

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

PROCEEDINGS

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

Photography, Mobile, and Immersive Imaging 2018

Editors: **Zhen He**, Intel Corp. (United States)
Feng Li, GoPro Inc. (United States)
Jon S. McElvain, Dolby Labs., Inc. (United States)
Nitin Sampat, Rochester Institute of Technology (United States)

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Photography, Mobile, and Immersive Imaging 2018

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Radka Tezaur, Intel Corporation (United States)

Gordon Wetzstein, Stanford University (United States)

Dietmar Wueller, Image Engineering GmbH & Co. KG (Germany)

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Photography, Mobile, and Immersive Imaging 2018

Monday, January 29, 2018

Simulation for Autonomous Vehicles and Machines JOINT SESSION

Session Chairs: Peter Catrysse, Stanford Univ. (United States); Patrick Denny, Valeo Vision Systems (Ireland); and Darnell Moore, Texas Instruments (United States)

3:30 – 4:50 pm

Grand Peninsula Ballroom BC

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

3:30 PMII-161
Optimizing image acquisition systems for autonomous driving, Henryk Blasinski¹, Joyce Farrell¹, Trisha Lian¹, Zhenyi Liu^{1,2}, and Brian Wandell¹; ¹Stanford University (United States) and ²Jilin University, China

3:50 AVM-162
Large scale collaborative autonomous vehicle simulation on smartphones, Andras Kemeny^{1,2}, Emmanuel Icart³, and Florent Colombeau²; ¹Arts et Métiers ParisTech, ²Renault-Nissan, and ³Scale-1 Portal (France)

4:10 AVM-163
Assessing the correlation between human driving behaviors and fixation patterns, Mingming Wang and Susan Farnand, Rochester Institute of Technology (United States)

4:30 AVM-164
Virtual simulation platforms for automated driving: Key care-about and usage model, Prashanth Viswanath, Mihir Mody, Soyeb Nagori, Jason Jones, and Hrushikesh Garud, Texas Instruments India Ltd. (India)

Camera Image Quality I

Session Chair: Mohamed Chaker Larabi, Université de Poitiers (France)

3:30 – 4:50 pm

Regency C

4:30 PMII-172
VCX: An industry initiative to create an objective camera module evaluation for mobile devices, Dietmar Wueller¹, Uwe Artmann¹, Vijay Rao², Guenter Reif², Joerg Kramer², and Fabian Knau²; ¹Image Engineering and ²Vodafone Group Services GmbH (Germany)

5:00 – 6:00 pm All-Conference Welcome Reception

Tuesday, January 30, 2018

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

Imaging System Performance I JOINT SESSION

Session Chairs: Elaine Jin, Nvidia Corporation (United States) and Jackson Roland, Apple Inc. (United States)

8:50 – 9:30 am

Regency A-B

This session is jointly sponsored by: Image Quality and System Performance XV, and Photography, Mobile, and Immersive Imaging 2018.

8:50 PMII-182
Lessons from design, construction, and use of various multicameras, Henry Dietz, Clark Demaree, Paul Eberhart, Chelsea Kuball, and Jong Wu, University of Kentucky (United States)

9:10 PMII-183
Relative impact of key rendering parameters on perceived quality of VR imagery captured by the Facebook surround 360 camera, Nora Pfund¹, Nitin Sampat¹, and Stephen Viggiano²; ¹Rochester Institute of Technology and ²RIT School of Photographic Arts and Sciences (United States)

Keynote: Imaging System Performance JOINT SESSION

Session Chair: Elaine Jin, Nvidia Corporation (United States)

9:30 – 10:10 am

Regency A-B

This session is jointly sponsored by: Image Quality and System Performance XV, and Photography, Mobile, and Immersive Imaging 2018.

Experiencing mixed reality using the Microsoft HoloLens,

Kevin Matherson, Microsoft Corporation (United States)
Dr. 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.

