, steganography, data hiding, forensics, media identification, and encryption to protect the authenticity, security, and ownership of media objects. Research results in these areas have translated into new paradigms and applications to monetize media objects without violating their ownership rights.

The Media Watermarking, Security, and Forensics conference is a premier destination for disseminating high-quality, cutting-edge research in these areas. The conference provides an excellent venue for researchers and practitioners to present their innovative work as well as to keep abreast with the latest developments in watermarking, security, and forensics. A unique feature of the conference is that the submission process only requires a structured abstract describing the work in progress, with the full paper to be submitted only a few weeks before the event. This allows researchers to present early results and fresh ideas from the laboratory to motivate new research directions in a timely manner.

A strong focus on how research results are applied in practice by the industry gives the conference its unique flavor.

**Conference Chairs:** Adnan M. Alattar, Digimarc Corp. (United States), and Nasir D. Memon, Tandon School of Engineering, New York Univ. (United States)

**Program Committee:** Mauro Barni, Univ. degli Studi di Siena (Italy); Sebastiane Battiato, Univ. degli Studi di Catania (Italy); Marc Chaumont, Lab. d'Informatique de Robotique et de Microelectronique de Montpellier (France); Scott A. Craver, Binghamton Univ. (United States); Edward J. Delp, Purdue Univ. (United States); Jana Dittmann, Otto-von-Guericke-Univ. Magdeburg (Germany); Gwenael Doërr, ContentArmor SAS (France); Maha El Choubassi, Intel Corporation (United States); Jessica Fridrich, Binghamton Univ. (United States); Anthony T. S. Ho, Univ. of Surrey (United Kingdom); Jiwu Huang, Sun Yat-Sen Univ. (China); Andrew D. Ker, Univ. of Oxford (United Kingdom); Matthias Kirchner, Binghamton Univ. (United States); Alex C. Kot, Nanyang Technological Univ. (Singapore); Chang-Tsun Li, The Univ. of Warwick (United Kingdom); William Puech, Laboratory d'Informatique de Robotique et de Microelectronique de Montpellier (France); Anderson Rocha, Univ. of Campinas (Brazil); Husrev Taha Sencar, TOBB Univ. of Economics and Technology (Turkey); Gaurav Sharma, Univ. of Rochester (United States); Yun Qing Shi, New Jersey Institute of Technology (United States); Ashwin Swaminathan, Magic Leap, Inc. (United States); Robert Ulichney, HP Labs, HP Inc. (United States); Claus Vielhauer, Univ. Magdeburg (Germany); Svyatoslav V. Voloshynovskiy, Univ. de Genève (Switzerland); and Chang Dong Yoo, Korea Advanced Institute of Science and Technology (Republic of Korea)



## Media Watermarking, Security, and Forensics 2017

Monday, January 30, 2017

### Keynote 1: Media Forensics

Session Chair: Adnan Alattar, Digimarc Corporation (United States)

**8:50 – 10:10 am**

Regency Ballroom A

MWSF-316

**The nimble challenges for media forensics**, P. Jonathon Phillips, National Institute of Standards and Technology (NIST) (United States)

Jonathon Phillips is a leading technologist in the fields of computer vision, biometrics, and face recognition. He is at National Institute of Standards and Technology (NIST), where he runs challenge problems and evaluations to advance biometric technology. His previous efforts include the Iris Challenge Evaluations (ICE), the Face Recognition Vendor Test (FRVT), the Face Recognition Grand Challenge and FERET. From 2000-2004, Phillips was assigned to DARPA. For his work on the FRVT 2002 he was awarded the Dept. of Commerce Gold Medal. His work has been reported in the New York Times, the BBC, and the Economist. He has appeared on NPR's Science Friday show. In an Essential Science Indicators analysis of face recognition publication over the past decade, Phillips' work ranks at #2 by total citations and #1 by cites per paper. In 2013, he won the inaugural Mark Everingham Prize. He is a fellow of the IEEE and IAPR.

10:10 – 10:30 am Coffee Break

### Watermarking

Session Chair: William Puech, University of Montpellier (France)

**10:30 – 11:45 am**

Regency Ballroom A

10:30

MWSF-317

**Embedding information into objects fabricated with 3-D printers by forming fine cavities inside them**, Masahiro Suzuki<sup>1</sup>, Piyarat Silapasuphakornwong<sup>1</sup>, Pailin Dechrueng<sup>2</sup>, Soravit Techavichian<sup>2</sup>, Hideyuki Torii<sup>1</sup>, and Kazutake Uehira<sup>1</sup>; <sup>1</sup>Kanagawa Institute of Technology (Japan) and <sup>2</sup>Chulalongkorn University (Thailand)

10:55

MWSF-319

**High-capacity reversible data hiding in encrypted images using MSB prediction**, Pauline Puteaux and William Puech, University of Montpellier (France)

11:20

MWSF-320

**The A Priori knowledge based secure payload estimation for additive model**, Sai Ma<sup>1,2</sup>, Xianfeng Zhao<sup>1,2</sup>, Qingxiao Guan<sup>1,2</sup>, and Chengduo Zhao<sup>1,2</sup>; <sup>1</sup>Institute of Information Engineering, Chinese Academy of Sciences and <sup>2</sup>University of Chinese Academy of Sciences (China)

11:45 am – 2:00 pm Lunch Break

### EI 2017 Opening Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**Giga-scale 3D computational microscopy**, Laura Waller, University of California, Berkeley (United States)

Laura Waller is the Ted Van Duzer Endowed Assistant Professor of Electrical Engineering and Computer Sciences (EECS) at UC Berkeley. She is a Senior Fellow at the Berkeley Institute of Data Science, and received her BS (2004), MEng (2005), and PhD (2010) in EECS from the Massachusetts Institute of Technology (MIT). Waller's talk is on computational imaging methods for fast capture of gigapixel-scale 3D intensity and phase images in a commercial microscope that employs illumination-side and detection-side coding of angle (Fourier) space with simple hardware and fast acquisition. The result is high-resolution reconstructions across a large field-of-view, achieving high space-bandwidth-time product.

3:00 – 3:30 pm Coffee Break

### Encryption

Session Chair: Gaurav Sharma, University of Rochester (United States)

**3:30 – 4:50 pm**

Regency Ballroom A

3:30

MWSF-321

**Benefits of combining forensic image creation and file carving**, Martin Steinebach, Fraunhofer SIT (Germany)

3:55

MWSF-322

**Codec-embedded MP3 partial encryption for DRM**, Martin Steinebach, Fraunhofer SIT (Germany)

4:20

MWSF-323

**How to recompress a JPEG crypto-compressed image?**, Vincent Itier<sup>1</sup> and William Puech<sup>2</sup>; <sup>1</sup>LIRMM and <sup>2</sup>University of Montpellier (France)

### Symposium Welcome Reception

**5:00 – 6:00 pm**

Atrium

Tuesday, January 31, 2017

### Deep Learning Steganalysis

Session Chair: Jessica Fridrich, SUNY Binghamton (United States)

**8:50 – 10:10 am**

Regency Ballroom A

8:50

MWSF-324

**Pre-training via fitting deep neural network to rich-model features extraction procedure and its effect on deep learning for steganalysis**, Jishen Zeng, Shunquan Tan, Bin Li, and Jiwu Huang, Shenzhen University (China)



9:15 MWSF-325  
**Histogram layer, moving convolutional neural networks towards feature-based steganalysis**, *Vahid Sedighianaraki and Jessica Fridrich, Binghamton University (United States)*

9:40 MWSF-326  
**Model based steganography with precover**, *Tomas Denmark and Jessica Fridrich, SUNY Binghamton (United States)*

10:00 am – 7:30 pm Industry Exhibition  
 10:10 – 10:30 am Coffee Break

**CNN and RNN Forensics**

Session Chair: Marc Chaumont, LIRMM Montpellier France (France)

**10:30 am – 12:10 pm**  
 Regency Ballroom A

10:30 MWSF-327  
**A preliminary study on convolutional neural networks for camera model identification**, *Luca Bondi<sup>1</sup>, David Güera Cobo<sup>2</sup>, Luca Baroffio<sup>1</sup>, Paolo Bestagini<sup>1</sup>, Edward Delp<sup>2</sup>, and Stefano Tubaro<sup>1</sup>; <sup>1</sup>Politecnico di Milano (Italy) and <sup>2</sup>Purdue University (United States)*

10:55 MWSF-328  
**Design principles of convolutional neural networks for multimedia forensics**, *Belhassen Bayar and Matthew Stamm, Drexel University (United States)*

11:20 MWSF-329  
**Image recapturing detection with convolutional and recurrent neural network**, *Haoliang Li, Shiqi Wang, and Alex Kot, Nanyang Technological University (Singapore)*

11:45 MWSF-330  
**Autoencoder with recurrent neural networks for video forgery detection**, *Dario D'Avino, Davide Cozzolino, Giovanni Poggi, and Luisa Verdoliva, University Federico II of Naples (Italy)*

12:10 – 2:00 pm Lunch Break

**EI 2017 Tuesday Plenary and Symposium Awards**  
 Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)  
**2:00 – 3:00 pm**  
 Grand Peninsula Ballroom D

**VR 2.0: Making virtual reality better than reality**, *Gordon Wetzstein, Stanford University (United States)*

*Gordon Wetzstein is an Assistant Professor of Electrical Engineering and, by courtesy, of Computer Science, at Stanford University, and leads the Stanford Computational Imaging Group. He received a PhD in computer science from the University of British Columbia (2011) where his doctoral dissertation focused on computational light modulation for image acquisition and display. In his talk, Wetzstein explores the frontiers of VR systems engineering. Eventually, VR/AR systems will redefine communication, entertainment, education, collaborative work, simulation, training, telesurgery, and basic vision research, as next-generation computational near-eye displays evolve to deliver visual experiences that are better than the real world.*

3:00 – 3:30 pm Coffee Break

**Keynote 2: Camera Verification in Practice**  
 Session Chair: Nasir Memon, New York University (United States)  
**3:30 – 4:30 pm**  
 Regency Ballroom A

**PRNU in practice**, *Walter Bruehs, Federal Bureau of Investigation (United States)* MWSF-339

*Walter E. Bruehs is employed by the Federal Bureau of Investigation as the Supervisory Photographic Technologist in the Forensic Audio, Video, and Image Analysis Unit, where he is an Examiner of Questioned Photographic Evidence. Part of Bruehs' responsibilities focus on seeking out and researching emerging digital imaging technologies as they apply to the Forensic arena. He heads a program designed to identify digital images to digital cameras or to other sets of digital images, based on the sensor noise of the capture device. He has a MS in electrical engineering from the University of Maine at Orono, as well as a BS in electrical engineering from Clarkson University. Prior to working at the FBI, he worked as an Imaging Scientist in the research labs of the Eastman Kodak Company, where he co-authored a patent, "Method and System for Improving an Image Characteristic Based on Image Content."*

**Media Watermarking, Security, and Forensics Program Committee Meeting**

**4:40 – 6:00 pm**  
 Regency Ballroom A

**Symposium Demonstration Session**  
**5:30 – 7:30 pm**  
 Grand Peninsula Ballroom E

**Wednesday, February 1, 2017**

**Sensor Noise Forensics**

Session Chair: Robert Ulichney, HP Labs, HP Inc. (United States)

**8:50 – 10:10 am**  
 Regency Ballroom A

8:50 MWSF-331  
**Videos versus still images: Asymmetric sensor pattern noise comparison on mobile phones**, *Chiara Galdi<sup>1</sup>, Frank Hartung<sup>2</sup>, and Jean-Luc Dugelay<sup>1</sup>; <sup>1</sup>Eurecom (France) and <sup>2</sup>FH Aachen (Germany)*

9:15 MWSF-332  
**Linear filter kernel estimation based on digital camera sensor noise**, *Chang Liu and Matthias Kirchner, Binghamton University (United States)*

9:40 MWSF-333  
**PRNU-based forgery detection with discriminative random fields**, *Sujoy Chakraborty and Matthias Kirchner, Binghamton University (United States)*

10:00 am – 4:00 pm Industry Exhibition  
 10:10 – 10:30 am Coffee Break



**Forensics & Authentication**

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Session Chair: Matthias Kirchner, Binghamton University (United States)

**10:30 am – 12:15 pm**

Regency Ballroom A

10:30 MWSF-335

**Sensitivity of different correlation measures to print-and-scan process,** Iuliia Tkachenko<sup>1</sup>, Christophe Destruel<sup>1</sup>, Olivier Strauss<sup>2</sup>, and William Puech<sup>2</sup>; <sup>1</sup>Authentication Industries and <sup>2</sup>University of Montpellier (France)

10:55 MWSF-336

**Scalable processing history detector for JPEG images,** Mehdi Boroumand and Jessica Fridrich, SUNY Binghamton (United States)

11:20 MWSF-337

**Deciphering severely degraded license plates,** Shruti Agarwal, Du Tran, Lorenzo Torresani, and Hany Farid, Dartmouth College (United States)

11:45 MWSF-338

**PCB surface fingerprints based counterfeit detection of electronic devices,** Taswar Iqbal<sup>1</sup> and Kai-Dietrich Wolf<sup>2</sup>; <sup>1</sup>Ex-memeber ISS and <sup>2</sup>University of Wuppertal, Institute for Security Sytems (Germany)

12:10

**Conference Closing Remarks**

12:15 – 2:00 pm Lunch Break

**EI 2017 Wednesday Plenary and Symposium Awards**

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**Designing VR video camera systems,** Brian Cabral, Facebook, Inc. (United States)

*Brian Cabral is Director of Engineering at Facebook, leading the Surround 360 VR camera team, specializing in computational photography, computer vision, and computer graphics. He has published a number of papers in the area of computer graphics and imaging including the pioneering Line Integral Convolution algorithm. Cabral discusses developing Facebook Surround 360, an open, high-quality 3D-360 video capture system. VR video capture systems are composed of multiple optical and digital components - all of which must operate as if they are one seamless optical system. The design of VR video cameras, optical choices, SNR, etc., require a new set of technologies and engineering approaches, with tight coupling to the computational system components.*

3:00 – 3:30 pm Coffee Break

**Symposium Interactive Papers (Poster) Session**

**5:30 – 7:00 pm**

Atrium

## Mobile Devices and Multimedia: Enabling Technologies, Algorithms, and Applications 2017

### Conference overview

The goal of this conference is to provide an international forum for presenting recent research results on multimedia for mobile devices and to bring together experts from both academia and industry for a fruitful exchange of ideas and discussion on future challenges. The authors are encouraged to submit work-in-progress papers as well as updates on previously reported systems. Outstanding papers may be recommended for the publication in the *Journal Electronic Imaging* or *Journal of Imaging Science and Technology*.

