

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

PROCEEDINGS

26 January 2020 — 30 January 2020 • Burlingame, CA, USA

Image Quality and System Performance XVII

Editors: **Nicolas Bonnier**, Apple Inc. (United States), and
Mylène Farias, University of Brasilia (Brazil)

These papers represent the program of Electronic Imaging 2020,
held 26 January — 30 January 2020, at the Hyatt Regency San Francisco Airport in Burlingame, CA.

Copyright 2020

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

All rights reserved. These proceedings, or parts thereof, may not be reproduced in any form without the written permission of the Society.

ISSN 2470-1173

<https://doi.org/10.2352/ISSN.2470-1173.2020.9.IQSP-A09>

Manuscripts are reproduced from PDFs as submitted and approved by authors; no editorial changes have been made.

Image Quality and System Performance XVII

Conference overview

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.

Awards

Best Student Paper
Best Paper

Paper authors listed as of 1 January 2020;
refer to manuscript for final authors.
Titles that are not listed with the proceedings
files were presentation-only.

Conference Chairs: Nicolas Bonnier, Apple Inc. (United States); and Mylène Farias, University of Brasilia (Brazil)

Program Committee: Alan Bovik, University of Texas at Austin (United States); Peter Burns, Burns Digital Imaging (United States); Brian Cooper, Lexmark International, Inc. (United States); Luke Cui, Amazon (United States); Susan Farnand, Rochester Institute of Technology (United States); Frans Gaykema, Océ Technologies B.V. (the Netherlands); Jukka Häkkinen, University of Helsinki (Finland); Dirk Hertel, E Ink Corporation (United States); Robin Jenkin, NVIDIA Corporation (United States); Elaine Jin, NVIDIA Corporation (United States); Mohamed-Chaker Larabi, University of Poitiers (France); Göte Nyman, University of Helsinki (Finland); Stuart Perry, University of Technology Sydney (Australia); Jonathan Phillips, Google Inc. (United States); Sophie Triantaphillidou, University of Westminster (United Kingdom); and Clément Viard, DxOMark Image Labs (United States)

Conference Sponsor



IMAGE QUALITY AND SYSTEM PERFORMANCE XVII

Monday, January 27, 2020

KEYNOTE: Automotive Camera Image Quality

JOINT SESSION

Session Chair: Luke Cui, Amazon (United States)

8:45 – 9:30 am

Regency B

This session is jointly sponsored by: Autonomous Vehicles and Machines 2020, and Image Quality and System Performance XVII.

8:45

Conference Welcome

8:50

AVM-001

LED flicker measurement: Challenges, considerations, and updates from IEEE P2020 working group, Brian Deegan, senior expert, Valeo Vision Systems (Ireland)

Biographies and/or abstracts for all keynotes are found on pages 9–14

Automotive Camera Image Quality

JOINT SESSION

Session Chair: Luke Cui, Amazon (United States)

9:30 – 10:10 am

Regency B

This session is jointly sponsored by: Autonomous Vehicles and Machines 2020, and Image Quality and System Performance XVII.

9:30

IQSP-018

A new dimension in geometric camera calibration, Dietmar Wueller, Image Engineering GmbH & Co. KG (Germany)

9:50

AVM-019

Automotive image quality concepts for the next SAE levels: Color separation probability and contrast detection probability, Marc Geese, Continental AG (Germany)

10:10 – 10:50 am Coffee Break

Predicting Camera Detection Performance

JOINT SESSION

Session Chair: Robin Jenkin, NVIDIA Corporation (United States)

10:50 am – 12:30 pm

Regency B

This session is jointly sponsored by: Autonomous Vehicles and Machines 2020, Human Vision and Electronic Imaging 2020, and Image Quality and System Performance XVII.