IQSP-208

10:00 AM – 7:30 pm Industry Exhibition

10:10 – 10:50 am Coffee Break

Imaging Algorithms

Session Chairs: Radka Tezaur, Intel Corporation (United States) and Dietmar Wueller, Image Engineering GmbH & Co. KG (Germany)

10:50 am – 12:30 pm

Regency A-B

10:50 PMII-244 [no paper]
KEYNOTE: Manipulating image composition in post-capture (Invited),
Orazio Gallo, Nvidia Research (United States)

11:30 PMII-241
Improving the reliability of phase detection autofocus, Chin-Cheng
Chan and Homer Chen, National Taiwan University (Taiwan)

11:50 PMII-242 [no paper]
Improved depth from defocus using the spectral ratio, David Morgan-
Mar and Matthew Arnison, Canon Information Systems Research Australia
(Australia)

12:10 PMII-243 [no paper]
**Hyperspectral mapping of oral and pharyngeal cancer: Estimation of
tumor-normal margin interface using machine learning**, Alex Hegyi¹,
Chris Holsinger², and Shamik Mascharak²; ¹PARC, a Xerox company and
²Stanford University (United States)

12:30 – 2:00 pm Lunch

Plenary Session

2:00 – 3:00 pm

Grand Peninsula Ballroom D

**Fast, Automated 3D Modeling of Buildings and Other GPS Denied
Environments**, Avidesh Zakhor, University of California, Berkeley (United
States)

Professor Avidesh Zakhor discusses fast, automated 3D modeling of build-
ings and other GPS denied environments with examples from her work
in 3D reality capture, and visual and metric documentation of building
interiors. Dr. Zakhor is a serial entrepreneur with startups in outdoor map-
ping, indoor mapping, and micro-lithography, currently CEO and founder
of Indoor Reality, a Silicon Valley startup with products in 3D reality capture,
and visual and metric documentation of building interiors.

Dr. Zakhor has been faculty member at University of California, Berkeley
since 1994 where she holds the Qualcomm Chair in the electrical
engineering and computer science department. She co-founded OPC
technology in 1996, which was acquired by Mentor Graphics in 1998,
and UrbanScan Inc. in 2005, acquired by Google in 2007. UrbanScan
created the first fully automated 3D outdoor mapping system for 3D exterior
models of buildings in urban environments. She has received a number
of best paper awards in 3D computer vision, image processing, signal
processing, is an IEEE fellow, and received the presidential young investiga-
tor award in 1992. Dr. Zakhor received her BSc in electrical engineering,
from the California Institute of Technology (1983), and her MS (1985) and
PhD (1987) in electrical engineering and computer science from MIT.

3:00 – 3:30 pm Coffee Break

Imaging Systems

Session Chairs: David Morgan-Mar, Canon Information Systems Research
Australia (Australia) and Nitin Sampat, Rochester Institute of Technology
(United States)

3:30 – 4:50 pm

Regency A-B

3:30 PMII-266 [no paper]
Multi-camera systems for AR/VR and depth sensing (invited), Ram
Narayanswamy and Evan Fletcher, Occipital Inc. (United States)

3:50 PMII-267 [no paper]
IQ challenges developing Light's L16 computational camera (invited),
John Sasinowski, Light Labs (United States)

4:10 PMII-268 [no paper]
The promise of high resolution 3D imagery (invited), Paul Banks,
TetraVue (United States)

4:30 PMII-269
Light field perception enhancement for integral displays, Basel Salahieh,
Yi Wu, and Oscar Nestares, Intel Corporation (United States)

Symposium Demonstration Session

5:30 – 7:30 pm

Grand Peninsula Ballroom E

Wednesday, January 31, 2018

Keynote: Mobile HDR Imaging

Session Chairs: Zhen He, Intel Corporation (United States) and Jiangtao
Kuang, Qualcomm Technologies, Inc. (United States)

8:50 – 9:30 am

Regency A-B

PMII-291 [no paper]
Extreme imaging using cell phones, Marc Levoy, Google Inc. (United
States)