**Awards:** Best Paper and Best Student Paper



**Conference Chairs:** David Akopian, The Univ. of Texas at San Antonio (United States) and Reiner Creutzburg, Fachhochschule Brandenburg (Germany)

**Program Committee:** John Adcock, FX Palo Alto Laboratory Inc. (United States); Sos Aghaian, The Univ. of Texas at San Antonio (United States); Faouzi Alaya Cheikh, Norwegian Univ. of Science and Technology (Norway); Noboru Babaguchi, Osaka Univ. (Japan); Nina Bhatti, HP Inc. (United States); C.L. Philip Chen, Univ. of Macau (Macao); Chang Wen Chen, The State Univ. of New York at Buffalo (United States); David Cook, Consultant (Namibia); Matthew Cooper, FX Palo Alto Laboratory (United States); Kenneth Crisler, Motorola, Inc. (United States); Francesco De Natale, Univ. degli Studi di Trento (Italy); Alberto Del Bimbo, Univ. degli Studi di Firenze (Italy); Stefan Edlich, Technische Fachhochschule Berlin (Germany); Atanas Gotchev, Tampere Univ. of Technology (Finland); Alan Hanjalic, Technische Univ. Delft (the Netherlands); Alexander Hauptmann, Carnegie Mellon Univ. (United States); Winston Hsu, National Taiwan Univ. (Taiwan); Gang Hua, Stevens Institute of Technology (United States); Catalin Lacatus, Qualcomm Technologies, Inc. (United States); Xin Li, West Virginia Univ. (United States); Qian Lin, HP Inc. (United States); Gabriel Marcu, Apple Inc. (United States); Vasileios Mezaris, Informatics and Telematics Institute (Greece); Chong-Wah Ngo, City Univ. of Hong Kong (China); Sethuraman Panchanathan, Arizona State Univ. (United States); Kari Pulli, Intel Corporation (United States); Yong Rui, Microsoft Corporation (China); Olli Silvén, Univ. of Oulu (Finland); John Smith, IBM Thomas J. Watson Research Center (United States); Hari Sundaram, Arizona State Univ. (United States); Jarmo Takala, Tampere Univ. of Technology (Finland); Marius Tico, Apple, Inc. (United States); Meng Wang, National Univ. of Singapore (Singapore); Rong Yan, Facebook Inc. (United States); and Jun Yang, Facebook Inc. (United States)

# Mobile Devices and Multimedia: Enabling Technologies, Algorithms, and Applications 2017

## Wednesday, February 1, 2017

### Mobile Sensors, Localization, and Applications

Session Chair: David Akopian, The University of Texas at San Antonio (United States)

**8:50 – 10:10 am**

Grand Peninsula Ballroom B

8:50 MOBMU-292  
**Introduction to WLAN-fingerprinting based indoor localization**, David Akopian, Ali Khalajmehrabadi, and Nikolaos Gatsis, The University of Texas at San Antonio (United States)

9:10 MOBMU-299  
**Android door and window image based measurements**, Khader Mohammad, Birzeit University (Palestine)

9:30 MOBMU-293  
**Usability of smart mobile micro photonic sensor systems for industrial and non-industrial quality assurance**, Paul-Gerald Dittich<sup>1,2</sup> and Dietrich Hofmann<sup>1</sup>; <sup>1</sup>Technologie- und Innovationspark Jena GmbH and <sup>2</sup>Technische Universität Ilmenau (Germany)

9:50 MOBMU-294  
**Blackmagic production camera raw color investigation by spectral analysis of Macbeth color charts**, Eberhard Hasche, Patrick Ingwer, Reiner Creutzburg, Thomas Schrader, Frederick Laube, and Timo Stigwarth, Technische Hochschule Brandenburg - Brandenburg University of Applied Sciences (Germany)

10:10 MOBMU-295  
**Liquid crystal lens characterization for integrated depth sensing and all in focus imaging application**, Simon Emberger<sup>1</sup>, Laurent Alacoque<sup>1</sup>, Antoine Dupret<sup>2</sup>, Jean Louis de Bougrenet de la Tocnaye<sup>3</sup>, Capucine Lecat-Mathieu de Boissac<sup>1</sup>, and Nicolas Fraval<sup>4</sup>; <sup>1</sup>LETI, CEA, <sup>2</sup>LIST-Léti, CEA, <sup>3</sup>Telecom Bretagne, and <sup>4</sup>Evosens (France)

10:00 am – 4:00 pm Industry Exhibition

10:30 – 11:00 am Coffee Break

### Emerging Applications and Methods

Session Chair: Reiner Creutzburg, Brandenburg University of Applied Sciences (Germany)

**11:00 am – 12:40 pm**

Grand Peninsula Ballroom B

11:00 MOBMU-296  
**High quality virtual lighting using image-based-lighting and projection onto meshes generated from Lidar and SfM Point Clouds**, Eberhard Hasche, Patrick Ingwer, Fabian Gassen, and Reiner Creutzburg, Technische Hochschule Brandenburg (Germany)

11:20 MOBMU-297  
**A billion words to remember**, George Nagy, Rensselaer Polytechnic Institute (United States)

11:40 MOBMU-298  
**Demographic prediction based on mobile user data**, Lyubov Podoyntsina, Alexander Romanenko, and Konstantin Kryzhanovskiy, Samsung R&D Institute (Russian Federation)

12:00 MOBMU-300  
**Optimizing video transmission for mobile devices**, Chulhee Lee<sup>1</sup>, Sangwook Baek<sup>2</sup>, Guiwon Seo<sup>2</sup>, Kyung-Won Kang<sup>2</sup>, and Jaemin Ryu<sup>1</sup>; <sup>1</sup>Yonsei University and <sup>2</sup>Yonsei University (Republic of Korea)

12:20 MOBMU-308  
**Comparative visualization of the geometry of a hollow box girder using 3D-LiDAR – Part 2: Reconstruction of a 3D geometric model**, Stefan Maack<sup>1</sup>, Jenny Knackmuss<sup>2</sup>, and Reiner Creutzburg<sup>2</sup>; <sup>1</sup>Bundesanstalt für Materialprüfung and <sup>2</sup>Technische Hochschule Brandenburg (Germany)

12:40 – 2:00 pm Lunch Break

### EI 2017 Wednesday Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**Designing VR video camera systems**, Brian Cabral, Facebook, Inc. (United States)

Brian Cabral is Director of Engineering at Facebook, leading the Surround 360 VR camera team, specializing in computational photography, computer vision, and computer graphics. He has published a number of papers in the area of computer graphics and imaging including the pioneering Line Integral Convolution algorithm. Cabral discusses developing Facebook Surround 360, an open, high-quality 3D-360 video capture system. VR video capture systems are composed of multiple optical and digital components – all of which must operate as if they are one seamless optical system. The design of VR video cameras, optical choices, SNR, etc., require a new set of technologies and engineering approaches, with tight coupling to the computational system components.

3:00 – 3:30 pm Coffee Break

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**Mobile Security, Safety, Privacy, Forensics**

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Session Chair: David Akopian, The University of Texas at San Antonio (United States)

**3:30 – 4:50 am**

Grand Peninsula Ballroom B

3:30 MOBMU-301

**Investigation of three security relevant aspects of Android eHealth Apps - Permissions, storage properties, and data transmission,** Jenny Knackmuss<sup>1</sup>, Eric Clausen<sup>2</sup>, and Reiner Creutzburg<sup>1</sup>; <sup>1</sup>Technische Hochschule Brandenburg and <sup>2</sup>AV-Test GmbH (Germany)

3:50 MOBMU-302

**Privacy issues in mobile health applications - Assessment of current Android Health Apps,** Anett Hoppe<sup>1</sup>, Jenny Knackmuss<sup>2</sup>, Maik Morgenstern<sup>1</sup>, and Reiner Creutzburg<sup>2</sup>; <sup>1</sup>AV-Test GmbH and <sup>2</sup>Technische Hochschule Brandenburg (Germany)

4:10 MOBMU-303

**A forensic mobile application designed for both steganalysis and steganography in digital images,** Enping Li<sup>1</sup> and Jun Yu<sup>2</sup>; <sup>1</sup>Bridgewater State University and <sup>2</sup>Marvell Semiconductors, Inc. (United States)

4:30 MOBMU-304

**Pokemon Go - A forensic analysis,** Reiner Creutzburg, Technische Hochschule Brandenburg (Germany)

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**Mobile Computing and Data Processing**

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Session Chair: Reiner Creutzburg, Brandenburg University of Applied Sciences (Germany)

**4:50 – 5:30 pm**

Grand Peninsula Ballroom B

4:50 MOBMU-305

**Computation of equidistant curve for the image with blurred contours,** Evgeny Semenishchev and Viacheslav Voronin, Don State Technical University (Russian Federation)

5:10 MOBMU-306

**Prune the convolutional neural networks with Sparse Shrink,** Xin Li and Changsong Liu, Tsinghua University (China)

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**Mobile Devices and Multimedia: Enabling Technologies, Algorithms, and Applications 2017 Interactive Papers Session**

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**5:30 – 7:00 pm**

Atrium

The following works will be presented at the EI 2017 Symposium Interactive Papers Session.

MOBMU-307

**Automated segmentation of ophthalmological OCT images,** Friedrich Müller<sup>1</sup> and Reiner Creutzburg<sup>2</sup>; <sup>1</sup>Nürnberger Str. 24a and <sup>2</sup>Technische Hochschule Brandenburg (Germany)

MOBMU-309

**Concept for software-based configuration of the organizational and technical security of a company of arbitrary size,** Thomas Möller<sup>1</sup>, Tanja Leschke<sup>1</sup>, Knut Bellin<sup>2</sup>, and Reiner Creutzburg<sup>2</sup>; <sup>1</sup>Assecor GmbH and <sup>2</sup>Technische Hochschule Brandenburg (Germany)

MOBMU-310

**Facilitated polling approach for SMS and IP messaging applications,** Shruti Mahadik, Rodrigo Escobar, Sahak Kaghyan, and David Akopian, The University of Texas at San Antonio (United States)

MOBMU-311

**A multi-platform characterization of delays inherent in Message Queue Telemetry Transport (MQTT) communications,** Brian Bendele and David Akopian, The University of Texas San Antonio (United States)

MOBMU-312

**Semi-automatic generation of multilingual lecture notes - Wikipedia books on different subjects in various languages,** Reiner Creutzburg, Technische Hochschule Brandenburg (Germany)

MOBMU-313

**The strange world of keyloggers - An overview,** Reiner Creutzburg, Technische Hochschule Brandenburg (Germany)

MOBMU-314

**The study of algorithms reducing the level of out-of-band radiation and inter carrier interference of the OFDM signal,** Valentin Fedosov<sup>1</sup>, Anna Lomakina<sup>1</sup>, Andrey Legin<sup>1</sup>, Danila Kovtun<sup>1</sup>, and Viacheslav Voronin<sup>2</sup>; <sup>1</sup>South Federal University and <sup>2</sup>Don State Technical University (Russian Federation)

MOBMU-315

**Two-tier state-machine programming for messaging applications,** Jafet Morales, Rodrigo Escobar, Sahak Kaghyan, Girish Vaidyanathan Natarajan, and David Akopian, The University of Texas at San Antonio (United States)

## Stereoscopic Displays and Applications XXVIII

### Conference overview

#### *The World's Premier Conference for 3D Innovation*

The Stereoscopic Displays and Applications conference (SD&A) focuses on developments covering the entire stereoscopic 3D imaging pipeline from capture, processing, and display to perception. The conference brings together practitioners and researchers from industry and academia to facilitate an exchange of current information on stereoscopic imaging topics. A highly-popular conference demonstration session provides authors with a perfect additional opportunity to showcase their work. Large-screen stereoscopic projection is available, and presenters are encouraged to make full use of these facilities during their presentations. Publishing your work at SD&A offers excellent exposure—across all publication outlets, SD&A has the highest proportion of papers in the top 100 cited papers in the stereoscopic imaging field (Google Scholar, May 2013).

**Awards:** Best use of stereoscopy in a presentation, Best film (animation) and Best film (live action)

**Events:** Monday evening 3D Theater

## Conference Sponsors



**Conference Chairs:** Andrew J. Woods, Curtin Univ. (Australia); Gregg E. Favalora, Draper (United States); Nicolas S. Holliman, Newcastle Univ. (United Kingdom); and Takashi Kawai, Waseda Univ. (Japan)

**Program Committee:** Neil A. Dodgson, Victoria Univ. of Wellington (New Zealand); Davide Gadia, Univ. degli Studi di Milano (Italy); Hideki Kakeya, Univ. of Tsukuba (Japan); Stephan R. Keith, SRK Graphics Research (United States); Michael Klug, Magic Leap, Inc. (United States); John D. Stern, Intuitive Surgical, Inc. (Retired) (United States); and Chris Ward, Lightspeed Design, Inc. (United States)

**Founding Chair:** John O. Merritt, The Merritt Group (United States)

## Stereoscopic Displays and Applications XXVIII

### Monday, January 30, 2017

#### Stereoscopic Human Factors and Applications

Session Chair: Takashi Kawai, Waseda University (Japan)

**8:50 – 10:20 am**

Grand Peninsula Ballroom D

8:50 SD&A-353

**Expert viewers' preferences for higher frame rate 3D film (JIST-first)**, Robert Allison<sup>1</sup>, Laurie Wilcox<sup>2</sup>, Roy Anthony<sup>3</sup>, John Helliker<sup>4</sup>, and Bert Dunk<sup>4</sup>; <sup>1</sup>York University, <sup>2</sup>Centre for Vision Research, York University, <sup>3</sup>Christie Digital, and <sup>4</sup>Sheridan College (Canada)

9:10 SD&A-354

**Investigating aircrew depth perception standards using a stereoscopic simulation environment**, Marc Winterbottom<sup>1</sup>, Charles Lloyd<sup>2</sup>, James Gaska<sup>1</sup>, Logan Williams<sup>1</sup>, Elizabeth Shoda<sup>3</sup>, and Steven Hadley<sup>1</sup>; <sup>1</sup>U.S. Air Force School of Aerospace Medicine, <sup>2</sup>Visual Performance LLC, and <sup>3</sup>Wyle Laboratories (United States)

9:30 SD&A-355

**Estimation of altitude in stereoscopic-3D versus 2D real-world scenes**, Lesley Deas<sup>1</sup>, Robert Allison<sup>1</sup>, Brittney Hartle<sup>1</sup>, Elizabeth Irving<sup>2</sup>, Mackenzie Ghalouf<sup>3</sup>, and Laurie Wilcox<sup>1</sup>; <sup>1</sup>York University, <sup>2</sup>University of Waterloo, and <sup>3</sup>Defence Research and Development Canada (Canada)

9:50 SD&A-356

**Study of objective parameters of 3D visual fatigue based on analysis of salient area**, Minghan Du, Yue Liu, Yongtian Wang, and Bochao Zou, Beijing Institute of Technology (China)

10:10  
**SD&A Opening Remarks**, Andrew Woods, Curtin University (Australia)

10:20 – 10:50 am Coffee Break

#### Autostereoscopic Displays I

Session Chair: Gregg Favalora, Draper (United States)

**10:50 am – 12:30 pm**

Grand Peninsula Ballroom D

10:50 SD&A-357

**Architectures and codecs for real-time light field streaming (JIST-first)**, Péter Kovács<sup>1,2</sup>, Alireza Zare<sup>1,3</sup>, Tibor Balogh<sup>2</sup>, Robert Bregovic<sup>1</sup>, and Atanas Gotchev<sup>1</sup>; <sup>1</sup>Tampere University of Technology (Finland), <sup>2</sup>Holografika (Hungary), and <sup>3</sup>Nokia Technologies (Finland)

11:10 SD&A-358

**Wide viewing angle projection-type integral 3D display system with multiple UHD projectors**, Hayato Watanabe, Masahiro Kawakita, Naoto Okaichi, Hisayuki Sasaki, Masanori Kano, Jun Arai, and Tomoyuki Mishina, Science and Technology Research Laboratories, NHK (Japan Broadcasting Corporation) (Japan)

11:30 SD&A-359

**A novel hardware based method for multiview glassesless 3D display**, Laurence Lujun Chen, 4D perception LLC (United States)

11:50 SD&A-360

**Multilevel light modulation of three-dimensional magneto-optic spatial light modulator using optically addressing method**, Kazuki Nakamura<sup>1</sup>, Kazuki Yamazaki<sup>1</sup>, Hiroyuki Takagi<sup>1</sup>, Taichi Goto<sup>1,2</sup>, Pang Boey Lim<sup>1</sup>, Hironaga Uchida<sup>1</sup>, and Mitsuteru Inoue<sup>1</sup>; <sup>1</sup>Toyohashi University of Technology and <sup>2</sup>JST PRESTO (Japan)

12:10 SD&A-361

**Integral three-dimensional display with high image quality using multiple flat-panel displays**, Naoto Okaichi, Hayato Watanabe, Hisayuki Sasaki, Jun Arai, Masahiro Kawakita, and Tomoyuki Mishina, Science and Technology Research Laboratories, NHK (Japan Broadcasting Corporation) (Japan)

12:30 – 2:00 pm Lunch Break

#### EI 2017 Opening Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**Giga-scale 3D computational microscopy**, Laura Waller, University of California, Berkeley (United States)

Laura Waller is the Ted Van Duzer Endowed Assistant Professor of Electrical Engineering and Computer Sciences (EECS) at UC Berkeley. She is a Senior Fellow at the Berkeley Institute of Data Science, and received her BS (2004), MEng (2005), and PhD (2010) in EECS from the Massachusetts Institute of Technology (MIT). Waller's talk is on computational imaging methods for fast capture of gigapixel-scale 3D intensity and phase images in a commercial microscope that employs illumination-side and detection-side coding of angle (Fourier) space with simple hardware and fast acquisition. The result is high-resolution reconstructions across a large field-of-view, achieving high space-bandwidth-time product.

3:00 – 3:30 pm Coffee Break

#### SD&A Keynote I: 3D and VR on a User's Desk

Session Chair: Andrew Woods, Curtin University (Australia)

**3:30 – 4:30 pm**

Grand Peninsula Ballroom D

SD&A-362

**Stereoscopic displays, tracking, interaction, education, and the web**, David Chavez, zSpace, Inc. (United States)

David Chavez brings 20 years of experience in start-up companies, working with technologies ranging from GSM infrastructure to laptops, printers, PDAs and smartphones, in both consumer and commercial product spaces. He has managed product development teams through the full range of the product life cycle, from initial concept to volume production. Chavez has extensive experience working with suppliers and manufacturing partners worldwide, with a particular emphasis in Asia. He has held various positions in product development organizations such as pen-based computer companies GO & EO, Hewlett Packard, and Handspring.

#### Symposium Welcome Reception

**5:00 – 6:00 pm**

Atrium

**SD&A Conference 3D Theater**

Session Chairs: John Stern, Intuitive Surgical, Inc. (United States), Chris Ward, Lightspeed Design, Inc. (United States), and Andrew Woods, Curtin University (Australia)

**6:00 – 7:30 pm**

Grand Peninsula Ballroom D

This ever-popular session of each year's Stereoscopic Displays and Applications Conference showcases the wide variety of 3D content that is being produced and exhibited around the world. All 3D footage screened in the 3D Theater Session is shown in high-quality polarized 3D on a large screen. The final program will be announced at the conference and 3D glasses will be provided.