10:50

AVM-038

Describing and sampling the LED flicker signal, Robert Sumner, Imatest, LLC (United States)

11:10

IQSP-039

Demonstration of a virtual reality driving simulation platform, Mingming Wang and Susan Farnand, Rochester Institute of Technology (United States)

11:30

AVM-040

Prediction and fast estimation of contrast detection probability, Robin Jenkin, NVIDIA Corporation (United States)

11:50

AVM-041

Object detection using an ideal observer model, Paul Kane and Orit Skorka, ON Semiconductor (United States)

12:10

AVM-042

Comparison of detectability index and contrast detection probability (JIST-first), Robin Jenkin, NVIDIA Corporation (United States)

12:30 – 2:00 pm Lunch

PLENARY: Frontiers in Computational Imaging

Session Chairs: Radka Tezaur, Intel Corporation (United States), and Jonathan Phillips, Google Inc. (United States)

2:00 – 3:10 pm

Grand Peninsula Ballroom D

Imaging the Unseen: Taking the First Picture of a Black Hole, Katie Bouman, assistant professor, Computing and Mathematical Sciences Department, California Institute of Technology (United States)

For abstract and speaker biography, see page 7

3:10 – 3:30 pm Coffee Break

Perceptual Image Quality

JOINT SESSION

Session Chairs: Mohamed Chaker Larabi, Université de Poitiers (France), and Jeffrey Mulligan, NASA Ames Research Center (United States)

3:30 – 4:50 pm

Grand Peninsula A

This session is jointly sponsored by: Human Vision and Electronic Imaging 2020, and Image Quality and System Performance XVII.

3:30

IQSP-066

Perceptual quality assessment of enhanced images using a crowd-sourcing framework, Muhammad Irshad¹, Alessandro Silva^{1,2}, Sana Alamgeer¹, and Mylène Farias¹; ¹University of Brasilia and ²IFG (Brazil)

3:50

IQSP-067

Perceptual image quality assessment for various viewing conditions and display systems, Andrei Chubarau¹, Tara Akhavan², Hyunjin Yoo², Rafal Mantiuk³, and James Clark¹; ¹McGill University (Canada), ²IRYStec Software Inc. (Canada), and ³University of Cambridge (United Kingdom)

4:10

HVEI-068

Improved temporal pooling for perceptual video quality assessment using VMAF, Sophia Batsi and Lisimachos Kondi, University of Ioannina (Greece)

4:30

HVEI-069

Quality assessment protocols for omnidirectional video quality evaluation, Ashutosh Singla, Stephan Fremerey, Werner Robitzka, and Alexander Raake, Technische Universität Ilmenau (Germany)

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

Tuesday, January 28, 2020

7:30 – 8:45 am Women in Electronic Imaging Breakfast;
pre-registration required

Video Quality Experts Group I

JOINT SESSION

Session Chairs: Kjell Brunnström, RISE Acreo AB (Sweden), and Jeffrey Mulligan, NASA Ames Research Center (United States)

8:50 – 10:10 am

Grand Peninsula A

This session is jointly sponsored by: Human Vision and Electronic Imaging 2020, and Image Quality and System Performance XVII.

8:50 HVEI-090

The Video Quality Experts Group - Current activities and research, Kjell Brunnström^{1,2} and Margaret Pinson³; ¹RISE Acreo AB (Sweden), ²Mid Sweden University (Sweden), and ³National Telecommunications and Information Administration, Institute for Telecommunications Sciences (United States)

9:10 HVEI-091

Quality of experience assessment of 360-degree video, Anouk van Kasteren^{1,2}, Kjell Brunnström^{1,3}, John Hedlund¹, and Chris Sijnders²; ¹RISE Research Institutes of Sweden AB (Sweden), ²University of Technology Eindhoven (the Netherlands), and ³Mid Sweden University (Sweden)

9:30 HVEI-092

Open software framework for collaborative development of no reference image and video quality metrics, Margaret Pinson¹, Philip Corriveau², Mikolaj Leszczuk³, and Michael Colligan⁴; ¹US Department of Commerce (United States), ²Intel Corporation (United States), ³AGH University of Science and Technology (Poland), and ⁴Spirent Communications (United States)

9:50 HVEI-093

Investigating prediction accuracy of full reference objective video quality measures through the ITS4S dataset, Antonio Servetti, Enrico Masala, and Lohic Fotio Tiotsop, Politecnico di Torino (Italy)

10:00 am – 7:30 pm Industry Exhibition - Tuesday

10:10 – 10:50 am Coffee Break

Video Quality Experts Group II

JOINT SESSION

Session Chair: Kjell Brunnström, RISE Acreo AB (Sweden)

10:50 am – 12:30 pm

Grand Peninsula A

This session is jointly sponsored by: Human Vision and Electronic Imaging 2020, and Image Quality and System Performance XVII.

