IS&T International Symposium on

Electronic Imaging

SCIENCE AND TECHNOLOGY

PROCEEDINGS

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Image Quality and System Performance XV

Editors: **Elaine Jin,** NVIDIA Corporation (United States);
Stuart Perry, University of Technology Sydney (Australia)

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Image Quality and System Performance XV

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Introduction

We live in a visual world. The perceived quality of images is of crucial importance in industrial, medical, and entertainment 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 and autonomous vehicles bring image processing into new aspects of society.

The power of imaging rests directly on the visual quality of the images and the performance of the systems that produce them. As the images are generally intended to be viewed by humans, a deep understanding of human visual perception is key 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 specify the requirements and assess the performance of modern imaging systems. It focuses on 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, virtual, mixed or augmented reality, LDR or HDR.

— Elaine Jin and Stuart Perry

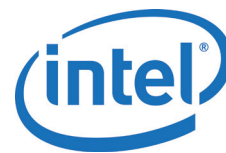**IQSP XV thanks Conference Sponsors**

Image Quality and System Performance XV

Monday, January 29, 2018

Automotive Camera Image Quality I `JOINT SESSION`

Session Chairs: Stuart Perry, University of Technology Sydney (Australia) and Buyue Zhang, Intel Corporation (United States)

8:50 – 10:20 am
Grand Peninsula Ballroom BC

This session is jointly sponsored by: Autonomous Vehicles and Machines 2018, and Image Quality and System Performance XV.

8:50   AVM-105
Fundamental imaging system analysis for autonomous vehicles, *Robin Jenkin, NVIDIA Corp. (United States)*

9:20   AVM-106
Optimizing automotive cameras for image quality, *Felix Heide and Dave Tokic, Algolux (Canada)*

9:40   IQSP-107
Color calibration of digital still cameras used on unmanned aerial vehicles, *Susan Farnand[1] and Ken Parulski[2]; [1]Rochester Institute of Technology and [2]aKAP Innovation, LLC (United States)*

10:00   IQSP-108
No reference prediction of quality metrics for H.264 compressed infrared image sequences for UAV applications, *Kabir Hossain, Claire Mantel, and Søren Forchhammer, Technical University of Denmark (Denmark)*

10:20 – 10:50 am   Coffee Break

Automotive Camera Image Quality II `JOINT SESSION`

Session Chairs: Luke Cui, Amazon (United States) and Darnell Moore, Texas Instruments (United States)

10:50 am – 12:40 pm
Grand Peninsula Ballroom BC

This session is jointly sponsored by: Autonomous Vehicles and Machines 2018, and Image Quality and System Performance XV.

10:50   AVM-145
P2020 - standard for automotive system image quality, *Patrick Denny, Valeo Vision Systems (Ireland)*

11:20   AVM-146
LED flicker: Root cause, impact and measurement for automotive imaging applications, *Brian Deegan, Valeo Vision Systems (Ireland)*

11:40   AVM-147
Visual quality evaluation of the multi-camera visualization in automotive surround view systems, *Vladimir Zlokolica[1,2], Mark Griffin[1], Aidan Casey[1], Daniela Solera[1], Brian Deegan[1], Patrick Denny[1], and Barry Dever[1]; [1]Valeo Vision Systems (Ireland) and [2]University of Novi Sad (Serbia)*

12:00   AVM-148
Detection probabilities: Performance prediction for sensors of autonomous vehicles, *Marc Geese, Ulrich Seger, and Alfredo Paolillo, Robert Bosch GmbH - Leonberg (Germany)*

12:20   AVM-149
Realistic image degradation with a measured PSF, *Christian Wittpahl, Hatem Ben Zakour, Matthias Lehmann, and Alexander Braun, Düsseldorf University of Applied Sciences (Germany)*

12:40 – 2:00 pm   Lunch

Plenary Session

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

Overview of Modern Machine Learning and Deep Neural Networks - Impact on Imaging and the Field of Computer Vision, *Greg Corrado, Google, Inc. (United States)*

Dr. Greg Corrado, co-founder of Google Brain, principal scientist, and director of augmented intelligence research at Google, provides an overview of modern machine learning and deep neural networks, with particular attention to its impact on imaging and the field of computer vision.

Dr. Corrado is a senior research scientist interested in biological neuroscience, artificial intelligence, and scalable machine learning. He has published in fields ranging across behavioral economics, neuromorphic device physics, systems neuroscience, and deep learning. At Google he has worked for some time on brain inspired computing, and most recently has served as one of the founding members and the co-technical lead of Google's large scale deep neural networks project. Prior to joining Google, Dr. Corrado was a staff research scientist at IBM. He received his MS in computer science and PhD in neuroscience from Stanford University.