**Tuesday, January 31, 2017**

7:15 – 8:45 am Women in Electronic Imaging Breakfast

**Human Vision and Stereoscopic Imaging** Joint Session

Session Chairs: Nicolas Holliman, University of Newcastle (United Kingdom), and Thrasyvoulos Pappas, Northwestern University (United States)

**8:50 – 10:10 am**

Grand Peninsula Ballroom D

This session is jointly sponsored by: Stereoscopic Displays and Applications XXVIII and Human Vision and Electronic Imaging 2017.

8:50 HVEI-378

**Depth-compressed expression for providing natural, visual experiences with integral 3D displays**, Yasuhito Sawahata and Toshiya Morita, Japan Broadcasting Corporation (Japan)

9:10 HVEI-379

**Blind quality prediction of stereoscopic 3D images**, Jiheng Wang<sup>1</sup>, Qingbo Wu<sup>2</sup>, Abdul Rehman<sup>1</sup>, Shiqi Wang<sup>1</sup>, and Zhou Wang<sup>1</sup>; <sup>1</sup>University of Waterloo (Canada) and <sup>2</sup>University of Electronic Science and Technology of China (China)

9:30 SD&A-380

**Pseudo-haptic by stereoscopic images and effects on muscular activity**, Takashi Kawai<sup>1</sup>, Fumiya Ohta<sup>1</sup>, Sanghyun Kim<sup>1</sup>, and Hiroyuki Morikawa<sup>1,2</sup>; <sup>1</sup>Waseda University and <sup>2</sup>Aoyama Gakuin University (Japan)

9:50 SD&A-381

**The effects of proximity cues on visual comfort when viewing stereoscopic contents (JIST-first)**, Yaohua Xie<sup>1</sup>, Danli Wang<sup>2</sup>, and Heng Qiao<sup>3</sup>; <sup>1</sup>Chinese Academy of Sciences, <sup>2</sup>Institute of Software, Chinese Academy of Sciences, and <sup>3</sup>Central University of Finance and Economics (China)

10:00 am – 7:30 pm Industry Exhibition

10:10 – 10:50 am Coffee Break

**Autostereoscopic Displays II**

Session Chair: Michael Klug, Magic Leap, Inc. (United States)

**10:50 am – 12:30 pm**

Grand Peninsula Ballroom D

10:50 SD&A-363

**See-through projection 3D display using time-division multiplexing**, Masahiro Kajimoto, Hiroki Kamoshita, and Tomohiro Yendo, Nagaoka University of Technology (Japan)

11:10 SD&A-364

**Flat autostereoscopic 3D display with enhanced resolution using a static color filter barrier**, Silvio Jurk, Mathias Kuhlmeier, Roland Bartmann, Bernd Duckstein, and René de la Barré, Fraunhofer Heinrich-Hertz-Institute (Germany)

11:30 SD&A-365

**Portrait and landscape mode convertible stereoscopic display using parallax barriers**, Yusuke Minami, Saki Osafune, Goro Hamagishi, Kayo Yoshimoto, and Hideya Takahashi, Osaka City University (Japan)

11:50 SD&A-366

**Digital holographic display with two-dimensional and three-dimensional convertible feature by high speed switchable diffuser**, Keehoon Hong, Yongjun Lim, KwanJung Oh, and Hyon-Gon Choo, Electronics and Telecommunications Research Institute (Republic of Korea)

12:10 SD&A-382

**A low-cost static volumetric display based on layered high incidence angle scattering**, Shawn Frayne, Looking Glass Factory, Inc. (United States)

12:30 – 2:00 pm Lunch Break

**EI 2017 Tuesday Plenary and Symposium Awards**

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**VR 2.0: Making virtual reality better than reality**, Gordon Wetzstein, Stanford University (United States)

*Gordon Wetzstein is an Assistant Professor of Electrical Engineering and, by courtesy, of Computer Science, at Stanford University, and leads the Stanford Computational Imaging Group. He received a PhD in computer science from the University of British Columbia (2011) where his doctoral dissertation focused on computational light modulation for image acquisition and display. In his talk, Wetzstein explores the frontiers of VR systems engineering. Eventually, VR/AR systems will redefine communication, entertainment, education, collaborative work, simulation, telesurgery, and basic vision research, as next-generation computational near-eye displays evolve to deliver visual experiences that are better than the real world.*

3:00 – 3:30 pm Coffee Break



**Stereo-cameras and Stereo-matching**

Session Chair: Neil Dodgson, University of Cambridge (United Kingdom)

**3:30 – 4:30 pm**

Grand Peninsula Ballroom D

3:30 SD&A-367

**Real time depth estimation method using hybrid camera system,** Eu-Tieum Baek and Yo-Sung Ho, Gwangju Institute of Science and Technology (Republic of Korea)

3:50 SD&A-368

**Pixel based adaptive normalized cross correlation for illumination invariant stereo matching,** YongJun Chang and Yo-Sung Ho, Gwangju Institute of Science and Technology (Republic of Korea)

4:10 SD&A-369

**Guide image filtering based disparity range control in stereo vision,** Ji-Hun Mun and Yo-Sung Ho, Gwangju Institute of Science and Technology (Republic of Korea)

**DISCUSSION: SD&A Forum**

Moderator: Neil Dodgson, University of Cambridge (United Kingdom)

**4:30 – 5:30 pm**

Grand Peninsula Ballroom D

This session is a chance for a hot topic to be discussed by a panel of distinguished guests. Topic and panelists to be announced.

**Symposium Demonstration Session**

**5:30 – 7:30 pm**

Grand Peninsula Ballroom E

**Wednesday, February 1, 2017**

**Stereoscopic Image Quality**

Session Chair: Björn Sommer, University of Konstanz (Germany)

**8:50 – 10:10 am**

Grand Peninsula Ballroom D

8:50 SD&A-340

**Sharpness mismatch and 6 other stereoscopic artifacts measured on 10 Chinese S3D movies,** Dmitriy Vatolin, Lomonosov Moscow State University (Russian Federation)

9:10 SD&A-370

**Bringing 3DMap to the 21<sup>st</sup> century,** Stephan Keith<sup>1</sup> and Andrew Woods<sup>2</sup>; <sup>1</sup>Independent Consultant (United States) and <sup>2</sup>Curtin University (Australia)

9:30 SD&A-371

**Subjective and objective study of the relation between 3D and 2D views based on depth and bit rate,** Balasubramanyam Appina, IIT Hyderabad (India)

9:50 SD&A-373

**Improved depth of field analysis of multilayer displays,** Hironobu Gotoda, National Institute of Informatics (Japan)

10:00 am – 4:00 pm Industry Exhibition

10:10 – 10:50 am Coffee Break

**3D Developments**

Session Chair: Takashi Kawai, Waseda University (Japan)

**10:50 – 11:30 am**

Grand Peninsula Ballroom D

10:50 SD&A-374

**Stereo rendering of photorealistic precipitation,** Syed Hussain and David McAllister, North Carolina State University (United States)

11:10 SD&A-372

**Utilization of stereoscopic 3D images in elementary school social studies classes,** Takashi Shibata<sup>1</sup>, Yoshiki Ishihara<sup>1</sup>, Kazunori Sato<sup>2,3</sup>, and Ryohei Ikejiri<sup>4</sup>; <sup>1</sup>Tokyo University of Social Welfare, <sup>2</sup>Takaido-higashi Elementary School, <sup>3</sup>Tohoku University, and <sup>4</sup>The University of Tokyo (Japan)

**SD&A Keynote II: 360° Multi-Camera Content Creation**

Session Chair: Gregg Favalora, Draper (United States)

**11:30 am – 12:30 pm**

Grand Peninsula Ballroom D

SD&A-375

**360° 3D capture: Meeting the need in VR,** Timothy Macmillan<sup>1</sup> and David Newman<sup>2</sup>; <sup>1</sup>Consultant and <sup>2</sup>GoPro Inc. (United States)

Tim MacMillan is an award-winning photographic artist whose career with Camera Array systems began in the 1980's. In the 1990's he established Time-Slice Films Ltd. to produce content and innovate array technology for clients such as the BBC, Sky TV, Discovery Channel, and many others. His distinctive approach has been influential in the development of special effects widely used today. MacMillan's work spans both the artistic and technical, with his early camera technology now in the (United Kingdom) Science Museum. As well as architecting and designing Array systems, he has also worked in HD Broadcast Product Development with Grass Valley Cameras, and is currently Senior Manager of Advanced Products at GoPro Cameras.

12:30 – 2:00 pm Lunch Break

**EI 2017 Wednesday Plenary and Symposium Awards**

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**Designing VR video camera systems,** Brian Cabral, Facebook, Inc. (United States)

Brian Cabral is Director of Engineering at Facebook, leading the Surround 360 VR camera team, specializing in computational photography, computer vision, and computer graphics. He has published a number of papers in the area of computer graphics and imaging including the pioneering Line Integral Convolution algorithm. Cabral discusses developing Facebook Surround 360, an open, high-quality 3D-360 video capture system. VR video capture systems are composed of multiple optical and digital components – all of which must operate as if they are one seamless optical system. The design of VR video cameras, optical choices, SNR, etc., require a new set of technologies and engineering approaches, with tight coupling to the computational system components.

3:00 – 3:30 pm Coffee Break

**Visualization Facilities** Joint Session

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Session Chairs: Margaret Dolinsky, Indiana University (United States), and Andrew Woods, Curtin University (Australia)

**3:30 – 5:40 pm**

Grand Peninsula Ballroom D

*This session is jointly sponsored by: Stereoscopic Displays and Applications XXVIII and The Engineering Reality of Virtual Reality 2017.*

3:30 SD&A-105

**Designing a cloud-based 3D visualization engine for smart cities,** Nicolas Holliman, Stephen Dowsland, Mark Turner, Richard Cloete, and Tom Picton, Newcastle University (United Kingdom)

3:50 SD&A-106

**Interactive computer graphics, stereo and VR practice at the Electronic Visualization Laboratory University of Illinois at Chicago,** Maxine Brown<sup>1</sup>, Jason Leigh<sup>2</sup>, Tom DeFanti<sup>3</sup>, and Daniel Sandin<sup>1</sup>; <sup>1</sup>The University of Illinois at Chicago, <sup>2</sup>University of Hawai'i at Manoa, and <sup>3</sup>University of California, San Diego (United States)

4:10 ERVR-107

**Designing at the Advanced Visualization Lab at Indiana University,** Margaret Dolinsky<sup>1</sup>, Eric Wernert<sup>2</sup>, Michael Boyles<sup>2</sup>, and Chris Eller<sup>2</sup>; <sup>1</sup>School of Art and Design, Indiana University and <sup>2</sup>Advanced Visualization Lab, Indiana University (United States)

4:30 ERVR-108

**Exploring Calit2,** Jürgen Schulze and Gregory Dawe, University of California, San Diego (United States)

4:50 SD&A-109

**3D-Stereoscopic immersive analytics projects at Monash University and University of Konstanz,** Björn Sommer<sup>1,3</sup>, David G. Barnes<sup>1,4</sup>, Sarah Boyd<sup>1</sup>, Thomas Chandler<sup>1</sup>, Maxime Cordeil<sup>1</sup>, Karsten Klein<sup>1,3</sup>, Toan Nguyen<sup>4</sup>, Hieu Nim<sup>1,5</sup>, Kingsley Stephens<sup>1</sup>, Dany Vohl<sup>2</sup>, Elliott Wilson<sup>1</sup>, Jon McCormack<sup>1</sup>, Kim Marriott<sup>1</sup>, and Falk Schreiber<sup>1,3</sup>; <sup>1</sup>Monash University (Australia), <sup>2</sup>Swinburne University of Technology (Australia), <sup>3</sup>University of Konstanz (Germany), <sup>4</sup>Monash Immersive Visualization Platform at Monash University (Australia), and <sup>5</sup>Australian Regenerative Medicine Institute of Monash University (Australia)

5:10 SD&A-110

**Image distortions in large-scale immersive display systems – Cylinder and wedge displays,** Andrew Woods<sup>1</sup>, Joshua Hollick<sup>1</sup>, Jesse Helliwell<sup>1</sup>, and Paul Bourke<sup>2</sup>; <sup>1</sup>Curtin University and <sup>2</sup>University of Western Australia (Australia)

5:30

**SD&A Closing Remarks,** Nicolas Holliman, Newcastle University (United Kingdom)

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**Stereoscopic Displays and Applications XXVIII Interactive Papers Session**

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**5:30 – 7:00 pm**

Atrium

*The following works will be presented at the EI 2017 Symposium Interactive Papers Session.*

SD&A-376

**Analysis of retinal images for retinal projection type super multi-view 3D head-mounted display,** Takashi Emoto, Tadayuki Konda, Kayo Yoshimoto, and Hideya Takahashi, Osaka City University (Japan)

SD&A-377

**A new design and algorithm for lenticular lenses display,** René de la Barré, Roland Bartmann, Mathias Kuhlmeier, Bernd Duckstein, and Silvio Jurk, Fraunhofer HHI (Germany)

## Surveillance: Applications and Algorithms 2017

### Overview

With the advent of low-cost/high-performance video sensors, imaging platforms, and computational equipment, it has become increasingly possible to process video streams in real-time on affordable cloud computational servers, desktop systems, and various hand held mobile devices. Applications of these technologies are changing the landscape in security and surveillance systems. Automated video understanding can enhance surveillance/monitoring systems beyond what is possible for human operators alone. These systems are being developed to maintain long-term surveillance on large numbers of video streams for various applications with minimal or no manual intervention. In addition, automated systems can coordinate multiple cameras and provide "synopsis" views of activities that can be used to predict/analyze potential events pre or post mortem. Over the past two decades, various video analytics algorithms have been proposed for autonomous understanding of events for a variety of surveillance applications. While most of the earlier solutions started from raw data and followed with the interpretation at increasing levels of semantic complexity, more recent techniques attempt to bridge the gap between signal-level and semantic level processing. Technological solutions to problems in surveillance have the potential for significant societal impacts on many fronts from airport/stadium/building/city security to patient/elderly care. There is an emerging global effort to develop effective surveillance systems. This Special Session Call for Papers is intended to bring together world class researchers and practitioners that develop and deploy imaging and video technologies to enable novel solutions in the surveillance and security arenas.

Chair: Sreenath Rao Vantaram, Intel Corporation (United States)



Photo: San Francisco Travel Association-Scott Chernis.

# Surveillance: Applications and Algorithms 2017 Session

**Tuesday, January 31, 2017**

**Surveillance: Applications and Algorithms Topics**

Session Chair: Sreenath Vantaram, Intel Corporation (United States)

**8:50 – 10:20 am**

Harbour

8:50

**Chair Opening Remarks**

9:00

SRV-349

**Traffic light recognition and dangerous driving events detection from surveillance video of vehicle camera**, Haike Guan, Ryohsuke Kasahara, and Tomoaki Yano, Ricoh Company, Ltd. (Japan)

9:20

SRV-350

**A combined HOG and deep convolution network cascade for pedestrian detection**, Yuriy Lipetski and Oliver Sidla, SLR Engineering GmbH (Austria)

9:40

SRV-352

**A multi-scale approach to skin pixel detection**, Siddharth Roheda<sup>1</sup> and Hari Kalva<sup>2</sup>; <sup>1</sup>North Carolina State University and <sup>2</sup>Florida Atlantic University (United States)

10:00

SRV-351

**Detecting and estimating sound events locations through a microphone array**, Josafat Martínez-García, Beatriz Juárez-Arreortúa, Alberto Vázquez-Cervantes, and Hugo Jimenez, Centro de Ingeniería y Desarrollo Industrial (Mexico)

10:00 am – 7:30 pm Industry Exhibition

10:20 – 10:50 am Coffee Break

**EI 2017 Tuesday Plenary and Symposium Awards**

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**VR 2.0: Making virtual reality better than reality**, Gordon Wetzstein, Stanford University (United States)

*Gordon Wetzstein is an Assistant Professor of Electrical Engineering and, by courtesy, of Computer Science, at Stanford University, and leads the Stanford Computational Imaging Group. He received a PhD in computer science from the University of British Columbia (2011) where his doctoral dissertation focused on computational light modulation for image acquisition and display. In his talk, Wetzstein explores the frontiers of VR systems engineering. Eventually, VR/AR systems will redefine communication, entertainment, education, collaborative work, simulation, training, telesurgery, and basic vision research, as next-generation computational near-eye displays evolve to deliver visual experiences that are better than the real world.*

3:00 – 3:30 pm Coffee Break

**Symposium Demonstration Session**

**5:30 – 7:30 pm**

Grand Peninsula Ballroom E

## Visual Information Processing and Communication VIII

### Conference overview

Processing, storage, and transmission of many types of visual information, including photos and stereo images, video, graphics, light fields, volumetric, spectral, etc., have become important engineering areas that attract interdisciplinary research interest. This conference is designed as a forum for presenting important research results as well as applications.