10:50 HVEI-128

Quality evaluation of 3D objects in mixed reality for different lighting conditions, Jesús Gutiérrez, Toinon Vigier, and Patrick Le Callet, Université de Nantes (France)

11:10 HVEI-129

A comparative study to demonstrate the growing divide between 2D and 3D gaze tracking quality, William Blakey^{1,2}, Navid Hajimirza¹, and Naeem Ramzan²; ¹Lumen Research Limited and ²University of the West of Scotland (United Kingdom)

11:30 HVEI-130

Predicting single observer's votes from objective measures using neural networks, Lohic Fotio Tiotsop¹, Tomas Mizdos², Miroslav Uhrina², Peter Pocta², Marcus Barkowsky³, and Enrico Masala¹; ¹Politecnico di Torino (Italy), ²Zilina University (Slovakia), and ³Deggendorf Institute of Technology (DIT) (Germany)

11:50 HVEI-131

A simple model for test subject behavior in subjective experiments, Zhi Li¹, Ioannis Katsavounidis², Christos Bampis¹, and Lucjan Janowski³; ¹Netflix, Inc. (United States), ²Facebook, Inc. (United States), and ³AGH University of Science and Technology (Poland)

12:10 HVEI-132

Characterization of user generated content for perceptually-optimized video compression: Challenges, observations, and perspectives, Suiyi Ling^{1,2}, Yoann Baveye^{1,2}, Patrick Le Callet³, Jim Skinner³, and Ioannis Katsavounidis³; ¹CAPACITÉS (France), ²Université de Nantes (France), and ³Facebook, Inc. (United States)

12:30 – 2:00 pm Lunch

PLENARY: Automotive Imaging

Session Chairs: Radka Tezaur, Intel Corporation (United States), and Jonathan Phillips, Google Inc. (United States)

2:00 – 3:10 pm

Grand Peninsula Ballroom D

Imaging in the Autonomous Vehicle Revolution, Gary Hicok, senior vice president, hardware development, NVIDIA Corporation (United States)

For abstract and speaker biography, see page 7

3:10 – 3:30 pm Coffee Break

Image Quality Metrics

JOINT SESSION

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

3:30 – 5:10 pm

Grand Peninsula A

This session is jointly sponsored by: Human Vision and Electronic Imaging 2020, and Image Quality and System Performance XVII.

3:30 IQSP-166

DXOMARK objective video quality measurements, Emilie Baudin, Laurent Chanas, and Frédéric Guichard, DXOMARK (France)

3:50 IQSP-167

Analyzing the performance of autoencoder-based objective quality metrics on audio-visual content, Helard Becerra¹, Mylène Farias¹, and Andrew Hines²; ¹University of Brasilia (Brazil) and ²University College Dublin (Ireland)

4:10 IQSP-168

No reference video quality assessment with authentic distortions using 3-D deep convolutional neural network, Roger Nieto¹, Hernan Dario Benitez Restrepo¹, Roger Figueroa Quintero¹, and Alan Bovik²; ¹Pontificia Universidad Javeriana, Cali (Colombia) and ²The University of Texas at Austin (United States)

4:30 IQSP-169
Quality aware feature selection for video object tracking, Roger Nieto¹, Carlos Quiroga², Jose Ruiz-Munoz³, and Hernan Benitez-Restrepo¹; ¹Pontificia Universidad Javeriana, Cali (Colombia), ²Universidad del Valle (Colombia), and ³University of Florida (United States)

4:50 IQSP-170
Studies on the effects of megapixel sensor resolution on displayed image quality and relevant metrics, Sophie Triantaphillidou¹, Jan Smejkal¹, Edward Fry¹, and Chuang Hsin Hung²; ¹University of Westminster (United Kingdom) and ²Huawei (China)

5:30 – 7:30 pm Symposium Demonstration Session

Wednesday, January 29, 2020

KEYNOTE: Image Capture

Session Chair: Nicolas Bonnier, Apple Inc. (United States)

8:50 – 9:50 am
 Harbour A/B

IQSP-190
Camera vs smartphone: How electronic imaging changed the game, Frédéric Guichard, DXOMARK (France)

Biographies and/or abstracts for all keynotes are found on pages 9–14

Image Capture Performance I

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

9:50 – 10:10 am
 Harbour A/B

IQSP-214
Comparing common still image quality metrics in recent High Dynamic Range (HDR) and Wide Color Gamut (WCG) representations, Anustup Choudhury and Scott Daly, Dolby Laboratories (United States)