3:00 – 3:30 pm   Coffee Break

Camera Image Quality I

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

3:30 – 4:50 pm
Regency C

3:30   IQSP-169
Measuring the impact of flare light on dynamic range, *Norman Koren, Imatest LLC (United States)*

3:50   IQSP-170
Quantitative measurement of contrast, texture, color, and noise for digital photography of high dynamic range scenes, *Gabriele Facciolo, Gabriel Pacianotto, Martin Renaudin, Clément Viard, and Frédéric Guichard , DxOMark Image Labs (France)*

4:10   IQSP-171
Camera resolution and distortion: Advanced edge fitting, *Peter Burns[1] and Don Williams[2]; [1]Burns Digital Imaging and [2]Image Science Associates (United States)*

4:30   PMII-172
VCX: An industry initiative to create an objective camera module evaluation for mobile devices, *Dietmar Wueller, Image Engineering GmbH & Co. KG (Germany)*

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

Tuesday, January 30, 2018

7:15 – 8:45 pm   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 Pfund[1], Nitin Sampat[1], and Stephen Viggiano[2]; [1]Rochester Institute of Technology and [2]RIT 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.

IQSP-208

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.

10:00 am – 7:30 pm   Industry Exhibition
10:10 – 10:50 am   Coffee Break

Imaging System Performance II

Session Chair: Frans Gaykema, Océ Technologies (Netherlands)

10:50 am – 12:30 pm
Regency C

10:50   IQSP-231

Bridging the gap between imaging performance and image quality measures, *Edward Fry[1], Sophie Triantaphillidou[1], Ralph Jacobson[1], John Jarvis[1], and Robin Jenkin[2]; [1]University of Westminster (United Kingdom) and [2]NVIDIA Corporation (United States)*

11:10   IQSP-232

The benefits of color over black-and-white images in task-oriented reconnaissance applications, *Cicely DiPaulo and Lawrence Scarff, UTC Aerospace Systems (United States)*

11:30   IQSP-233

Using the immersive methodology to assess the quality of videos transmitted in UDP and TCP-based scenarios, *Helard Becerra Martinez and Mylène C.Q. Farias, University of Brasilia (Brazil)*

11:50   IQSP-234

Perceptual strengths of video impairments that combine blockiness, blurriness, and packet-loss artifacts, *Alexandre Fieno da Silva[1] and Mylène C.Q. Farias[2]; [1]Federal Institute of Triangulo Mineiro and [2]University of Brasília (Brazil)*

12:10   IQSP-235

Assessing the quality of video conferencing: From quality of service to quality of communication, *Muhammad Shahid, Mekides Assefa Abebe, and Jon Yngve Hardeberg, Norwegian University of Science and Technology (Norway)*

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, *Avideh Zakhor, University of California, Berkeley (United States)*

Professor Avideh Zahkor discusses fast, automated 3D modeling of buildings 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 mapping, 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 investigator 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

Keynote: Imaging and Astronomy, Prof. Joel Primack Joint Session
Session Chairs: Susan Farnand, Rochester Institute of Technology
(United States) and Kurt Niel, University of Applied Sciences Upper
Austria (Austria)

3:30 – 4:30 pm
Cypress B

*This session is jointly sponsored by: Color Imaging XXIII: Displaying,
Processing, Hardcopy, and Applications, and Image Quality and
System Performance XV.*

COLOR-259

**Computer vision and deep learning applied to simulations and
imaging of galaxies and the evolving universe,** *Joel Primack,
University of California, Santa Cruz (United States)*

*The keynote speaker is Dr. Joel R. Primack, Distinguished Professor
of Physics Emeritus, University of California, Santa Cruz. Dr. Primack
specializes in the formation and evolution of galaxies and the nature of
the dark matter that makes up most of the matter in the universe. After
helping to create what is now called the "Standard Model" of particle
physics, Dr. Primack began working in cosmology in the late 1970s,
and he became a leader in the new field of particle astrophysics. His
1982 paper proposed that a natural candidate for the dark matter is
the lightest supersymmetric particle, still perhaps the leading candidate.
He is one of the principal originators and developers of the theory
of Cold Dark Matter, which has become the basis for the standard
modern picture of structure formation in the universe. With support from
NASA, NSF, and DOE, he has been using supercomputers to simulate
and visualize the evolution of the universe and the formation of galaxies
under various assumptions, and comparing the predictions of these
theories to the latest observational data. He organized and led the
University of California systemwide Center for High-Performance Astro-
Computing, 2010-2015. Dr. Primack was one of the main advisors
for the Smithsonian Air and Space Museum's 1996 IMAX film Cosmic
Voyage, and he has worked with leading planetariums to help make
the invisible universe visible.*

Imaging and Astronomy Afternoon Session Joint Session
Session Chairs: Susan Farnand, Rochester Institute of Technology (United
States) and Alessandro Rizzi, Università degli Studi di Milano (Italy)