Topics include:

- Compression of visual information: image, video, graphics, and light-field coding, compression standards, very-low bit rate coding, high quality image/video/graphics coding, volumetric data coding
- Media over networks: media streaming, video over wireless networks, error resilience, scalability, quality of service, cross-layer optimization for improved media delivery, streaming media delivery networks
- Visual information processing: filtering, interpolation (e.g. deinterlacing, frame-rate conversion), restoration, compressed-domain processing, superresolution, multimodal media processing
- Visual information representations: multiresolution analysis, subbands, wavelets, sparse decompositions for visual data, related estimation, analysis, and reconstruction algorithms
- Pattern matching of visual data: machine learning, augmented reality, mobile applications
- Object-based methods: segmentation and tracking, feature extraction
- Synthetic imaging and rendering: stereo, multiview and 3D video, synthetic image/video and graphics representations, 3D and animated 3D models, virtual reality, visualization and display techniques
- Application systems: DTV, electronic cinema, multimedia content retrieval, man-machine interface, imaging/video surveillance
- Media system design: hardware and software architectures and implementation issues, scalable computations, low-power implementations, multicore algorithm design
- Compression of medical imaging information
- Other timely topics related to visual information communication and processing



**Conference Chairs:** Edward Delp, Purdue Univ. (United States); and Robert L. Stevenson, Univ. of Notre Dame (United States)

**Program Committee:** John Apostolopoulos, HP Inc. (United States); Vasudev Bhaskaran, Qualcomm Technologies, Inc. (United States); Mireille Boutin, Purdue Univ. (United States); Chang Wen Chen, The State Univ. of New York at Buffalo (United States); Gerard de Haan, Philips Research Nederland B.V. (the Netherlands); Eric Dubois, Univ. of Ottawa (Canada); Frederic Dufaux, Télécom ParisTech (France); Keigo Hirakawa, Univ. of Dayton (United States); Marta Karczewicz, Qualcomm Technologies, Inc. (United States); Lisimachos Kondi, Univ. of Ioannina (Greece); Janusz Konrad, Boston Univ. (United States); Chun-Chieh Jay Kuo, The Univ. of Southern California (United States); Peyman Milanfar, Univ. of California, Santa Cruz (United States); Antonio Ortega, The Univ. of Southern California (United States); Thrasylvos Pappas, Northwestern Univ. (United States); William Pearlman, Rensselaer Polytechnic Institute (United States); Fernando Pereira, Instituto de Telecomunicações (Portugal); Béatrice Pesquet-Popescu, Télécom Paris Tech (France); Majid Rabbani, Consultant (United States); Eli Saber, Rochester Institute of Technology (United States); Amir Said, Qualcomm Technologies Inc. (United States); Dan Schonfeld, Univ. of Illinois at Chicago (United States); Andrew Segall, Sharp Labs of America, Inc. (United States); Gaurav Sharma, Univ. of Rochester (United States); Andrew Tescher, AGT Associates (United States); Anthony Vetro, Mitsubishi Electric Research Labs (United States); John Woods, Rensselaer Polytechnic Institute (United States); and Wenwu Zhu, Tsinghua Univ. (China)

# Visual Information Processing and Communication VIII

Monday, January 30, 2017

## Image and Video Compression

10:50 am – 12:30 pm

Cypress A

10:50 VIPC-398

**A fast TU mode decision algorithm based on residual difference for HEVC**, Nian-Rong Li<sup>1</sup>, Kai-Wen Liang<sup>1</sup>, Zong-Yi Chen<sup>1</sup>, Hui-Yu Jiang<sup>1</sup>, Jiunn-Tsair Fang<sup>2</sup>, and Pao-Chi Chang<sup>1</sup>; <sup>1</sup>National Central University and <sup>2</sup>Ming Chuan University (Taiwan)

11:10 VIPC-399

**A fast intra mode decision algorithm for HEVC**, Weihang Liao, Daiqin Yang, and Zhenzhong Chen, Wuhan University (China)

11:30 VIPC-400

**Diamond frequency domain inter frame motion estimation for HEVC**, Abdelrahman Abdelazim<sup>1</sup>, Ahmed Hamza<sup>2</sup>, Mohamed Hefeida<sup>1</sup>, and Djamel Ait-Boudaoud<sup>2</sup>; <sup>1</sup>The American University of the Middle East (Kuwait) and <sup>2</sup>University of Portsmouth (United Kingdom)

11:50 VIPC-401

**Compression of infrared images**, Claire Mantel and Soren Forchhammer, Denmark Technical University (Denmark)

12:10 VIPC-402

**Graph regularized sparse coding by modified online dictionary learning**, Lingdao Sha, Jing Wang, and Dan Schonfeld, University of Illinois at Chicago (United States)

12:30 – 2:00 pm Lunch Break

### El 2017 Opening Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

2:00 – 3:00 pm

Grand Peninsula Ballroom D

**Giga-scale 3D computational microscopy**, Laura Waller, University of California, Berkeley (United States)

Laura Waller is the Ted Van Duzer Endowed Assistant Professor of Electrical Engineering and Computer Sciences (EECS) at UC Berkeley. She is a Senior Fellow at the Berkeley Institute of Data Science, and received her BS (2004), MEng (2005), and PhD (2010) in EECS from the Massachusetts Institute of Technology (MIT). Waller's talk is on computational imaging methods for fast capture of gigapixel-scale 3D intensity and phase images in a commercial microscope that employs illumination-side and detection-side coding of angle (Fourier) space with simple hardware and fast acquisition. The result is high-resolution reconstructions across a large field-of-view, achieving high space-bandwidth-time product.

3:00 – 3:30 pm Coffee Break

## Segmentation

3:30 – 4:30 pm

Cypress A

3:30 VIPC-403

**A coarse-to-fine framework for video object segmentation**, Chi Zhang<sup>1</sup> and Alexander Loui<sup>2</sup>; <sup>1</sup>Rochester Institute of Technology and <sup>2</sup>Kodak Alaris Inc. (United States)

3:50 VIPC-404

**A fast and accurate segmentation method for medical images**, Jiatao Wu, Yong Li, Chunxiao Fan, and Hongbin Jin, Beijing University of Posts and Telecommunications (China)

4:10 VIPC-405

**Adaptive combination of local motion, appearance, and shape for video segmentation (JIST-first)**, Soochahn Lee<sup>1</sup>, Woo-sung Shim<sup>2</sup>, and Se-hoon Kim<sup>2</sup>; <sup>1</sup>Soonchunhyang University and <sup>2</sup>Samsung Electronics (Republic of Korea)

### Symposium Welcome Reception

5:00 – 6:00 pm

Atrium

Tuesday, January 31, 2017

## Techniques for Image and Video Processing

8:50 – 10:10 am

Cypress A

8:50 VIPC-406

**Improvement of infrared image based on directional anisotropic wavelet transform**, Hongbin Jin<sup>1</sup>, Chunxiao Fan<sup>1</sup>, Quanxin Wang<sup>2</sup>, and Yong Li<sup>1</sup>; <sup>1</sup>Beijing University of Posts and Telecommunications and <sup>2</sup>Ultimedical, Inc (China)

9:10 VIPC-407

**New diamond half-pel hexagon serach algorithm for block matching motion estimation**, Abdelrahman Abdelazim<sup>1</sup>, Ahmed Hamza<sup>2</sup>, Bassam Noaman<sup>1</sup>, and Djamel Ait-Boudaoud<sup>2</sup>; <sup>1</sup>The American University of the Middle East (Kuwait) and <sup>2</sup>University of Portsmouth (United Kingdom)

9:30 VIPC-408

**Self-example-based edge enhancement algorithm for around view monitor images**, Dong Yoon Choi<sup>1</sup>, Ji Hoon Choi<sup>1</sup>, Jin Wook Choi<sup>2</sup>, and Byung Cheol Song<sup>1</sup>; <sup>1</sup>Inha University and <sup>2</sup>Hyundai Motor Company (Republic of Korea)

9:50 VIPC-409

**Adaptive multireference prediction using a symmetric framework**, Zoe Liu<sup>1</sup>, Debargha Mukherjee<sup>1</sup>, Wei-Ting Lin<sup>2</sup>, Paul Wilkins<sup>1</sup>, Jingning Han<sup>1</sup>, Yaowu Xu<sup>1</sup>, and James Bankoski<sup>1</sup>; <sup>1</sup>Google Inc. and <sup>2</sup>University of California, Santa Barbara (United States)

10:00 am – 7:30 pm Industry Exhibition

10:10 – 10:50 am Coffee Break

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**Databases and Classification**

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**10:50 – 11:30 am**

Cypress A

10:50

VIPC-411

**Semi-supervised learning feature representation for historical Chinese character recognition**, Xiaoyi Yu, Wei Fan, and Jun Sun, Fujitsu R&D Co. Limited (China)

11:10

VIPC-412

**Document image classification on the basis of layout information**, Sergey Zavalishin<sup>1,2</sup>, Andrey But<sup>3</sup>, Ilya Kurilin<sup>1</sup>, and Michael Rychagov<sup>1</sup>; <sup>1</sup>Samsung R&D Institute Russia, <sup>2</sup>Ryazan State Radio Electronics University (RSREY), and <sup>3</sup>Kaspersky Lab (Russian Federation)

11:30 am – 2:00 pm    Lunch Break

**EI 2017 Tuesday Plenary and Symposium Awards**

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**VR 2.0: Making virtual reality better than reality**, Gordon Wetzstein, Stanford University (United States)

*Gordon Wetzstein is an Assistant Professor of Electrical Engineering and, by courtesy, of Computer Science, at Stanford University, and leads the Stanford Computational Imaging Group. He received a PhD in computer science from the University of British Columbia (2011) where his doctoral dissertation focused on computational light modulation for image acquisition and display. In his talk, Wetzstein explores the frontiers of VR systems engineering. Eventually, VR/AR systems will redefine communication, entertainment, education, collaborative work, simulation, training, telesurgery, and basic vision research, as next-generation computational near-eye displays evolve to deliver visual experiences that are better than the real world.*

3:00 – 3:30 pm    Coffee Break

**Symposium Demonstration Session**

**5:30 – 7:30 pm**

Grand Peninsula Ballroom E

## Visualization and Data Analysis 2017

### Conference overview

The Conference on Visualization and Data Analysis (VDA) 2017 covers all research and development and application aspects of data visualization and visual analytics. Since the first VDA conference was held in 1994, the annual event has grown steadily into a major venue for visualization researchers and practitioners from around the world to present their work and share their experiences.

**Award:** Kostas Pantazos Memorial Award for Outstanding Paper

### Conference Sponsor



Photo: San Francisco Travel Association-Can Balicoglu

**Conference Chairs:** Thomas Wischgoll, Wright State Univ. (United States); Song Zhang, Mississippi State Univ. (United States); and David Kao, NASA Ames Research Center (United States)

**Program Committee:** Madjid Allili, Bishop's Univ. (Canada); Wes Bethel, Lawrence Berkeley National Lab. (United States); Abon Chaudhuri, WalmartLabs (United States); Yi-Jen Chiang, New York Univ. (United States); Hank Childs, Univ. of Oregon (United States); Jaegul Choo, Korea Univ. (Republic of Korea); Joseph Cottam, Indiana Univ. (United States); Sussan Einakian, Univ. of Alabama in Huntsville (United States); Christoph Garth, Technische Univ. Kaiserslautern (Germany); John Gerth, Stanford Univ. (United States); Matti Gröhn, Finnish Institute of Occupational Health (Finland); Christopher Healey, North Carolina State Univ. (United States); Mario Hlawitschka, Univ. of Leipzig (Germany); Halldor Janetzko, Univ. of Konstanz (Germany); Ming Jiang, Lawrence Livermore National Laboratory (United States); Alark Joshi, Univ. of San Francisco (United States); Andreas Kerren, Linnaeus Univ. (Sweden); Robert Lewis, Washington State Univ. (United States); Peter Lindstrom, Lawrence Livermore National Laboratory (United States); Lars Linsen, Jacobs Univ. Bremen GmbH (Germany); Zhanping Liu, Old Dominion Univ. (United States); Aidong Lu, Univ. of North Carolina at Charlotte (United States); G. Elisabeta Marai, Univ. of Illinois at Chicago (United States); Richard May, Pacific Northwest National Lab. (United States); Joerg Meyer, Magic Leap, Inc. (United States); Harald Obermaier, Univ. of California, Davis (United States); Donald Pellegrino, The Dow Chemical Co. (United States); Theresa-Marie Rhyne, Computer Graphics and E-Learning (United States); René Rosenbaum, meeCoda (Germany); Jibonananda Sanyal, Oak Ridge National Lab. (United States); Pinaki Sarder, Univ. of Buffalo (United States); Graig Sauer, Towson Univ. (United States); Inga Scheler, Technische Univ. Kaiserslautern (Germany); Jürgen Schulze, Univ. of California, San Diego (United States); Christopher Shaw, Simon Fraser Univ. (Canada); Chad Steed, Oak Ridge National Laboratory (United States); Kalpathi Subramanian, Univ. of North Carolina at Charlotte (United States); Shigeo Takahashi, Univ. of Aizu (Japan); Chaoli Wang, Michigan Technological Univ. (United States); Tino Weinkauff, Royal Institute of Technology (Sweden); Jie Yan, Bowie State Univ. (United States); Hsu-Chun Yen, National Taiwan Univ. (Taiwan); Leishi Zhang, Middlesex Univ. London (United Kingdom); Wenjin Zhou, Oakand Univ. (United States); and Caroline Ziemkiewicz, Brown Univ. (United States)



## Wednesday, February 1, 2017

### El 2017 Wednesday Plenary and Symposium Awards

Session Chairs: Joyce E. Farrell, Stanford University, and Nitin Sampat, Rochester Institute of Technology (United States)

**2:00 – 3:00 pm**

Grand Peninsula Ballroom D

**Designing VR video camera systems**, Brian Cabral, Facebook, Inc. (United States)

Brian Cabral is Director of Engineering at Facebook, leading the Surround 360 VR camera team, specializing in computational photography, computer vision, and computer graphics. He has published a number of papers in the area of computer graphics and imaging including the pioneering Line Integral Convolution algorithm. Cabral discusses developing Facebook Surround 360, an open, high-quality 3D-360 video capture system. VR video capture systems are composed of multiple optical and digital components - all of which must operate as if they are one seamless optical system. The design of VR video cameras, optical choices, SNR, etc., require a new set of technologies and engineering approaches, with tight coupling to the computational system components.

3:00 – 3:30 pm Coffee Break

### Keynote: Topological Data Analysis

Session Chair: Thomas Wischgoll, Wright State University (United States)

**3:30 – 4:30 pm**

Cypress B

VDA-383

**Topological analysis at the extreme scale: Finding features in large data sets**, Gunther Weber, Lawrence Berkeley National Laboratory and University of California, Davis (United States)

Gunther Weber is a Staff Scientist in LBNL's Computational Research Division and an Adjunct Associate Professor of Computer Science at UC Davis. His research interests include computer graphics, scientific visualization, topological data analysis methods, parallelization of visualization algorithms, hierarchical data representation methods, and bioinformatics. Prior to joining LBNL, Weber worked as a Project Scientist at the Institute for Data Analysis and Visualization (IDAV) at UC Davis focusing on visualization of three-dimensional gene expression data (with researchers of LBNL's Genomics and Life Sciences divisions), topological exploration of scalar data, and visualization of brain imaging data and experimental earthquake data. Weber earned his PhD in computer science, from the University of Kaiserslautern, Germany (2003).

### Visualization and Data Analysis 2017 Interactive Papers Oral Previews

Session Chair: Thomas Wischgoll, Wright State University (United States)

**4:30 – 4:50 pm**

Cypress B

In this session interactive poster authors will each provide a brief oral preview of their poster presentation, which will be presented fully in the Visualization and Data Analysis 2017 portion of the Symposium Interactive Papers Session at 5:30 pm on Wednesday.

4:30

VDA-384

**An interactive tool for Analyzing the Correlation, Uncertainty, and Clustering (ACUC) over ensembles in climate dataset**, Najmeh Abedzadeh, Mississippi State University (United States)

4:36

VDA-385

**Analysis enhanced particle-based flow visualization**, Lieyu Shi, Lei Zhang, Wei Cao, and Guoning Chen, University of Houston (United States)

4:42

VDA-450

**Constellations of movement: An interactive application to visualise research in motor imagery decoding**, Jennifer Rogers<sup>1</sup>, Matthieu Poyade<sup>1</sup>, and Frank Pollick<sup>2</sup>; <sup>1</sup>Glasgow School of Art and <sup>2</sup>University of Glasgow (United Kingdom)

### Panel: Application Papers: What are they and how should they be evaluated?

Panel Moderator: Gunther Weber, Lawrence Berkeley National Laboratory (United States)

**4:50 – 5:30 pm**

Cypress B

This panel will start a discussion in the community about what goals an application paper ought to have, what its main contributions to the state of art of visualization should be, and how it ought to be evaluated by reviewers. How do we as a community generate clear evaluation criteria for this type of paper?