Dr. Marc Levoy is a computer graphics researcher and Professor Emeritus
of computer science and electrical engineering at Stanford University
and a principal engineer at Google. He is noted for pioneering work in
volume rendering, light fields, and computational photography. Dr. Levoy
first studied computer graphics as an architecture student under Donald P.
Greenberg at Cornell University. He received his BArch (1976) and MS
in Architecture (1978). He developed a 2D computer animation system
as part of his studies, receiving the Charles Goodwin Sands Memorial
Medal for this work. Greenberg and he suggested to Disney that they
use computer graphics in producing animated films, but the idea was
rejected by several of the Nine Old Men who were still active. Following
this, they were able to convince Hanna-Barbera Productions to use their
system for television animation. Despite initial opposition by animators,
the system was successful in reducing labor costs and helping to save the
company, and was used until 1996. Dr. Levoy worked as director of the
Hanna-Barbera Animation Laboratory from 1980 to 1983. He then did
graduate study in computer science under Henry Fuchs at the University
of North Carolina at Chapel Hill, and received his PhD (1989). While
there, he published several important papers in the field of volume
rendering, developing new algorithms (such as volume ray tracing), im-
proving efficiency, and demonstrating applications of the technique. He
joined the faculty of Stanford's Computer Science Department in 1990.
In 1991, he received the National Science Foundation's Presidential
Young Investigator Award. In 1994, he co-created the Stanford Bunny,
which has become an icon of computer graphics. He took a leave of
absence from Stanford in 2011 to work at GoogleX as part of Project
Glass. In 2014 he retired from Stanford to become full-time at Google,
where he currently leads a team in Google Research that works broadly
on cameras and photography. One of his projects is HDR+ mode for the
Nexus and Google Pixel smartphones. In 2016 the French agency DxO
gave the Pixel the highest rating ever given to a smartphone camera. See
more https://en.wikipedia.org/wiki/Marc_Levoy.

Mobile HDR Imaging

Session Chairs: Zhen He, Intel Corporation (United States) and Jiangtao Kuang, Qualcomm Technologies, Inc. (United States)

9:30 – 10:10 am

Regency A-B

9:30

PMII-311

Overview of state-of-the-art algorithms for stack-based high-dynamic range (HDR) imaging (invited), Pradeep Sen, University of California, Santa Barbara (United States)

9:50

PMII-312 [no paper]

Deep high dynamic range imaging of dynamic scenes (invited), Ravi Ramamoorthi, University of California, San Diego (United States)

10:00 am – 4:00 pm Industry Exhibition

10:10 – 10:40 am Coffee Break

Keynote: Immersive Imaging JOINT SESSION

Session Chair: Gordon Wetzstein, Stanford Univ. (United States)

10:40 – 11:20 am

Grand Peninsula Ballroom D

This session is jointly sponsored by: The Engineering Reality of Virtual Reality 2018, Photography, Mobile, and Immersive Imaging 2018, and Stereoscopic Displays and Applications XXIX.

PMII-320 [no paper]

Real-time capture of people and environments for immersive computing, Shahram Izadi, perceptivIO, Inc. (United States)

Dr. Shahram Izadi is co-founder and CTO of perceptivIO, a new Bay Area startup working on bleeding-edge research and products at the intersection of real-time computer vision, applied machine learning, novel displays, sensing, and human-computer interaction. Prior to perceptivIO, Dr. Izadis was a research manager at Microsoft, managing a team of researchers and engineers, called Interactive 3D Technologies, working on moonshot projects in the area of augmented and virtual reality and natural user interfaces.

Immersive Imaging JOINT SESSION

Session Chair: Gordon Wetzstein, Stanford Univ. (United States)

11:20 am – 12:40 pm

Grand Peninsula Ballroom D

This session is jointly sponsored by: The Engineering Reality of Virtual Reality 2018, Photography, Mobile, and Immersive Imaging 2018, and Stereoscopic Displays and Applications XXIX.

11:20

PMII-350 [no paper]

SpinVR: Towards live-streaming 3D virtual reality video, Donald Dansereau, Robert Konrad, Aniq Masood, and Gordon Wetzstein, Stanford University (United States)

11:40

PMII-351 [no paper]

Towards a full parallax cinematic VR system, Haricharan Lakshman, Dolby Labs (United States)

12:00

PMII-352

Towards perceptual evaluation of six degrees of freedom virtual reality rendering from stacked omnistereo representation, Jayant Thatte and Bernd Girod, Stanford University (United States)

12:20

PMII-353

Image systems simulation for 360° camera rigs, Trisha Lian, Joyce Farrell, and Brian Wandell, Stanford University (United States)

Camera Image Quality II

Session Chair: Mylène Farias, University of Brasilia (Brazil)

10:50 am – 12:10 pm

Regency C

11:50

PMII-344

Statistic analysis of millions of digital photos 2018, Dietmar Wueller¹ and Reiner Fogeth²; ¹Image Engineering GmbH & Co. KG and ²CEWE Stiftung & Co. KGaA (Germany)