4:30 – 5:10 pm
Cypress B

*This session is jointly sponsored by: Color Imaging XXIII: Displaying,
Processing, Hardcopy, and Applications, and Image Quality and System
Performance XV.*

4:30   COLOR-285
About color correction in astrophotography, *Alessandro Rizzi, Daniele
Marini, and Cristian Bonanomi, Università degli Studi di Milano (Italy)*

4:50   SD&A-286
TileViz: Tile visualization for astro-chemistry, *Martial Mancip[1], Riccardo
Spezia[1,2], Yannick Jeanvoine[2], and Cécile Balsier[1]; [1]CNRS and [2]Université
d'Evry Val d'Essonnes (France)*

Imaging and Astronomy Discussion Joint Session
Session Chairs: Susan Farnand, Rochester Institute of Technology
(United States) and Daniele Marini, Università degli Studi di Milano
(Italy)

5:10 – 5:30 pm
Cypress B

*This session is jointly sponsored by: Color Imaging XXIII: Displaying,
Processing, Hardcopy, and Applications, and Image Quality and
System Performance XV.*

Symposium Demonstration Session

5:30 – 7:30 pm
Grand Peninsula Ballroom E

Wednesday, January 31, 2018

Machine Learning and Image Quality

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

8:50 – 10:00 am
Regency C

8:50   IQSP-298
A neural-based stereoscopic image quality assessment with reference,
Aladine Chetouani, University of Orléans (France)

9:10   IQSP-299
**Advantages of incorporating perceptual component models into a
machine learning framework for prediction of display quality,** *Anustup
Choudhury and Scott Daly, Dolby Laboratories, Inc. (United States)*

9:30   IQSP-300 [no paper]
NIMA: Neural image assessment, *Hossein Talebi and Peyman Milanfar,
Google Research (United States)*

10:00 am – 4:00 pm   Industry Exhibition

10:00 – 10:50 am   Coffee Break

Camera Image Quality II

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

10:50 am – 12:10 pm
Regency C

10:50   IQSP-340
Image quality benchmark of computational bokeh, *Wolf Hauser,
Balthazar Neveu, Jean-Benoit Jourdain, Clément Viard, and Frédéric
Guichard, DxOMark Image Labs (France)*

11:10   IQSP-341
Measurement of noise using the dead leaves pattern, *Uwe Artmann,
Image Engineering GmbH & Co. KG (Germany)*

11:30   IQSP-342
**Development of a perceptually calibrated objective metric for auto
white balance,** *Elaine Jin[1], Yixuan Wang[2] and Wentao Liu[3]; [1]NVIDIA
Corporation (United States), [2]Apple Inc. (United States), and [3]University of
Waterloo (Canada)*

11:50   PMII-344

Statistic analysis of millions of digital photos 2018, *Dietmar Wueller[1] and Reiner Fageth[2]; [1]Image Engineering GmbH & Co. KG and [2]CeWe (Germany)*

12:10 – 2:00 pm   Lunch

Plenary Session

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

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

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

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

3:00 – 3:30 pm   Coffee Break

Image Quality Modeling

Session Chair: Peter Burns, Burns Digital Imaging (United States)

3:30 – 4:50 pm
Regency C

3:30   IQSP-365

Image quality loss and compensation for visually impaired observers, *Sophie Triantaphillidou[1], Edward Fry[1], Vicent Sanchis-Jurado[2], and Álvaro Pons[2]; [1]University of Westminster (United Kingdom) and [2]University de Valencia (Spain)*

3:50   IQSP-366

A full-reference image quality assessment metric for 3D synthesized views, *Shishun Tian, Lu Zhang, Luce Morin, and Olivier Déforges, Institut National des Sciences Appliquées de Rennes (France)*

4:10   IQSP-367

No-reference image quality assessment using salient local binary patterns, *Pedro Garcia Freitas, Welington Yorihiko Lima Akamine, and Mylène C.Q. Farias, University of Brasília (Brazil)*

4:30   IQSP-368

Quality assessment of out-of-focus blurred images based on objects depth ordering and saliency, *Sid Ahmed Fezza[1] and Mohamed Chaker Larabi[2]; [1]National Institute of Telecommunications and ICT (Algeria) and [2]Université de Poitiers (France)*

Image Quality Panel
Panel Moderator: Robin Jenkin, NVIDIA Corporation (United States)

4:50 – 5:30 pm
Regency C

Image Quality and System Performance XV 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.

IQSP-405

Smartphone calibration for crowd-sourced determination of the presence of cyanobacteria in water samples, *Katherine Carpenter, Anthony Vodacek, and Susan Farnand, Rochester Institute of Technology (United States)*

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

5:30 – 7:30 pm
The Grove