### Symposium Interactive Papers (Poster) Session

**5:30 – 7:00 pm**

Atrium

## Thursday, February 2, 2017

### Information Visualization

Session Chair: Song Zhang, Mississippi State University (United States)

**8:50 – 10:10 am**

Cypress B

8:50

VDA-386

**Declarative guide creation**, Joseph Cottam and Andrew Lumsdaine, Indiana University (United States)

9:10

VDA-387

**Visual-interactive semi-supervised labeling of human motion capture data**, Jürgen Bernard<sup>1</sup>, Eduard Dobermann<sup>1</sup>, Anna Vögele<sup>2</sup>, Björn Krüger<sup>3</sup>, Jörn Kohlhammer<sup>4</sup>, and Dieter Fellner<sup>1</sup>; <sup>1</sup>Technische Universität Darmstadt (Germany), <sup>2</sup>University of Bonn (Germany), <sup>3</sup>Gokhale Method Institute (United States), and <sup>4</sup>Fraunhofer Institute for Computer Graphics Research IGD (Germany)

9:30

VDA-388

**Visual-interactive creation and validation of text clustering workflows to explore document collections**, Tobias Ruppert<sup>1</sup>, Michael Staab<sup>2</sup>, Andreas Bannach<sup>1</sup>, Hendrik Lücke-Tieke<sup>1</sup>, Jürgen Bernard<sup>2</sup>, Arjan Kuijper<sup>1,2</sup>, and Jörn Kohlhammer<sup>1,2</sup>; <sup>1</sup>Fraunhofer Institute for Computer Graphics Research IGD and <sup>2</sup>Technische Universität Darmstadt (Germany)

9:50 VDA-389  
**AssisTag: Seamless integration of content-based and keyword-based image exploration for category search (JIST-first)**, Kazuyo Mizuno, Daisuke Sakamoto, and Takeo Igarashi, *The University of Tokyo (Japan)*

10:10 – 10:50 am Coffee Break

**Virtual Reality**

Session Chair: Song Zhang, Mississippi State University (United States)

**10:50 – 11:30 am**

Cypress B

10:50 VDA-390  
**Megacity: A collaborative virtual reality environment for emergency response, training, and decision making**, Sharad Sharma<sup>1</sup>, Phillip Devreaux<sup>1</sup>, David Scribner<sup>2</sup>, Jock Grynovicki<sup>2</sup>, and Peter Grazaitis<sup>2</sup>; <sup>1</sup>Bowie State University and <sup>2</sup>Army Research Laboratory (United States)

11:10 VDA-391  
**Display systems for visualization and simulation in virtual environments**, Thomas Wischgoll, *Wright State University (United States)*

**Scientific Visualization**

Session Chair: David Kao, NASA Ames Research Center (United States)

**11:30 am – 12:10 pm**

Cypress B

11:30 VDA-392  
**Ray traced volume clipping using multi-hit BVH Traversal**, Stefan Zellmann<sup>1</sup>, Mauritius Hoevens<sup>2</sup>, and Ulrich Lang<sup>1</sup>; <sup>1</sup>University of Cologne and <sup>2</sup>University Hospital of Cologne (Germany)

11:50 VDA-393  
**Effectiveness of feature-driven storytelling in 3D time-varying data visualization (JIST-first)**, Aidong Lu, Li Yu, and Lane Harrison, *University of North Carolina at Charlotte (United States)*

12:10 – 2:00 pm Lunch Break

**Graphs and Hierarchies**

Session Chair: Thomas Wischgoll, *Wright State University (United States)*

**2:00 – 2:40 pm**

Cypress B

2:00 VDA-394  
**A visual and statistical benchmark of graph sampling methods**, Fangyan Zhang<sup>1</sup>, Song Zhang<sup>1</sup>, and Pak Wong<sup>2</sup>; <sup>1</sup>Mississippi State University and <sup>2</sup>Pacific Northwest National Laboratory (United States)

2:20 VDA-395  
**Inferring partial orders of nodes for hierarchical network layout (JIST-first)**, Hsiang-Yun Wu<sup>1</sup>, Shigeo Takahashi<sup>2</sup>, Hiroko Miyamura<sup>3</sup>, Satoshi Ohzahata<sup>4</sup>, and Akihiro Nakao<sup>5</sup>; <sup>1</sup>Keio University, <sup>2</sup>University of Aizu, <sup>3</sup>Japan Atomic Energy Agency, <sup>4</sup>The University of Electro-Communications, and <sup>5</sup>The University of Tokyo (Japan)

**Flow Visualization**

Session Chair: David Kao, NASA Ames Research Center (United States)

**2:40 – 3:20 pm**

Cypress B

2:40 VDA-396  
**Closest point sparse octree for surface flow visualization**, Mark Kim and Charles Hansen, *University of Utah (United States)*

3:00 VDA-397  
**Accelerating advection via approximate block exterior flow maps**, Ryan Bleile<sup>1</sup>, Linda Sugiyama<sup>2</sup>, Christoph Garth<sup>3</sup>, and Hank Childs<sup>1</sup>; <sup>1</sup>University of Oregon (United States), <sup>2</sup>Massachusetts Institute of Technology (United States), and <sup>3</sup>University of Kaiserslautern (Germany)

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

**3:00 – 5:00 pm**

Atrium

3:20 – 4:00 pm Coffee Break

## Short Courses

Sunday, January 29, 2017

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**NEW for 2017** E101: Stereoscopic Display Application Issues

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**Instructors:** John Merritt, The Merritt Group (United States) and Andrew Woods, Curtin University (Australia)

**8:00 am – 5:45 pm (8 hours)**

**Course Level:** Intermediate

**Fee:** Member fee\*: \$465 / Non-member fee: \$510 / Student fee: \$185  
\*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

When correctly implemented, stereoscopic 3D video displays can provide significant benefits in many areas, including endoscopy and other medical imaging, remote-control vehicles and telemanipulators, stereo 3D CAD, molecular modeling, 3D computer graphics, 3D visualization, and video-based training. This course conveys a concrete understanding of basic principles and pitfalls that should be considered in transitioning from 2D to 3D displays, and in testing for performance improvements. In addition to the traditional lecture sessions, there is a “workshop” session to demonstrate stereoscopic hardware and 3D imaging/display principles, emphasizing the key issues in an ortho-stereoscopic video display setup, and showing video from a wide variety of applied stereoscopic imaging systems.

**Benefits:**

- List critical human factors guidelines for stereoscopic display configuration & implementation.
- Calculate optimal camera focal length, separation, display size, and viewing distance to achieve a desired level of depth acuity.
- Calculate comfort limits for focus/fixation mismatch and on-screen parallax values, as a function of focal length, separation, convergence, display size, and viewing distance factors.
- Set up a large-screen stereo display system using AV equipment readily available at most conference sites for slides and for full-motion video.
- Evaluate the trade-offs among currently available stereoscopic display technologies for your proposed applications.
- List the often-overlooked side-benefits of stereoscopic displays that should be included in a cost/benefit analysis for proposed 3D applications.
- Avoid common pitfalls in designing tests to compare 2D vs. 3D displays.
- Calculate and demonstrate the distortions in perceived 3D space due to camera and display parameters.
- Design and set up an orthostereoscopic 3D imaging/display system.
- Understand the projective geometry involved in stereo modeling.
- Understand the trade-offs among currently available stereoscopic display system technologies and determine which will best match a particular application.

**Intended Audience:** Engineers, scientists, and program managers involved with video display systems for applications such as: medical imaging & endoscopic surgery, simulators & training systems, teleoperator systems (remote-control vehicles & manipulators), computer graphics, 3D CAD systems, data-space exploration and visualization, and virtual reality.

*John O. Merritt is a display systems consultant at The Merritt Group, Williamsburg, MA, with more than 25 years' experience in the design and human-factors evaluation of stereoscopic video displays for telepresence and telerobotics, scientific visualization, and medical imaging.*

*Andrew J. Woods is manager of the Curtin HIVE visualization facility and a research engineer at Curtin University's Centre for Marine Science and Technology in Perth, Western Australia. He has more than 20 years of experience working on the design, application, and evaluation of stereoscopic image and video capture and display equipment.*

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**E102: Introduction to Image Quality Testing: Targets, Software, and Standards**

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**Instructors:** Peter Burns, Burns Digital Imaging (United States) and Don Williams, Image Science Associates (United States)

**8:00 – 10:00 am (2 hours)**

**Course Level:** Introductory

**Fee:** Member fee\*: \$165 / Non-member fee: \$195 / Student fee: \$60  
\*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

This course introduces imaging performance evaluation for image capture and provides a foundation for more advanced topics, e.g., system characterization and performance benchmarking. We adopt a scenario-based approach by describing several situations where imaging performance needs evaluation. Each of these, from design to quality assurance for manufacturing, is addressed in terms of suggested methods, color test charts, and standard reporting. For several important attributes, we describe international standards, guidelines, and current best practice. We demonstrate how testing standards can be adapted to evaluate capture devices ranging from cameras to scientific detectors. Examples are drawn from various applications, including consumer, museum, mobile, and clinical imaging.

**Benefits:**

- Understand the difference between imaging performance and image quality.
- Describe performance standards, guidelines, and current best practices.
- Understand how color-encoding, image resolution, distortion, and noise are evaluated.
- Compare various commercial analysis software products and (color, resolution) test charts.
- Select evaluation methods and test targets to meet your project needs.
- Identify sources of system variability and understand measurement error.

**Intended Audience:** This course is intended for a wide audience: image scientists, quality engineers, and others evaluating digital camera and scanner performance. No background in imaging performance (optical distortion, color-error, MTF, etc.) evaluation will be assumed.

*Peter Burns is a consultant working in imaging system evaluation, modeling, and image processing. Previously he worked for Carestream Health, Xerox, and Eastman Kodak. A frequent instructor and speaker at technical conferences, he has contributed to several imaging standards. He has taught imaging courses at Kodak, SPIE, and IS&T technical conferences, and at the Center for Imaging Science, RIT.*

*Don Williams, founder of Image Science Associates, was with Kodak Research Laboratories. His work focuses on quantitative signal and noise performance metrics for digital capture imaging devices and imaging fidelity issues. He co-leads the TC 42 standardization efforts on digital print and film scanner resolution (ISO 16067-1, ISO 16067-2), scanner dynamic range (ISO 21550), and is the editor for the second edition to digital camera resolution (ISO 12233).*

**EI03: Concepts, Procedures, and Practical Aspects of Measuring Resolution in Mobile and Compact Imaging Devices and the Impact of Image Processing**

**Instructors:** Uwe Artmann, Image Engineering GmbH & Co KG (Germany) and Kevin Matherson, Microsoft Corporation (United States)

**8:00 – 10:00 am (2 hours)**

**Course Level:** Introductory/Intermediate

**Fee:** Member fee\*: \$165 / Non-member fee: \$195 / Student fee: \$60  
\*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

Resolution is often used to describe image quality of electronic imaging systems. Components of an imaging system such as lenses, sensors, and image processing impact the overall resolution and image quality achieved in devices such as digital and mobile phone cameras. While image processing can in some cases improve the resolution of an electronic camera, it can also introduce artifacts as well. This course is an overview of spatial resolution methods used to evaluate electronic imaging devices and the impact of image processing on the final system resolution. The course covers the basics of resolution and impacts of image processing, international standards used for the evaluation of spatial resolution, and practical aspects of measuring resolution in electronic imaging devices such as target choice, lighting, sensor resolution, and proper measurement techniques.

**Benefits:**

- Understand terminology used to describe resolution of electronic imaging devices.
- Describe the basic methods of measuring resolution in electronic imaging devices and their pros and cons.
- Understand point spread function and modulation transfer function.
- Learn slanted edge spatial frequency response (SFR).
- Learn Siemens Star SFR.
- Contrast transfer function.
- Difference between and use of object space and image space resolution.
- Describe the impact of image processing functions on spatial resolution.
- Understand practical issues associated with resolution measurements.
- Understand targets, lighting, and measurement set up.
- Learn measurement of lens resolution and sensor resolution.
- Appreciate RAW vs. processed image resolution measurements.
- Learn cascade properties of resolution measurements.
- Understand measurement of camera resolution.
- Understand the practical considerations when measuring real lenses.

**Intended Audience:** Managers, engineers, and technicians involved in the design and evaluation of image quality of digital cameras, mobile cameras, video cameras, and scanners would benefit from participation. Technical staff of manufacturers, managers of digital imaging projects, as well as journalists and students studying image technology are among the intended audience.

*Kevin J. Matherson is a director of optical engineering at Microsoft Corporation working on advanced optical technologies for consumer products. Prior to Microsoft, he participated in the design and development of compact cameras at HP and has more than 15 years of experience developing miniature cameras for consumer products. His primary research interests focus on sensor characterization, optical system design and analysis, and the optimization of camera image quality. Matherson holds a Masters and PhD in optical sciences from the University of Arizona.*

*Uwe Artmann studied photo technology at the University of Applied Sciences in Cologne following an apprenticeship as a photographer and finished with the German 'Diploma Engineer'. He is now the CTO at Image Engineering, an independent test lab for imaging devices and manufacturer of all kinds of test equipment for these devices. His special interest is the influence of noise reduction on image quality and MTF measurement in general.*

**NEW for 2017 EI04: Electronic Imaging of Secure Documents**

**Instructor:** Alan Hodgson, Alan Hodgson Consulting Ltd. (United Kingdom)

**8:00 – 10:00 am (2 hours)**

**Course Level:** Introductory

**Fee:** Member fee\*: \$165 / Non-member fee: \$195 / Student fee: \$60  
\*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

This short course highlights the opportunities for electronic imaging technology in the broad secure documents market. There are specific opportunities for a broad range of electronic imaging technologies for the inspection and verification of a wide selection of secure documents.

For the purposes of this short course we consider the market for secure documents to encompass brand protection, packaging, and high security documents. The course is illustrated with examples from the high security end as personal identification documents provide a great illustration of the features and challenges in this sector.

This course is a mirror of one given to the high security printing community on the threats and opportunities that the technologies presented at this conference bring to secure documents. The benefits that this interaction brings is that the course is tuned to reflect the needs and opportunities for both communities.

**Benefits:**

- Understand the fundamentals driving security printing opportunities.
- Identify opportunities for electronic imaging solutions in this market segment.
- Gain an overview of how mobile imaging, machine vision, and multispectral characterization can be used in the security print market sector.

**Intended Audience:** Imaging scientists, systems developers, and engineers who are looking for applications of their technology in the field of security documents, from brand protection to personal identification. It is likely to be of particular interest to those with a background in visual perception, mobile imaging, and image processing as these will figure as potential application areas in this short course.

*Alan has 35 years' experience in imaging science and printing, initially from the photography industry. Working on holography and scientific imaging he made the transition to digital imaging through astrophotography, conservation and security printing. He recently spent seven years at 3M, specializing in print solutions for high security documents such as passports and identity cards. He has since returned to his consultancy business, working on projects that include security, imaging, and printed electronics applications. Alan has a BSc in colour chemistry and a PhD in instrumentation, both from the department of chemistry at the University of Manchester. After a 30 year gap he has returned to the university as a Visiting Academic, investigating technology opportunities for secure documents. He is immediate Past President of IS&T and a Fellow of The Royal Photographic Society.*

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**EI05: Advanced Image Enhancement and Deblurring**

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**Instructor:** Majid Rabbani, Consultant (United States)

**8:00 am – 12:15 pm (4 hours)**

**Course Level:** Advanced

**Fee:** Member fee\*: \$260 / Non-member fee: \$290 / Student fee: \$90  
\*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

This course explains some of the advanced algorithms used for contrast enhancement, noise reduction, and sharpening and deblurring of still images and video. Applications include consumer and professional imaging, medical imaging, forensic imaging, surveillance, and astronomical imaging. Many image examples complement the technical descriptions.

**Benefits:**

- Understand advanced algorithms used for contrast enhancement such as CLAHE, Photoshop Shadows/Highlights, and Dynamic Range Compression (DRC).
- Understand advanced techniques used in image sharpening such as advanced variations of nonlinear unsharp masking, etc.
- Understand recent advancements in image noise removal, such as bilateral filtering and nonlocal means.
- Understand how motion information can be utilized in image sequences to improve the performance of various enhancement techniques.
- Understand Wiener filtering and its variations for performing image deblurring (restoration).

**Intended Audience:** Scientists, engineers, and technical managers who need to understand and/or apply the techniques employed in digital image processing in various products in a diverse set of applications such as medical imaging, professional and consumer imaging, forensic imaging, etc. will benefit from this course. Some knowledge of digital filtering (convolution) and frequency decomposition is necessary for understanding the deblurring concepts.