10:00 am – 3:30 pm Industry Exhibition - Wednesday

10:10 – 10:50 am Coffee Break

Image Capture Performance II

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

10:50 am – 12:10 pm
 Harbour A/B

IQSP-239
Validation of modulation transfer functions and noise power spectra from natural scenes (JIST-first), Edward Fry¹, Sophie Triantaphillidou¹, Robin Jenkin², and Ralph Jacobson¹; ¹University of Westminster (United Kingdom) and ²NVIDIA Corporation (United States)

IQSP-240
Application of ISO standard methods to optical design for image capture, Peter Burns¹, Don Williams², Heidi Hall³, John Griffith³, and Scott Cahal³; ¹Burns Digital Imaging, ²Image Science Associates, and ³Moondog Optics (United States)

IQSP-241
Camera system performance derived from natural scenes, Oliver van Zwabenberg¹, Sophie Triantaphillidou¹, Robin Jenkin², and Alexandra Psarrou¹; ¹University of Westminster (United Kingdom) and ²NVIDIA Corporation (United States)

IQSP-242
Correcting misleading image quality measurements, Norman Koren, Imatest LLC (United States)

12:30 – 2:00 pm Lunch

PLENARY: VR/AR Future Technology

Session Chairs: Radka Tezaur, Intel Corporation (United States), and Jonathan Phillips, Google Inc. (United States)

2:00 – 3:10 pm
 Grand Peninsula Ballroom D

Quality Screen Time: Leveraging Computational Displays for Spatial Computing, Douglas Lanman, director, Display Systems Research, Facebook Reality Labs (United States)

For abstract and speaker biography, see page 7

3:10 – 3:30 pm Coffee Break

Image Quality of Omnidirectional Environment

Session Chair: Stuart Perry, University of Technology Sydney (Australia)

3:30 – 5:10 pm
 Harbour A/B

IQSP-284
Subjective and viewport-based objective quality assessment of 360-degree videos, Roberto Azevedo¹, Neil Birkbeck², Ivan Janatra², Balu Adsumilli², and Pascal Frossard¹; ¹Ecole Polytechnique Fédérale de Lausanne (Switzerland) and ²YouTube (United States)

IQSP-285
Statistical characterization of tile decoding time of HEVC-encoded 360° video, Henrique Garcia¹, Mylène Farias¹, Ravi Prakash², and Marcelo Carvalho¹; ¹University of Brasilia (Brazil) and ²The University of Texas at Dallas (United States)

IQSP-286
Complexity optimization for the upcoming versatile video coding standard, Mohamed Chaker Larabi, Université de Poitiers (France)

IQSP-287
On the improvement of 2D quality assessment metrics for omnidirectional images, Mohamed Chaker Larabi, Université de Poitiers (France)

IQSP-288
The cone model: Recognizing gaze uncertainty in virtual environments, Anjali Jogeshwar, Mingming Wang, Gabriel Diaz, Susan Farnand, and Jeff Pelz, Rochester Institute of Technology (United States)

Image Quality and System Performance XVII Interactive Papers Session

5:30 – 7:00 pm

Sequoia

The following works will be presented at the EI 2020 Symposium Interactive Papers Session.

IQSP-314
A comprehensive system for analyzing the presence of print quality defects, Runzhe Zhang¹, Yi Yang¹, Eric Maggard², Yousun Bang³, Minki Cho³, and Jan Allebach¹; ¹Purdue University (United States), ²HP Inc. (United States), and ³HP Printing Korea Co. Ltd. (Republic of Korea)

IQSP-315
DNN-based ISP parameter inference algorithm for automatic image quality optimization, Younghoon Kim, Jungmin Lee, Sung-su Kim, Cheoljong Yang, TaeHyung Kim, and JoonSeo Yim, Samsung Electronics (Republic of Korea)

IQSP-316
Effective ISP tuning framework based on user preference feedback, Cheoljong Yang, Jinyun Kim, Jungmin Lee, Younghoon Kim, Sung-su Kim, TaeHyung Kim, and JoonSeo Yim, Samsung Electronics (Republic of Korea)

IQSP-317
Evaluation of optical performance characteristics of endoscopes, Quanzeng Wang and Wei-Chung Cheng, US Food and Drug Administration (United States)

