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Electronic Imaging
SCIENCE AND TECHNOLOGY

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PROCEEDINGS

Image Quality and System Performance XIV

Editors: **Robin Jenkin,** ON Semiconductor Corp. (United States);
Elaine Jin, Google Inc. (United States)

These papers represent the program of Electronic Imaging 2017,
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Society for Imaging Science and Technology
7003 Kilworth Lane • Springfield, VA 22151 USA
703/642-9090; 703/642-9094 fax
info@imaging.org; www.imaging.org

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Image Quality and System Performance XIV

Introduction

Imaging is omnipresent in modern life. From the images captured and displayed on smart phones, to those used by automotive systems to control cars. The objective and subjective quality of images is of crucial importance in industrial, medical, automotive and entertainment 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 understanding the quality of the images and the systems that produce them whether intended for consumption by humans or machine vision algorithms.

IQSP brings together engineers and scientists from industry and academia, who strive to understand what constitutes 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 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.

The fourteenth year of Image Quality and System Performance has brought together a rich program including two keynote speakers: Dr Anil Kokaram, Google USA, on Automated Video Quality Measurement and Application, and Dr Elaine Jin, Google USA, reporting on the work of the IEEE P1858 CPIQ Standard. Technical sessions focus on topics including no reference quality measurement, machine learning, MTF and systems measurements, print and display quality as well as novel tools.

— Robin Jenkin and Elaine Jin

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Image Quality and System Performance XIV

Monday January 30, 2017

No Reference Quality Measurement

Session Chair: Robin Jenkin, ON Semiconductor (United States)

8:50 – 10:10 AM
Harbour

8:50 7
Blind image quality assessment using multiscale local binary patterns (JIST-first), *Pedro Garcia Freitas, Welington Y.L. Akamine, and Mylène C.Q. Farias, University of Brasilia (Brazil)* [IQSP-218]

9:10 15
Dimension reduction-based attributes selection in no-reference learning-based image quality algorithms, *Christophe Charrier[1], Abdelhakim Saadane[2], and Christine Fernandez Maloigne[3]; [1]Normandie University, [2]Université de Nantes, and [3]Université de Poitiers (France)* [IQSP-219]

9:30 21
GPGPU based implementation of a high performing No Reference (NR)- IQA algorithm, BLIINDS-II, *Aman Yadav[1], Sohum Sohoni[1], and Damon Chandler[2]; [1]Arizona State University (United States) and [2]Shizuoka University (Japan)* [IQSP-220]

9:50 26
No-reference image contrast assessment based on just-noticeable-difference, *Minsub Kim, Ki Sun Song, and Moon Gi Kang, Yonsei University (Republic of Korea)* [IQSP-221]

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 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 CCts 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 30
MS-UNIQUE: Multi-model and sharpness-weighted unsupervised image quality estimation, *Mohit Prabhushankar, Dogancan Temel, and Ghassan AlRegib, Georgia Institute of Technology (United States)* [IQSP-223]

11:50 36
Microarchitectural analysis of a GPU implementation of the most apparent distortion image quality assessment algorithm, *Vignesh Kannan[1], Joshua Holloway[1], Sohum Sohoni[1], and Damon Chandler[2]; [1]Arizona State University (India) and [2]Shizuoka University (Japan)* [IQSP-224]

12:10 42
Image quality assessment by comparing CNN features between images (JIST-first), *Seyed Ali Amirshahi[1], Marius Pedersen[2], and Stella X. Yu[1]; [1]University of California, Berkeley (United States) and [2]Norwegian University of Science and Technology (Norway)* [IQSP-225]

12:30 – 2:00 PM Lunch Break

3:00 – 3:30 PM Coffee 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-bandwith-time product.