*Majid Rabbani has 35 years of experience in digital imaging. After a 33-year career at Kodak Research labs, he retired in 2016 with the rank of Kodak Fellow. Currently, he is a visiting professor at Rochester Institute of Technology (RIT). He is the co-recipient of the 2005 and 1988 Kodak C. E. K. Mees Awards and the co-recipient of two Emmy Engineering Awards (1990 and 1996). He has 44 issued US patents and is the co-author of the book Digital Image Compression Techniques published in 1991 and the creator of six video/CDROM courses in the area of digital imaging. Rabbani is a Fellow of SPIE and IEEE and a Kodak Distinguished Inventor. He has been an active educator in the digital imaging community for the past 30 years.*

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**EI06: Fundamentals of Deep Learning**

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**Instructor:** Raymond Ptucha, Rochester Institute of Technology (United States)

**8:00 am – 12:15 pm (4 hours)**

**Course Level:** Intermediate. Basic machine learning exposure and prior experience programming using a scripting language helpful.

**Fee:** Member fee\*: \$260 / Non-member fee: \$290 / Student fee: \$90  
\*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

Deep learning has been revolutionizing the machine learning community winning numerous competitions in computer vision and pattern recognition. Success in this space spans many domains including object detection, classification, speech recognition, natural language processing, action recognition and scene understanding. In some cases, results are on par with and even

surpassing the abilities of humans. Activity in this space is pervasive, ranging from academic institutions to small startups to large corporations. This short course encompasses the two hottest deep learning fields: convolutional neural networks (CNNs) and recurrent neural networks (RNNs), and then gives attendees hands-on training on how to build custom models using popular open source deep learning frameworks. CNNs are end-to-end, learning low level visual features and classifier simultaneously in a supervised fashion, giving substantial advantage over methods using independently solved features and classifiers. RNNs inject temporal feedback into neural networks. The best performing RNN framework, Long Short Term Memory modules, are able to both remember long term sequences and forget more recent events. This short course describes what deep networks are, how they evolved over the years, and how they differ from competing technologies. Examples are given demonstrating their widespread usage in imaging, and as this technology is described, indicating their effectiveness in many applications.

There are an abundance of approaches to getting started with deep learning, ranging from writing C++ code to editing text with the use of popular frameworks. After understanding how these networks are able to learn complex systems, a hands-on portion provided by NVIDIA's Deep Learning Institute, we demonstrate usage with popular open source utilities to build state-of-the-art models. An overview of popular network configurations and how to use them with frameworks is discussed. The session concludes with tips and techniques for creating and training deep neural networks to perform classification on imagery, assessing performance of a trained network, and modifications for improved performance.

**Benefits:**

- To become familiar with deep learning concepts and applications.
- To understand how deep learning methods, specifically convolutional neural networks and recurrent neural networks work.
- To gain hands-on experience building, testing, and improving the performance of deep networks using popular open source utilities.

**Intended Audience:** The short course is intended for engineers, scientists, students, and managers interested in acquiring a broad understanding of deep learning. Prior familiarity with basics of machine learning and a scripting language are helpful.

*Raymond Ptucha is an assistant professor in computer engineering at the Rochester Institute of Technology specializing in machine learning, computer vision, robotics, and embedded control. Ptucha was a research scientist with Eastman Kodak Company for 20 years where he worked on computational imaging algorithms and was awarded 26 US patents with another 23 applications on file. He graduated from SUNY/Buffalo with a BS in computer science (1988) and a BS in electrical engineering (1989). He earned a MS in image science (2002) and PhD in computer science from RIT (2013). He was awarded an NSF Graduate Research Fellowship in 2010 and his PhD research earned the 2014 Best RIT Doctoral Dissertation Award. Ptucha is a passionate supporter of STEM education and is an active member of his local IEEE chapter and FIRST robotics organizations.*

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**EI08: 3D Imaging**

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**Instructor:** Gady Agam, Illinois Institute of Technology (United States)

**8:00 am – 12:15 pm (4 hours)**

**Course Level:** Introductory

**Fee:** Member fee\*: \$260 / Non-member fee: \$290 / Student fee: \$90  
\*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

The purpose of this course is to introduce algorithms for 3D structure inference from 2D images. In many applications, inferring 3D structure from

2D images can provide crucial sensing information. The course begins by reviewing geometric image formation and mathematical concepts that are used to describe it, and then moves to discuss algorithms for 3D model reconstruction.

The problem of 3D model reconstruction is an inverse problem in which we need to infer 3D information based on incomplete (2D) observations. We discuss reconstruction algorithms which utilize information from multiple views. Reconstruction requires the knowledge of some intrinsic and extrinsic camera parameters and the establishment of correspondence between views. Also discussed are algorithms for determining camera parameters (camera calibration) and for obtaining correspondence using epipolar constraints between views. The course introduces relevant 3D imaging software components available through the industry standard OpenCV library.

**Benefits:**

- Describe fundamental concepts in 3D imaging.
- Develop algorithms for 3D model reconstruction from 2D images.
- Incorporate camera calibration into your reconstructions.
- Classify the limitations of reconstruction techniques.
- Use industry standard tools for developing 3D imaging applications.

**Intended Audience:** Engineers, researchers, and software developers who develop imaging applications and/or use camera sensors for inspection, control, and analysis. The course assumes basic working knowledge concerning matrices and vectors.

*Gady Agam is an associate professor of computer science at the Illinois Institute of Technology. He is the director of the visual computing lab at IIT which focuses on imaging, geometric modeling, and graphics applications. He received his PhD from Ben-Gurion University in 1999.*

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### E109: Color and Calibration in Mobile Imaging Devices

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**Instructors:** Uwe Artmann, Image Engineering GmbH & Co KG (Germany) and Kevin Matherson, Microsoft Corporation (United States)

**10:15 am – 12:15 pm (2 hours)**

**Course Level:** Introductory/Intermediate

**Fee:** Member fee\*: \$165 / Non-member fee: \$195 / Student fee: \$60  
\*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

When an image is captured using a digital imaging device it needs to be rendered. For consumer cameras this processing is done within the camera and covers various steps like dark current subtraction, flare compensation, shading, color compensation, demosaicing, white balancing, tonal and color correction, sharpening, and compression. Each of these steps have a significant influence on image quality. In order to design and tune cameras, it is important to understand how color camera hardware varies as well as the methods that can be used to calibrate such variations. This course provides the basic methods describing the capture and processing of a color camera image. Participants get to examine the basic color image capture and how calibration can improve images using a typical color imaging pipeline. In the course, participants are shown how raw image data influences color transforms and white balance. The knowledge acquired in understanding the image capture and calibration process can be used to understand tradeoffs in improving overall image quality.

**Benefits:**

- Understand how hardware choices in compact cameras impact calibrations and the type of calibrations performed and how such choices can impact overall image quality.
- Describe basic image processing steps for compact color cameras.
- Understand calibration methods for mobile camera modules.

- Describe the differences between class calibration and individual module calibration.
- Understand how spectral sensitivities and color matrices are calculated.
- Describe required calibration methods based on the hardware chosen and the image processing used.
- Appreciate artifacts associated with color shading and incorrect calibrations.
- Learn about the impacts of pixel saturation and the importance of controlling it on color.
- Learn about the impact of tone reproduction on perceived color (skin tone, memory colors, etc.)

**Intended Audience:** People involved in the design and image quality of digital cameras, mobile cameras, and scanners would benefit from participation. Technical staff of manufacturers, managers of digital imaging projects, as well as journalists and students studying image technology are among the intended audience.

*Kevin J. Matherson is a director of optical engineering at Microsoft Corporation working on advanced optical technologies for consumer products. Prior to Microsoft, he participated in the design and development of compact cameras at HP and has more than 15 years of experience developing miniature cameras for consumer products. His primary research interests focus on sensor characterization, optical system design and analysis, and the optimization of camera image quality. Matherson holds a masters and PhD in optical sciences from the University of Arizona.*

*Uwe Artmann studied Photo Technology at the University of Applied Sciences in Cologne following an apprenticeship as a photographer, and finished with the German 'Diploma Engineer'. He is now CTO at Image Engineering, an independent test lab for imaging devices and manufacturer of all kinds of test equipment for these devices. His special interest is the influence of noise reduction on image quality and MTF measurement in general.*

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### E110: High-Dynamic-Range Imaging in Cameras, Displays, and Human Vision

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**Instructors:** John McCann, McCann Imaging (United States) and Alessandro Rizzi, Università degli Studi di Milano (Italy)

**10:15 am – 12:15 pm (2 hours)**

**Course Level:** To Intermediate

**Fee:** Member fee\*: \$165 / Non-member fee: \$195 / Student fee: \$60  
\*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

Recent advances in television and displays emphasize HDR technology. High-dynamic range (HDR) imaging records and displays more information than conventional imaging. Non-uniform illumination increases the range of light from a scene. HDR techniques are often associated with recording natural images, such as the Ansel Adams's Zone system. After a detailed description of the dynamic range problem in image acquisition, this course focuses on standard methods of creating and manipulating HDR images, replacing myths with measurements of scenes, camera images, and visual appearances. The course presents measurements about the limits of accurate camera acquisition (range and color) and the usable range of light for displays presented to human vision. It discusses the principles of tone rendering and the role of HDR spatial comparisons.

**Benefits:**

- Explore the history of HDR imaging.
- Understand dynamic range and quantization: the 'salame' metaphor.
- Compare single and multiple-exposures for scene capture.
- Measuring optical limits in acquisition and visualization.

- Discover relationships between HDR range and scene dependency; the effect of glare.
- Discuss the limits of RAW scene capture in LDR and normal scenes.
- Learn about techniques to verify reciprocity and linearity limits.
- Learn about scene dependent glare in RAW image capture.
- Explore the limits of our vision system on HDR.
- Calculate retinal luminance.
- Identify tone-rendering problems and spatial methods.
- Review recent advances in HDR television and cinema.

**Intended Audience:** Students, color scientists, imaging researchers, medical imagers, software and hardware engineers, photographers, cinematographers, and production specialists interested in using HDR in imaging applications.

*Alessandro Rizzi has studied the field of digital imaging and vision since 1990. His main research topic is the use of color information in digital images with particular attention to color perception mechanisms. He is a full professor at the Dept. of Computer Science at University of Milano teaching fundamentals of digital imaging and colorimetry. He is one of the founders of the Italian Color Group and member of several program committees of conferences related to color and digital imaging.*

*John McCann received a degree in biology from Harvard College (1964). He worked in, and managed, the Vision Research Laboratory at Polaroid from 1961 to 1996. He has studied human color vision, digital image processing, large format instant photography, and the reproduction of fine art. His publications and patents have studied Retinex theory, color constancy, color from rod/cone interactions at low light levels, appearance with scattered light, and HDR imaging. He is a Fellow of IS&T and the Optical Society of America (OSA). He is a past President of IS&T and the Artists Foundation, Boston. He is the IS&T/OSA 2002 Edwin H. Land Medalist and IS&T 2005 Honorary Member.*

**NEW for 2017 E12: Psychophysics Lab: In Depth and Step-by-Step**

**Instructor:** Stephen Viggiano, RIT School of Photographic Arts and Sciences (United States)

**10:15 am – 12:15 pm (2 hours)**

**Course Level:** Introductory

**Fee:** Member fee\*: \$165 / Non-member fee: \$195 / Student fee: \$60 \*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

Learn how to use human observations to assess image quality and get hands-on experience doing it. After an introduction/review of psychometric image preference assessment, complete step-by-step instructions will be given for two different types of experiments. A hands-on experience is the focus of the tutorial. Rank-order and graphical scaling image preference experiments are conducted and analyzed using ordinary spreadsheet software. Error bars are computed and range tests run so that the stimuli may be placed in groups not statistically significantly different from each other.

**Benefits:**

- Construct an image preference scale from rank-order and graphical scaling experiments.
- Establish statistical significance between different alternatives.
- Understand results of these type experiments presented by others.
- Recognize the advantages (and disadvantages) of these experiment types over other methods.
- Avoid pitfalls in older analysis methods.

**Intended Audience:** The course assumes no prior experience with psychometric-based image preference/quality assessment, so those new to psychometrics can expect to understand the material; all that's assumed is a passing familiarity (perhaps from a previous life) with basic statistics. However, because the focus is on the hands-on activities, even those familiar with psychometrics who wish to bring their knowledge up to date are encouraged to attend. If you're using paired comparison and want to learn a faster, more efficient way, or if you've tried rank-order in the past but are unfamiliar with modern analysis techniques, or have been wary of unreasonable assumptions (which are avoided in this modern analysis protocol), you should attend this tutorial. Scientific, engineering, and marketing personnel will all benefit from this hands-on experience.

*J. A. Stephen Viggiano, PhD, is assistant professor in photographic sciences at Rochester Institute of Technology's School of Photographic Arts and Sciences, and was Principal and Founder of Acolyte Color Research, a consulting and research firm specializing in solutions to problems in color science and technology. Viggiano has taught statistics at RIT's School of Mathematical Sciences and graduate faculty at RIT's School of Printing Management and Sciences. He was employed by RIT Research Corporation until its closing in 2001, where he had risen to the position of Principal Imaging Scientist. He has presented this workshop as part of graduate-level courses at RIT, as well as for corporate and government clients.*

**NEW for 2017 E13: Real-time and Parameter-Free Anomaly Detection from Image Streams**

**Instructor:** Bruno Costa, Ford Motor Company (United States)

**1:30 – 3:30 pm (2 hours)**

**Course Level:** Introductory/Intermediate

**Fee:** Member fee\*: \$165 / Non-member fee: \$195 / Student fee: \$90 \*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

Anomaly detection plays a very important role in many different areas nowadays. Online and real-time detection of anomalies in data streams is especially important in areas where prompt awareness and action can be crucial, such as surveillance, cyber security, industries, health and, more recently, autonomous vehicles. This short course presents a few recently introduced techniques for anomaly detection in data streams applied to different computer vision scenarios. Such techniques are based on the concepts of typicality and eccentricity of data, unsupervised learning, and on-the-fly non-parametric training.

**Benefits:**

- Overview and implementation of typicality and eccentricity data analytics,
- Unsupervised learning/clustering of data streams.
- Anomaly detection and foreign object tracking.
- Application to video streams.

**Intended Audience:** Computer scientists, electrical and computer engineers, and students.

*Bruno Costa received his PhD in electrical and computer engineering from the Federal University of Rio Grande do Norte (Brazil). He was adjunct professor at the Federal Institute of Rio Grande do Norte (Brazil) and recently joined Ford - Palo Alto as a research engineer. His recent work includes topics in the areas of machine learning, autonomous learning systems, unsupervised learning, and computer vision.*

**E114: Perceptual Metrics for Image and Video Quality in a Broader Context: From Perceptual Transparency to Structural Equivalence**

**Instructors:** Sheila Hemami, Draper (United States) and Thrasyvoulos Pappas, Northwestern University (United States)

**1:30 – 5:45 pm (4 hours)**

**Course Level:** Intermediate (Prerequisites: Basic understanding of image compression algorithms; background in digital signal processing and basic statistics: frequency-based representations, filtering, distributions.)

**Fee:** Member fee\*: \$260 / Non-member fee: \$290 / Student fee: \$90 \*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

The course examines objective criteria for the evaluation of image quality that are based on models of visual perception. The primary emphasis will be on image fidelity, i.e., how close an image is to a given original or reference image, but we will broaden the scope of image fidelity to include structural equivalence. Also discussed is no-reference and limited-reference metrics. An examination of a variety of applications with special emphasis on image and video compression is included. We examine near-threshold perceptual metrics, which explicitly account for human visual system (HVS) sensitivity to noise by estimating thresholds above which the distortion is just-noticeable, and supra-threshold metrics, which attempt to quantify visible distortions encountered in high compression applications or when there are losses due to channel conditions. The course also considers metrics for structural equivalence, whereby the original and the distorted image have visible differences but both look natural and are of equally high visual quality. This short course takes a close look at procedures for evaluating the performance of quality metrics, including database design, models for generating realistic distortions for various applications, and subjective procedures for metric development and testing. Throughout the course we discuss both the state of the art and directions for future research.

**Benefits:**

- Gain a basic understanding of the properties of the human visual system and how current applications (image and video compression, restoration, retrieval, etc.) attempt to exploit these properties.
- Gain an operational understanding of existing perceptually-based and structural similarity metrics, the types of images/artifacts on which they work, and their failure modes.
- Understand current distortion models for different applications and how they can be used to modify or develop new metrics for specific contexts.
- Understand the differences between sub-threshold and supra-threshold artifacts, the HVS responses to these two paradigms, and the differences in measuring that response.
- Understand criteria by which to select and interpret a particular metric for a particular application.
- Understand the capabilities and limitations of full-reference, limited-reference, and no-reference metrics, and why each might be used in a particular application.