IQSP-318
Human preference on chroma boosting in images, Fu Jiang¹, Huanzhao Zeng², and Weijuan Xi²; ¹Rochester Institute of Technology and ²Google Inc. (United States)

IQSP-319
Prediction of performance of 2D DCT-based filter and adaptive selection of its parameter, Oleksii Rubel¹, Sergiy Abramov¹, Vladimir Lukin¹, and Karen Egiazarian²; ¹National Aerospace University (Ukraine) and ²Tampere University (Finland)

IQSP-320
Quantification method for video motion correction performance in mobile image sensor, Sungho Cha, Jaehyuk Hur, Sung-su Kim, TaeHyung Kim, and JoonSeo Yim, Samsung Electronics (Republic of Korea)

IQSP-321
Region of interest extraction for image quality assessment, Runzhe Zhang¹, Eric Maggard², Yousun Bang³, Minki Cho³, and Jan Allebach¹; ¹Purdue University (United States), ²HP Inc. (United States), and ³HP Printing Korea Co. Ltd. (Republic of Korea)

IQSP-322
Relation between image quality and scan resolution: Part I, Zhenhua Hu¹, Litaο Hu¹, Peter Bauer², Todd Harris², and Jan Allebach¹; ¹Purdue University and ²HP Inc. (United States)

IQSP-323
Document image quality assessment with relaying reference to determine minimum readable resolution for compression, Litaο Hu¹, Zhenhua Hu¹, Jan Allebach¹, Peter Bauer², and Todd Harris²; ¹Purdue University and ²HP Inc. (United States)

5:30 – 7:00 pm EI 2020 Symposium Interactive Posters Session

5:30 – 7:00 pm Meet the Future: A Showcase of Student and Young Professionals Research

Thursday, January 30, 2020

Image Capture Performance III

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

8:50 – 10:10 am

Harbour A/B

8:50 IQSP-345
Noise power spectrum scene-dependency in simulated image capture systems, Edward Fry¹, Sophie Triantaphillidou¹, Robin Jenkin^{1,2}, Ralph Jacobson¹, and John Jarvis¹; ¹University of Westminster (United Kingdom) and ²NVIDIA Corporation (United States)

9:10 IQSP-346
Verification of long-range MTF testing through intermediary optics, Alexander Schwartz, Sarthak Tandon, and Jackson Knappen, Imatest, LLC (United States)

9:30 IQSP-347
Measuring camera Shannon information capacity with a Siemens star image, Norman Koren¹ and Robin Jenkin²; ¹Imatest LLC and ²NVIDIA Corporation (United States)

9:50 IQSP-348
Scene-and-process-dependent spatial image quality metrics (JIST-first), Edward Fry¹, Sophie Triantaphillidou¹, Robin Jenkin², and John Jarvis¹; ¹University of Westminster (United Kingdom) and ²NVIDIA Corporation (United States)

10:10 – 10:50 am Coffee Break

System Performance

Session Chair: Jukka Häkkinen, University of Helsinki (Finland)

10:50 am – 12:30 pm

Harbour A/B

10:50 IQSP-370
Depth map quality evaluation for photographic applications, Eloi Zalczer¹, François-Xavier Thomas¹, Laurent Chanas¹, Gabriele Facciolo², and Frédéric Guichard¹; ¹DXOMARK and ²ENS Cachan (France)

11:10 IQSP-371
Prediction of Lee filter performance for Sentinel-1 SAR images, Oleksii Rubel¹, Vladimir Lukin¹, Andrii Rubel¹, and Karen Egiazarian²; ¹National Aerospace University (Ukraine) and ²Tampere University (Finland)

11:30 IQSP-372
Evaluating whole-slide imaging viewers used in digital pathology, Wei-Chung Cheng¹, Samuel Lam², Qi Gong¹, and Paul Lemaille³; ¹US Food and Drug Administration and ²University of Maryland (United States)

11:50 IQSP-373
Inkjet quality ruler experiments and print uniformity predictor, Yi Yang¹, Utpal Sarkar², Isabel Borrell², and Jan Allebach¹; ¹Purdue University (United States) and ²HP Inc. (Spain)

JOIN US AT THE NEXT EI!

IS&T International Symposium on

Electronic Imaging

SCIENCE AND TECHNOLOGY

Imaging across applications . . . Where industry and academia meet!



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

www.electronicimaging.org