Novel Tools

Session Chair: Luke Cui, Amazon (United States)

3:30 – 4:50 PM
Harbour

3:30 52
Potential contrast - A new image quality measure, *Arie Shaus, Shira Faigenbaum-Golovin, Barak Sober, and Eli Turkel, Tel Aviv University (Israel)* [IQSP-226]

3:50 59
Observer calibrator for color vision research, *Zhen Zhou, Ben Grotton, Kevin Kruse, Alex Skinner, Antonio DoVale, Susan Farnand, Mark Fairchild* [IQSP-227]

4:10 64
Knowledge based taxonomic scheme for full reference objective image quality measurement models (JIST-first), *Atidel Lahoulou[1], Mohamed Chaker Larabi[2], Azeddine Beghdadi[3], Emmanuel Viennet[3], and Ahmed Bouridane[4]; [1]University of Jijel (Algeria), [2]Université de Poitiers (France), [3]Université Paris 13 (France), and [4]Northumbria University (United Kingdom)* [IQSP-228]

4:30 79
A RGB/NIR data set for evaluating dehazing algorithms, *Julia Lüthen[1], Julian Wörmann[2], Martin Kleinsteuber[2], and Johannes Steurer[1]; [1]ARRI Cinetechnik and [2]Technische University München (Germany)* [IQSP-229]

5:00 – 6:00 PM All-Conference Welcome Reception, 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.

Towards the development of the IEEE P1858 CPIQ standard – A validation study, *Elaine Jin[1], Jonathan Phillips[1], Susan Farnand[2], Margaret Belska[3], Vinh Tran[3], Ed Chang[1], Yixuan Wang[3], and Benjamin Tseng[4]; [1]Google Inc. (United States), [2]Rochester Institute of Technology (United States), [3]NVIDIA (United States), and [4]Apkudo (Australia)* [IQSP-249]

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 95
A methodology for perceptual image quality assessment of smartphone cameras – Color quality, *Susan Farnand[1], Young Jang[2], Lark Kwon Choi[2], and Chuck Han[2]; [1]Rochester Institute of Technology and [2]Qualcomm (United States)* [IQSP-250]

9:40 100
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[1], Ashley Solter[1], Fernando Voltolini de Azambuja[1], Nitin Sampat[1], Stephen Viggiano[1], Brian Rodricks[2], and Cheng Lu[3]; [1]Rochester Institute of Technology, [2]SensorSpace, LLC, and [3]Intel Corporation (United States)* [IQSP-251]

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

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

11:10 105
Reverse-projection method for measuring camera MTF, *Stan Birchfield, Microsoft Corporation (United States)* [IQSP-254]

11:30 113
Texture MTF from images of natural scenes, *Riccardo Branca[1], Sophie Triantaphillidou[1], and Peter Burns[2]; [1]University of Westminster (United Kingdom) and [2]Burns Digital Imaging (United States)* [IQSP-255]

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

12:10 121
The effects of misregistration on the dead leaves cross-correlation texture blur analysis, *Robert Sumner[1], Ranga Burada[1], and Noah Kram[2]; [1]Imatest, LLC and [2]Rochester Institute of Technology (United States)* [IQSP-257]

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

3:30 130
Towards a quantitative evaluation of multi-imaging systems, *Martin Renaudin, Anna-Cecilia Vlachomitrou, Gabriele Facciolo, Wolf Hauser,Clement Sommelet, Clement Viard, and Frédéric Guichard, DxO (France) [IQSP-230]*

3:50 141
Resolution enhancement through superimposition of projected images – How to evaluate the quality?, *Svein Arne Hansen[1,2], Jon Yngve Hardeberg[2], and Muhammad Nadeem Akram[1]; [1]University College of Southeast Norway, [2]Barco, and [3]Norwegian University of Science and Technology (Norway)* [IQSP-231]

4:10 147
Evaluation of major factors affecting spatial resolution of gamma-rays camera, *Hongwei Xie, Jinchuan Chen, Qiang Yi, Faqiang Zhang, and Linbo Li, Institute of Nuclear Physics and Chemistry (China)* [IQSP-232]

4:30 152
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)* [IQSP-233]