**Intended Audience:** Image and video compression specialists who wish to gain an understanding of how performance can be quantified. Engineers and Scientists who wish to learn about objective image and video quality evaluation. Managers who wish to gain a solid overview of image and video quality evaluation. Students who wish to pursue a career in digital image processing. Intellectual Property and Patent Attorneys who wish to gain a more fundamental understanding of quality metrics and the underlying technologies. Government laboratory personnel who work in imaging.

*Thrasyvoulos N. Pappas received SB, SM, and PhD in electrical engineering and computer science from MIT in 1979, 1982, and 1987, respectively. From 1987 until 1999, he was a member of the technical staff at Bell Laboratories, Murray Hill, NJ. He is currently a professor in the department of electrical and computer engineering at Northwestern University, which he joined in 1999. His research interests are in image and video quality and compression, image and video analysis, content-based retrieval, perceptual models for multimedia processing, model-based halftoning, and tactile and multimodal interfaces. Pappas has served as co-chair of the 2005 SPIE/IS&T Electronic Imaging (EI) Symposium, and since 1997 he has been co-chair of the EI Conference on Human Vision and Electronic Imaging. Pappas is a Fellow of IEEE and SPIE. He is currently serving as Vice President-Publications for the Signal Processing Society of IEEE. He has also served as Editor-in-Chief of the IEEE Transactions on Image Processing (2010-12), elected member of the Board of Governors of the Signal Processing Society of IEEE (2004-06), chair of the IEEE Image and Multidimensional Signal Processing (now IMVSP) Technical Committee, and technical program co-chair of ICIP-01 and ICIP-09.*

*Sheila S. Hemami received a BSEE from the University of Michigan (1990), MSEE and PhD from Stanford University (1992 and 1994). She was most recently at Northwestern University as professor and chair of the electrical engineering and computer science department at the College of Engineering; with Hewlett-Packard Laboratories in Palo Alto, California in 1994; and with the School of Electrical Engineering at Cornell University from 1995-2013. She is currently Director, Strategic Technical Opportunities, at Draper, Cambridge, MA. Her research interests broadly concern communication of visual information from the perspectives of both signal processing and psychophysics. She was elected a Fellow of the IEEE in 2009 for contributions to robust and perceptual image and video communications. Hemami has held various visiting positions, most recently at the University of Nantes, France and at Ecole Polytechnique Fédérale de Lausanne, Switzerland. She has received numerous university and national teaching awards, including Eta Kappa Nu's C. Holmes MacDonald Award. She was a Distinguished Lecturer for the IEEE Signal Processing Society in 2010-2011, was editor-in-chief for the IEEE Transactions on Multimedia from 2008-2010. She has held various technical leadership positions in the IEEE.*

**E115: Introduction to CMOS Image Sensor Technology**

**Instructor:** Arnaud Darmont, APHESA SPRL (Belgium)

**1:30 – 5:45 pm (4 hours)**

**Course Level:** Beginner/Intermediate

**Fee:** Member fee\*: \$260 / Non-member fee: \$290 / Student fee: \$90 \*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

This short course is a good refresher for image sensor and camera design engineers but is primarily targeted for newcomers to the technology or to less technical people who need to have a better understanding of the CMOS imaging technology. The course starts from the light and light sources and follows the natural path through the imaging system until an image is available out of a camera. Lenses, microlenses, color filters, photodiodes, pixel circuits, pixel arrays, readout circuits, and analog-to-digital conversion are described in details. The description includes an analysis of the noise sources, signal-to-noise, dynamic range, and the most important formulas are provided.

**Benefits:**

- Understand the general principles of imaging (lighting, optics, sensor, and camera).
- Learn CMOS image sensor architecture.



- Understand CMOS image sensor noise sources and performance figures (signal-to-noise ratio, dynamic range).
- Understand and compare rolling and global shutters.
- Understand the key design tradeoffs.
- Learn the basics of color imaging.
- Learn the basics of photography.

**Intended Audience:** The short course is intended for engineers, scientists, students, and managers who need to acquire a beginner or intermediate level of technical knowledge about CMOS image sensor principles, architecture, and performance.

*Arnaud Darmont is owner and CEO of APHESA, a company founded in 2008 specializing in image sensor consulting, custom camera design, the EMVA1288 standard, and camera benchmarking. He holds a degree in electronic engineering from the University of Liège (Belgium). Prior to founding APHESA, he worked for more than seven years in the field of CMOS image sensors and high dynamic range imaging. He is a member of the EMVA1288 working group since 2006.*

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### EI16: 3D Video Processing Techniques for Immersive Environments

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**Instructor:** Yo-Sung Ho, Gwangju Institute of Science and Technology (Republic of Korea)

**1:30 – 5:45 pm (4 hours)**

**Course Level:** Intermediate

**Fee:** Member fee\*: \$260 / Non-member fee: \$290 / Student fee: \$90 \*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

With the emerging market of 3D imaging products, 3D video has become an active area of research and development in recent years. 3D video is the key to provide more realistic and immersive perceptual experiences than the existing 2D counterpart. There are many applications of 3D video, such as 3D movie and 3DTV, which are considered the main drive of the next-generation technical revolution. Stereoscopic display is the current mainstream technology for 3DTV, while auto-stereoscopic display is a more promising solution that requires more research endeavors to resolve the associated technical difficulties. This short course lecture covers the current state-of-the-art technologies for 3D contents generation. After defining the basic requirements for 3D realistic multimedia services, we cover various multi-modal immersive media processing technologies. Also addressed is the depth estimation problem for natural 3D scenes and several challenging issues of 3D video processing, such as camera calibration, image rectification, illumination compensation and color correction. The course discusses JCT-3V activities for 3D video coding, including depth map estimation, prediction structure for multi-view video coding, multi-view video-plus-depth coding, and intermediate view synthesis for multi-view video display applications.

**Benefits:**

- Understand the general trend of 3D video services.
- Describe the basic requirements for realistic 3D video services.
- Identify the main components of 3D video processing systems.
- Estimate camera parameters for camera calibration.
- Analyze the captured data for image rectification and illumination compensation.
- Apply image processing techniques for color correction and filtering.
- Estimate depth map information from stereoscopic and multi-view images.
- Synthesize intermediate views at virtual viewpoints.
- Review MPEG and JCT-3V activities for 3D video coding.

- Design a 3D video system to handle multi-view video-plus-depth data.
- Discuss various challenging problems related to 3D video services.

**Intended Audience:** Scientists, engineers, technicians, or managers who wish to learn more about 3D video and related processing techniques. Undergraduate training in engineering or science is assumed.

*Yo-Sung Ho has been developing video processing systems for digital TV and HDTV, first at Philips Labs in New York and later at ETRI in Korea. He is currently a professor at the school of electrical and computer engineering at Gwangju Institute of Science and Technology (GIST) in Korea, and also Director of Realistic Broadcasting Research Center at GIST. He has given several tutorial lectures at various international conferences, including the 3DTV Conference, the IEEE International Conference on Image Processing (ICIP), and the IEEE International Conference on Multimedia & Expo (ICME). He earned his PhD in electrical and computer engineering at the University of California, Santa Barbara. He has been an associate editor of IEEE Transactions on Circuits and Systems for Video Technology (TCSVT).*

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### EI17: Perception and Cognition for Imaging

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**Instructor:** Bernice Rogowitz, Visual Perspectives (United States)

**1:30 – 5:45 pm (4 hours)**

**Course Level:** Introductory/Intermediate

**Fee:** Member fee\*: \$260 / Non-member fee: \$290 / Student fee: \$90 \*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

Imaging, visualization, and computer graphics provide visual representations of data in order to communicate, provide insight and enhance problem solving. The human observer actively processes these visual representations using perceptual and cognitive mechanisms that have evolved over millions of years. The goal of this tutorial is to provide an introduction to these processing mechanisms, and to show how this knowledge can guide the decisions we make about how to represent data visually, how we visually represent patterns and relationships in data, and how we can use human pattern recognition to extract features in the data.

**Benefits:**

- Understand basic principles of spatial, temporal, and color processing by the human visual system.
- Explore basic cognitive processes, including visual attention and semantics.
- Develop skills in applying knowledge about human perception and cognition to interactive visualization and computer graphics applications.

**Intended Audience:** Imaging scientists, engineers, and application developers, and domain experts using imaging systems in their analysis of financial, medical, or other data. Students interested in understanding imaging systems from the perspective of the human user and anyone interested in how the visual world is processed by our eye-brain system.

*Bernice Rogowitz is a multidisciplinary scientist, working at the intersection of human perception, imaging, and visualization. She received her BS in experimental psychology from Brandeis University, a PhD in vision science from Columbia University, and was a post-doctoral Fellow in the Laboratory for Psychophysics at Harvard University. For many years, she was a scientist and research manager at the IBM T.J. Watson Research Center and is currently active in research and teaching through her consulting company, Visual Perspectives. Her work includes fundamental research in human color and pattern perception, novel perceptual approaches for visual data analysis and image semantics, and human-centric methods to enhance visual problem solving in medical, financial, and scientific applications. As the founder and co-chair of the IS&T Conference on Human*

*Vision and Electronic Imaging, she is a leader in defining the research agenda for human-computer interaction in imaging, driving technology innovation through research in human perception, cognition, and aesthetics. Rogowitz is a Fellow of IS&T and SPIE, a Senior Member of IEEE, and a 2015 IS&T Senior Member.*

### EI18: Camera Module Calibration for Mobile Imaging Devices

**Instructors:** Uwe Artmann, Image Engineering GmbH & Co KG (Germany) and Kevin Matherson, Microsoft Corporation (United States)

**1:30 – 5:45 pm (4 hours)**

**Course Level:** Introductory/Intermediate

**Fee:** Member fee\*: \$260 / Non-member fee: \$290 / Student fee: \$90  
\*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

Digital and mobile imaging camera and system performance is determined by a combination of sensor characteristics, lens characteristics, and image processing algorithms. Smaller pixels, smaller optics, smaller modules, and lower cost result in more part-to-part variation driving the need for calibration to maintain good image quality. This short course provides an overview of issues associated with compact imaging modules used in mobile and digital imaging. The course covers optics, sensors, actuators, camera modules and the camera calibrations typically performed to mitigate issues associated with production variation of lenses, sensor, and autofocus actuators.

#### Benefits:

- Describe illumination, photons, sensor, and camera radiometry.
- Select optics and sensor for a given application.
- Understand the optics of compact camera modules used for mobile imaging.
- Understand the difficulties in minimizing sensor and camera modules.
- Assess the need for per unit camera calibrations in compact camera modules.
- Determine camera spectral sensitivities.
- Understand autofocus actuators and why per unit calibrations are required.
- How to perform the various calibrations typically done in compact camera modules (relative illumination, color shading, spectral calibrations, gain, actuator variability, etc.).
- Equipment required for performing calibrations.
- Compare hardware tradeoffs such as temperature variation, its impact on calibration and overall influence on final quality.

**Intended Audience:** People involved in the design and image quality of digital cameras, mobile cameras, and scanners will benefit from participation. Technical staff of manufacturers, managers of digital imaging projects, as well as journalists and students studying image technology are among the intended audience.

*Kevin J. Matherson is a director of optical engineering at Microsoft Corporation working on advanced optical technologies for consumer products. Prior to Microsoft, he participated in the design and development of compact cameras at HP and has more than 15 years of experience developing miniature cameras for consumer products. His primary research interests focus on sensor characterization, optical system design and analysis, and the optimization of camera image quality. Matherson holds a masters and PhD in optical sciences from the University of Arizona.*

*Uwe Artmann studied Photo Technology at the University of Applied Sciences in Cologne following an apprenticeship as a photographer, and*

*finished with the German 'Diploma Engineer'. He is now CTO at Image Engineering, an independent test lab for imaging devices and manufacturer of all kinds of test equipment for these devices. His special interest is the influence of noise reduction on image quality and MTF measurement in general.*

### EI19: OpenVX: A Standard API for Accelerating Computer Vision

**Instructors:** Radhakrishna Giduthuri, Advanced Micro Devices (United States) and Kari Pulli, Intel Corporation (United States)

**1:30 – 5:45 pm (4 hours)**

**Course Level:** Introductory (OpenVX architecture and its relation to other related APIs) to intermediate (the practical programming aspects, requiring familiarity with C++)

**Fee:** Member fee\*: \$260 / Non-member fee: \$290 / Student fee: \$90  
\*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

OpenVX is a royalty-free open standard API released by the Khronos Group in 2014. OpenVX enables performance and power-optimized computer vision functionality, especially important in embedded and real-time use cases. The course covers both the function-based API and the graph API that enable OpenVX developers to efficiently run computer vision algorithms on heterogeneous computing architectures. A set of example algorithms from computational photography and advanced driver assistance mapped to the graph API is discussed. Also covered is the relationship between OpenVX and OpenCV, as well as OpenCL. The course includes hands-on practice session that gets the participants started on solving real computer vision problems using OpenVX.

**Benefits:** Understanding the architecture of OpenVX computer vision API, its relation to OpenCV, OpenGL, and OpenCL APIs; getting fluent in actually using OpenVX for real-time image processing and computer vision tasks.

**Intended Audience:** Engineers, researchers, and software developers who develop computer vision and machine learning applications and want to benefit from transparent HW acceleration.

*Kari Pulli is Sr. Principal Engineer at Intel. Earlier he was VP of computational imaging at Light. He was also Senior Director of Research at NVIDIA and before that, Nokia Fellow at Nokia Research center; in both places he headed a research team called Mobile Visual Computing. Pulli has a long background in standardization and at Khronos he has contributed to many mobile media standards including OpenVX. He is a frequent author and speaker at venues like CVPR and SIGGRAPH, with h-index of 27. He has a PhD from University of Washington, MBA from University of Oulu, and has taught and worked as a researcher at University of Oulu, Stanford University, and MIT.*

*Radhakrishna Giduthuri is a design engineer at Advanced Micro Devices (AMD) focusing on development of computer vision toolkit and libraries for heterogeneous compute platforms. He has extensive background with software design and performance tuning for various computer architectures ranging from General Purpose DSPs, Customizable DSPs, Media Processors, Heterogeneous Processors, GPUs, and several CPUs. He is a member of Khronos OpenVX working group representing AMD. In the past he was a member of SMPTE video compression standardizing committee for several years. He is also winner of outstanding leadership and professional services award for IEEE Central Area in 2016.*

**NEW for 2017** **EI20: Computer Vision for Autonomous Driving**

**Instructor:** Rony Ferzli, Intel Corporation (United States)

**3:45 – 5:45 pm (2 hours)**

**Course Level:** Introductory to Intermediate

**Fee:** Member fee\*: \$165 / Non-member fee: \$195 / Student fee: \$60  
\*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

Computer vision algorithms are the backbone for any autonomous driving system. These algorithms play a key role in the perception and scene understanding enabling vehicles to operate not only under normal conditions, but also to adjust for unusual situations. The goal of the course is to present building blocks or ingredients needed for autonomous vehicles scenarios (such as lane departure warning, distance estimation, vehicle detection, traffic light detection, pedestrian detection, tracking, and sign detection) using classical approaches as well as latest research using deep learning. The short course also touches on design choices related to tradeoffs between complexity, performance, and accuracy. In addition, the course focuses on ADAS platforms, SDK tools, and how these can be used to develop and test computer vision algorithms.

**Benefits:**

- Understand the ADAS challenges.
- Understand ADAS scenarios.
- Describe the latest research in computer vision related to ADAS.
- Identify available platforms and tools to start development.
- Understand the complexity of each scenario and CV algorithm selection process based on a set of criteria (quality, performance, cost, power).

**Intended Audience:** The short course is intended for engineers, scientists, and students who need to acquire technical knowledge about computer vision algorithms used in Advanced Driver Assistance Systems (ADAS) and available tools used for development.

Rony Ferzli received his BE and ME in electrical engineering from the American University of Beirut, Lebanon, (1999 and 2002, respectively). He received his PhD in electrical engineering from Arizona State University (ASU), Tempe (2007). From 2007 to 2012, he worked in the R&D Unified Communications Group at Microsoft Corp., Redmond, WA, designing next generation video codecs for video conferencing products. Ferzli joined Intel Corporation in 2012 where he is currently a platform architect engineer at the Internet of Things Group (IoTG), researching and enabling computer vision and machine learning algorithms for Intel ADAS platforms. Prior to his current role, he worked on mobile devices SOC media technologies and next generation graphics as well as developing algorithms for HDTVs pre and post processing. He has more than 50 publications and patents in research areas such as image and video processing, DSP architectures and real-time systems, neural networks, and mixed-signal design. He holds several awards such as the Intel Division Award and IEEE SPS 2015 best paper award.

**Monday, January 30, 2017**

**EI22 Introduction to Digital Color Imaging**

**Instructor:** Gaurav Sharma, University of Rochester (United States)

**8:30 am – 12:45 pm (4 hours)**

**Course Level:** Introductory

**Fee:** Member fee\*: \$260 / Non-member fee: \$290 / Student fee: \$90  
\*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

This short course provides an introduction to color science and digital color imaging systems. Foundational knowledge is introduced first via an overview of the basics of color science and perception, color representation, and the physical mechanisms for displaying and printing colors. Building upon this base, an end-to-end systems view of color imaging is presented that covers color management and color image processing for display, capture, and print. A key objective of the course is to highlight the interactions between the different modules in a color imaging system and to illustrate via examples how co-design has played an important role in the development of current digital color imaging devices and algorithms.