12:40 – 2:00 pm Lunch

Plenary Session

2:00 – 3:00 pm

Grand Peninsula Ballroom D

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

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

3:00 – 3:30 pm Coffee Break

Panel: Immersive Imaging

Panel Moderator: Nitin Sampat, Rochester Institute of Technology (United States)

3:30 – 4:50 pm

Regency A-B

Photography, Mobile, and Immersive Imaging 2018 Interactive (Poster) Papers Session

5:30 – 7:00 pm

The Grove

The following works will be presented at the EI 2018 Symposium Interactive Papers Session.

PMII-409

Multispectral, high dynamic range, time domain continuous imaging, Henry Dietz, Paul Eberhart, and Clark Demaree, University of Kentucky (United States)

PMII-245
Texture enhancement via high-resolution style transfer for single-image super-resolution, Il Jun Ahn and Woo Hyun Nam, Samsung Electronics Co. Ltd. (Republic of Korea)

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

5:30 – 7:30 pm
The Grove

Thursday, February 1, 2018

Keynote: Imaging Sensors and Technologies for Automotive Intelligence JOINT SESSION

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

8:50 – 9:30 am
Grand Peninsula Ballroom BC

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

PMII-415 [no paper]

Advances in automotive image sensors, Boyd Fowler¹ and Johannes Solhusvik²; ¹OmniVision Technologies (United States) and ²OmniVision Technologies Europe Design Center (Norway)
Dr. Boyd Fowler joined OmniVision in December 2015 as the vice president of marketing and was appointed chief technology officer in July 2017. Dr. Fowler's research interests include CMOS image sensors, low noise image sensors, noise analysis, data compression, and machine learning and vision. Prior to joining OmniVision, he was co-founder and vice president of engineering at Pixel Devices, where he focused on developing high-performance CMOS image sensors. After Pixel Devices was acquired by Agilent Technologies, Dr. Fowler was responsible for advanced development of commercial CMOS image sensor products. In 2003, Dr. Fowler joined Fairchild Imaging as the CTO and vice president of technology, where he developed SCMOS image sensors for high-performance scientific applications. After Fairchild Imaging was acquired by BAE Systems, Dr. Fowler was appointed the technology director of the CCD/CMOS image sensor business. He has authored numerous technical papers, book chapters, and patents. Dr. Fowler received his MSEE and PhD in electrical engineering from Stanford University (1990 and 1995 respectively).

Imaging Sensors and Technologies for Automotive Intelligence JOINT SESSION

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

9:30 – 9:50 am
Grand Peninsula Ballroom BC

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

9:30 IMSE-422
Partial reset HDR image sensor with improved fixed pattern noise performance, Volodymyr Seliuchenko^{1,2}, Sharath Patil^{1,3}, Marcelo Mizuki¹, Saad Ahmad¹, and Maarten Kuijk²; ¹Melexis (Belgium), ²Vrije University Brussel (Belgium), and ³University of Massachusetts Lowell (United States)

9:50 – 10:50 am Coffee Break

Camera Image Processing JOINT SESSION

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

10:50 am – 12:10 pm
Grand Peninsula Ballroom BC

This session is jointly sponsored by: Image Processing: Algorithms and Systems XVI, and Photography, Mobile, and Immersive Imaging 2018.

10:50 IPAS-439
Color interpolation algorithm for the Sony-RGBW color filter array, Jonghyun Kim and Moon Gi Kang, Yonsei University (Republic of Korea)

11:10 IPAS-440
High dynamic range imaging with a single exposure-multiplexed image using smooth contour prior, Mushfiqur Rouf and Rabab Ward, University of British Columbia (Canada)

11:30 IPAS-441
Enhancement of underwater color images by two-side 2-D quaternion discrete Fourier transform, Artyom Grigoryan¹, Aparna John¹, and Sos Aghaian²; ¹University of Texas at San Antonio and ²City University of New York/CSI (United States)

11:50 PMII-442
An automatic tuning method for camera denoising and sharpening based on a perception model, Weijuan Xi¹, Huanzhao Zeng², and Jonathan Phillips²; ¹Purdue University and ²Google Inc. (United States)