4:50 159
Detection of streaks caused by dust in the sheetfed scanners, *Daulet Kenzhebalin[1], Xing Liu[1], Ni Yan[1], Peter Bauer[2], Jerry Wagner[2] and Jan Allebach[1]; [1]Purdue University and [2]HP Inc. (United States)* [IQSP-234]

5:10 I
Effect of dark current distribution on image quality, *Orit Skorka, Pulla Reddy Ailuri, Leo Anzagira, and Radu Ispasoiu, ON Semiconductor (United States)* [IQSP-235]

5:30 – 7:30 PM Symposium Demonstration Session, Grand Peninsula Ballroom E

Wednesday February 1, 2017

Print Quality

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

9:10 – 9:50 AM
Harbour

9:10 166
Feature ranking and selection used in a machine learning framework for predicting uniformity of printed pages, *Minh Nguyen[1,2] and Jan Allebach[1], [1]Purdue University and [2]Duos Technologies (United States)* [IQSP-238]

9:30 174
Real-time print quality diagnostics, *Zuguang Xiao[1], Minh Nguyen[1], Eric Maggard[2], Mark Shaw[2], Jan Allebach[1], and Amy Reibman[1]; [1]Purdue University, and [2]HP Inc. (United States)* [IQSP-239]

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

10:50 180
UHD quality analyses at various viewing conditions, *C. Lee, S. Baek, S. Youn, S. Woo and J. Baek, Yonsei University (Republic of Korea)* [IQSP-240]

11:10 186
Image quality assessment for holographic display, *Wontaek Seo, Hoon Song, Jungkwuen 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)* [IQSP-241]

11:30 191
Subjective viewer preference model for automatic HDR down conversion, *Lucien Lenzen and Mike Christmann, Hochschule RheinMain (Germany)* [IQSP-242]

11:50 198
Towards Foveated Just Noticeable Difference Modeling for Virtual Reality, *Yuqiao Deng, Yingxue Zhang, Daiqin Yang, and Zhenzhong Chen, Wuhan University (China)* [IQSP-243]

12:10 – 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

Camera 3A

Session Chair: Jonathan Phillips, Google Inc. (United States)

3:30 – 4:50 PM
Harbour

3:30 202
A framework for auto-exposure subjective comparison, *Seungseok Oh[1], Clayton Passmore[1,2], Bobby Gold[1], Taylor Skilling[1,3], Sean Pieper[1], Taek Kim[1], and Margaret Belska[1]; [1]NVIDIA (United States), [2]University of Waterloo (Canada), and [3]Northeastern University (United States)* [IQSP-244]

3:50 209
Autofocus measurement for imaging devices, *Pierre Robisson, Jean-Benoit Jourdain, Wolf Hauser, Clément Viard, and Frédéric Guichard* [IQSP-245]

4:10 219
Auto Focus Performance - What can we expect from today's cameras?, *Uwe Artmann, Image Engineering GmbH & Co KG (Germany)* [IQSP-246]

4:30 227
Autofocus analysis: Latency and sharpness, *Katrina Passarella, Brett Frymire, and Ed Chang, Google, Inc (United States)* [IQSP-247]

PANEL: Image Quality Discussion
Panel Moderators: Robin Jenkin, ON Semiconductor, and Elaine Jin, Google Inc. (United States)
4:50 – 5:30 PM
Harbour

Image Quality and System Performance XIV Interactive Papers Session

5:30 – 7:00 PM
Grand Peninsula Ballroom E
The following works will be presented at the EI 2017 Symposium Interactive Papers Session.

231
Optical aberration correction of scanning holographic display, *Hyun-Eui Kim, Min-Sik Park, Hyon-Gon Choo, and Jinwoong Kim, Electonics and Telecommunications Research Institute (Republic of Korea)* [IQSP-248]

235
Solid-mottle method for measuring in laser-printers, *Dae-Gun Ko, Su-Han Song, Ki-Youn Lee, You-Sun Bang, Ki-Min Kang and Seong-Wook Han, Samsung Electronics (Republic of Korea)* [IQSP-236]