**Benefits:**

- Explain how color is perceived starting from a physical stimulus and proceeding through the successive stages of the visual system by using the concepts of tristimulus values, opponent channel representation, and simultaneous contrast.
- Describe the common representations for color and spatial content in images and their interrelations with the characteristics of the human visual system.
- List basic processing functions in a digital color imaging system and schematically represent a system from input to output for common devices such as a digital cameras, displays, and color printers.
- Describe why color management is required and how it is performed.
- Explain the role of color appearance transforms in image color manipulations for gamut mapping and enhancement.
- Explain how interactions between color and spatial dimensions are commonly utilized in designing color imaging systems and algorithms.
- Cite examples of algorithms and systems that break traditional cost, performance, and functionality tradeoffs through system-wide optimization.

**Intended Audience:** The short course is intended for engineers, scientists, students, and managers interested in acquiring a broad-system wide view of digital color imaging systems. Prior familiarity with basics of signal and image processing, in particular Fourier representations, is helpful although not essential for an intuitive understanding.

Gaurav Sharma is a professor of electrical and computer engineering and of computer science at the University of Rochester where his research spans signal and image processing, computer vision, color imaging, and bioinformatics. He has extensive experience in developing and applying probabilistic models in these areas. Prior to joining the University of Rochester, he was a principal scientist and project leader at the Xerox Innovation Group. Additionally, he has consulted for several companies on the development of image processing and computer vision algorithms. He holds 51 issued patents and has authored more than a 150 peer-reviewed publications. He is the editor of the Digital Color Imaging Handbook published by CRC Press and served as the Editor-in-Chief for the SPIE/IS&T Journal of Electronic Imaging from 2011 through 2015. Sharma is a fellow of IS&T, IEEE, and SPIE

**EI23: Noise Sources at the Camera Level and the Use of International Standards for its Characterization**

**Instructors:** Uwe Artmann, Image Engineering GmbH & Co KG (Germany) and Kevin Matherson, Microsoft Corporation (United States)

**10:30 am – 12:30 pm (2 hours)**

**Course Level:** Introductory to Intermediate

**Fee:** Member fee\*: \$165 / Non-member fee: \$195 / Student fee: \$60  
\*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

This short course provides an overview of noise sources associated with “light in to byte out” in digital and mobile imaging cameras. The course discusses common noise sources in imaging devices, the influence of image processing on these noise sources, the use of international

standards for noise characterization, and simple hardware test setups for characterizing noise.

**Benefits:**

- Become familiar with basic noise source in mobile and digital imaging devices.
- Learn how image processing impacts noise sources in digital imaging devices.
- Make noise measurements based on international standards: EMVA 1288, ISO 14524, ISO 15739, and visual noise measurements.
- Describe simple test setups for measuring noise based on international standards.
- Predict system level camera performance using international standards.

**Intended Audience:** People involved in the design and image quality of digital cameras, mobile cameras, and scanners would benefit from participation. Technical staff of manufacturers, managers of digital imaging projects, as well as journalists and students studying image technology are among the intended audience.

*Kevin J. Matherson is a director of optical engineering at Microsoft Corporation working on advanced optical technologies for consumer products. Prior to Microsoft, he participated in the design and development of compact cameras at HP and has more than 15 years of experience developing miniature cameras for consumer products. His primary research interests focus on sensor characterization, optical system design and analysis, and the optimization of camera image quality. Matherson holds a masters and PhD in optical sciences from the University of Arizona.*

*Uwe Artmann studied Photo Technology at the University of Applied Sciences in Cologne following an apprenticeship as a photographer, and finished with the German 'Diploma Engineer'. He is now CTO at Image Engineering, an independent test lab for imaging devices and manufacturer of all kinds of test equipment for these devices. His special interest is the influence of noise reduction on image quality and MTF measurement in general.*

### Tuesday, January 31, 2017

#### **EL24: Joint Design of Optics and Image Processing for Imaging Systems**

**Instructor:** David Stork, Rambus (United States)

**8:30 am – 12:45 pm (4 hours)**

**Course Level:** Introductory to Intermediate

**Fee:** Member fee\*: \$260 / Non-member fee: \$290 / Student fee: \$90  
\*(after January 9, 2017 prices for all courses increase by \$50, \$25 for students)

For centuries, optical imaging system design centered on exploiting the laws of the physics of light and materials (glass, plastic, reflective metal,) to form high-quality (sharp, high-contrast, undistorted,) images that "looked good." In the past several decades, the optical images produced by such systems have been ever more commonly sensed by digital detectors and the image imperfections corrected in software. The new era of electro-optical imaging offers a more fundamental revision to this paradigm, however, now the optics and image processing can be designed jointly to optimize an end-to-end digital merit function without regard to the traditional quality of the intermediate optical image. Many principles and guidelines from the optics-only era are counterproductive in the new era of electro-optical imaging and must be replaced by principles grounded on both the physics of photons and the information of bits. This short course describes the theoretical and algorithmic foundations of new methods of jointly designing the optics and image processing of electro-optical imaging systems. The course also focuses on the new concepts and approaches rather than commercial tools.

**Benefits:**

- Describe the basics of information theory.
- Characterize electro-optical systems using linear systems theory.
- Compute a predicted mean-squared error merit function.
- Characterize the spatial statistics of sources.
- Implement a Wiener filter.
- Implement spatial convolution and digital filtering.
- Make the distinction between traditional optics-only merit functions and end-to-end digital merit functions.
- Perform point-spread function engineering.
- Become aware of the image processing implications of various optical aberrations.
- Describe wavefront coding and cubic phase plates.
- Utilize the power of spherical coding.
- Compare super-resolution algorithms and multi-aperture image synthesizing systems.
- Simulate the manufacturability of jointly designed imaging systems.
- Evaluate new methods of electro-optical compensation.

**Intended Audience:** Optical designers familiar with system characterization (f#, depth of field, numerical aperture, point spread functions, modulation transfer functions,) and image processing experts familiar with basic operations (convolution, digital sharpening, information theory).

*David Stork is Distinguished Research Scientist and Research Director at Rambus Labs and a Fellow of the International Association for Pattern Recognition. He holds 40 US patents and has written nearly 200 technical publications including eight books or proceedings volumes such as Seeing the Light, Pattern Classification (2nd ed.) and HAL's Legacy. He has given more than 230 technical presentations on computer image analysis of art in 19 countries.*

## General Information

### Registration

#### Onsite Registration and Badge Pick-Up Hours

Sunday 29 January.....	7:00 am to 8:00 pm
Monday 30 January .....	7:00 am to 5:00 pm
Tuesday 31 January .....	8:00 am to 5:00 pm
Wednesday 1 February.....	8:00 am to 5:00 pm
Thursday 2 February .....	8:30 am to 5:00 pm

#### Symposium Registration

Symposium Registration Includes: Admission to all technical sessions, coffee breaks, the Symposium Reception, and support of free access to all the EI proceedings papers on the IS&T Digital Library. Separate registration fees are required for short courses.

#### Short Course Registration

Courses and workshops are priced separately. Course-only registration includes your selected course(s), course notes, coffee breaks, and admittance to the exhibition. Courses will take place in various meeting rooms at the Hyatt Regency San Francisco Airport. Room assignments are noted on the course admission tickets and distributed with registration materials.

#### Refund Information

To cover bank charges and processing fees, there is a cancellation fee of \$75 until 21 January 2017. After that date, the cancellation fee is 50% of the total plus \$75. All requests for refunds must be made in writing. No refunds will be given after 20 February 2017.

### Author/Presenter Information

#### Speaker AV Preparation

##### Conference Office

Open during Registration Hours

Each conference room has an LCD projector, screen, lapel microphone, and laser pointer. All presenters are encouraged to visit the Speaker AV Prep Room to confirm that their presentation and personal laptop is compatible with the audiovisual equipment supplied in the conference rooms. Speakers who have requested special equipment, prior to the request deadline, are asked to report to the AV Prep Room to confirm their requested equipment is available.

**No shared laptops are provided.**

### Policies

#### Granting Attendee Registration and Admission

IS&T, or their officially designated event management, in their sole discretion, reserves the right to accept or decline an individual's registration for an event. Further, IS&T, or event management, reserves the right to prohibit entry or remove any individual whether registered or not, be they attendees, exhibitors, representatives, or vendors, who in their sole opinion are not, or whose conduct is not, in keeping with the character and purpose of the event. Without limiting the foregoing, IS&T and event management reserve the right to remove or refuse entry to any attendee, exhibitor, representative, or vendor who has registered or gained access under false pretenses, provided false information, or for any other reason whatsoever that they deem is cause under the circumstances.

#### IS&T Code of Conduct/Anti-Harassment Policy

The Society for Imaging Science and Technology (IS&T; [imaging.org](http://imaging.org)) is dedicated to ensuring a harassment-free environment for everyone, regardless of gender, gender identity/expression, race/ethnicity, sexual orientation, disability, physical appearance,

## About IS&T

The Society for Imaging Science and Technology (IS&T)—the organizer of the Electronic Imaging Symposium—is an international non-profit dedicated to keeping members and other imaging professionals apprised of the latest developments in the field through conferences, educational programs, publications, and its website. IS&T encompasses all aspects of imaging, with particular emphasis on digital printing, electronic imaging, color science, sensors, virtual reality, photofinishing, image preservation, and hybrid imaging systems.

IS&T offers members:

- Free, downloadable access to more than 6,000 papers from IS&T conference proceedings via [www.ingentaconnect.com/content/ist](http://www.ingentaconnect.com/content/ist)
- A complimentary online subscription to the *Journal of Imaging Science & Technology* or the *Journal of Electronic Imaging*
- Reduced rates on products found in the IS&T bookstore, including technical books, conference proceedings, and journal subscriptions
- Reduced registration fees at all IS&T sponsored conferences—a value equal to the difference between member and nonmember rates alone—and short courses
- Access to the IS&T member directory
- Subscription to The Reporter, a quarterly newsletter
- An honors and awards program
- Networking opportunities through active participation in chapter activities and conference, program, and other committees

Contact IS&T for more information on these and other benefits.

#### IS&T

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age, language spoken, national origin, and/or religion. As an international, professional organization with community members from across the globe, IS&T is committed to providing a respectful environment where discussions take place and ideas are shared without threat of belittlement, condescension, or harassment in any form. This applies to all interactions with the Society and its programs/events, whether in a formal conference session, in a social setting, or on-line.

Harassment includes offensive verbal comments related to gender, sexual orientation, etc., as well as deliberate intimidation; stalking; harassing photography, recording, or postings; sustained disruption of talks or other events; inappropriate physical contact; and unwelcome sexual attention. Please note that the use of sexual language and/or imagery is never appropriate, including within conference talks, online exchanges, or the awarding of prizes. Participants asked to stop any harassing behavior are expected to comply immediately.

Those participating in IS&T activities who violate these or IS&T's Publications Policy may be sanctioned or expelled from the conference and/or membership without a refund at the discretion of IS&T. If you are being harassed, notice that someone else is being harassed, or have any other concerns, please contact the IS&T Executive Director or e-mail [incident.report@imaging.org](mailto:incident.report@imaging.org) immediately. Please note that all reports are kept confidential and only shared with those who "need to know"; retaliation in any form against anyone reporting an incident of harassment, independent of the outcome, will not be tolerated.

#### **Identification**

To verify registered participants and provide a measure of security, IS&T will ask attendees to present a government issued Photo ID at registration to collect registration materials. Individuals are not allowed to pick up badges for attendees other than themselves. Further, attendees may not have some other person participate in their place at any conference-related activity. Such other individuals will be required to register on their own behalf to participate.

#### **Capture and Use of a Person's Image**

By registering for an IS&T event, I grant full permission to IS&T to capture, store, use, and/or reproduce my image or likeness by any audio and/or visual recording technique (including electronic/digital photographs or videos), and create derivative works of these images and recordings in any IS&T media now known or later developed, for any legitimate IS&T marketing or promotional purpose. By registering for an IS&T event, I waive any right to inspect or approve the use of the images or recordings or of any written copy. I also waive any right to royalties or other compensation arising from or related to the use of the images, recordings, or materials. By registering, I release, defend, indemnify and hold harmless IS&T from and against any claims, damages or liability arising from or related to the use of the images, recordings or materials, including but not limited to claims of defamation, invasion of privacy, or rights of publicity or copyright infringement, or any misuse, distortion, blurring, alteration, optical illusion or use in composite form that may occur or be produced in taking, processing, reduction or production of the finished product, its publication or distribution.

#### **Payment Method**

Registrants for paid elements of the event, who do not provide a method of payment, will not be able to complete their registration. Individuals with incomplete registrations will not be able to attend the conference until payment has been made. IS&T accepts VISA, MasterCard, American Express, Discover, Diner's Club, checks and wire transfers. Onsite registrations can also pay with Cash.

#### **Audio, Video, Digital Recording Policy**

Conferences, courses, and poster sessions: For copyright reasons, recordings of any kind are prohibited without prior written consent of the presenter. Attendees may not capture nor

use the materials presented in any meeting room without written permission. Consent forms are available at Speaker Check-In. Individuals not complying with this policy will be asked to leave a given session and asked to surrender their recording media.

**Exhibition Hall:** For security and courtesy reasons, recordings of any kind are prohibited unless one has explicit permission from on-site company representatives. Individuals not complying with this policy will be asked to surrender their recording media and to leave the exhibition hall. Your registration signifies your agreement to be photographed or videotaped by IS&T in the course of normal business. Such photos and video may be used in IS&T marketing materials or other IS&T promotional items.

### ***Laser Pointer Safety Information/Policy***

IS&T supplies tested and safety-approved laser pointers for all conference meeting rooms. For safety reasons, IS&T requests that presenters use provided laser pointers. Use of a personal laser pointer represents user's acceptance of liability for use of a non-IS&T-supplied laser pointer. Laser pointers in Class II and IIIa (<5 mW) are eye safe if power output is correct, but output must be verified because manufacturer labeling may not match actual output. Misuse of any laser pointer can lead to eye damage.

### ***Underage Persons on Exhibition Floor Policy***

For safety and insurance reasons, no one under the age of 16 will be allowed in the exhibition area during move-in and move-out. During open exhibition hours, only children over the age of 12 accompanied by an adult will be allowed in the exhibition area.

### ***Unauthorized Solicitation Policy***

Unauthorized solicitation in the Exhibition Hall is prohibited. Any non-exhibiting manufacturer or supplier observed to be distributing information or soliciting business in the aisles, or in another company's booth, will be asked to leave immediately.

### ***Unsecured Items Policy***

Personal belongings should not be left unattended in meeting rooms or public areas. Unattended items are subject to removal by security. IS&T is not responsible for items left unattended.

### ***Wireless Internet Service Policy***

At IS&T events where wireless is included with your registration, IS&T provides wireless access for attendees during the conference and exhibition but cannot guarantee full coverage in all locations, all of the time. Please be respectful of your time and usage so that all attendees are able to access the internet.

Excessive usage (e.g., streaming video, gaming, multiple devices) reduces bandwidth and increases cost for all attendees. No routers may be attached to the network. Properly secure your computer before accessing the public wireless network. Failure to do so may allow unauthorized access to your laptop as well as potentially introduce viruses to your computer and/or presentation. IS&T is not responsible for computer viruses or other computer damage.

### ***Mobile Phones and Related Devices Policy***

Mobile phones, tablets, laptops, pagers, and any similar electronic devices should be silenced during conference sessions. Please exit the conference room before answering or beginning a phone conversation.

### ***Smoking***

For the health and consideration of all attendees, smoking is not permitted at any event elements, such as but not limited to: plenaries, conferences, workshops, courses, poster sessions, hosted meal functions, receptions, and in the exhibit hall. Most facilities also prohibit smoking in all or specific areas. Attendees should obey any signs preventing or authorizing smoking in specified locations.

***Hold Harmless***

Attendee agrees to release and hold harmless IS&T from any and all claims, demands, and causes of action arising out of or relating to your participation in the event you are registering to participate in and use of any associated facilities or hotels.

***Event Cancellation***

If for some unforeseen reason IS&T should have to cancel the event, registration fees processed will be refunded to registrants. Registrants will be responsible for cancellation of travel arrangements or housing reservations and the applicable fees.



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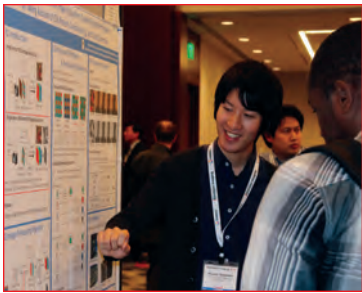
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