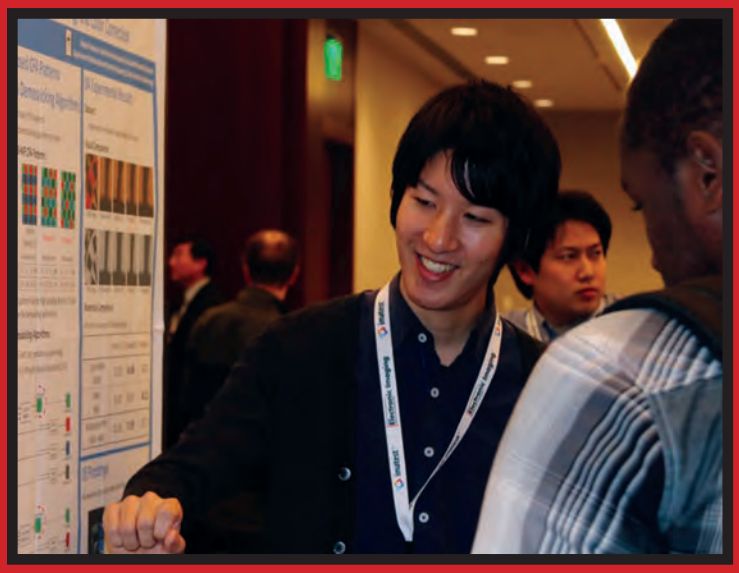
IS&T International Symposium on

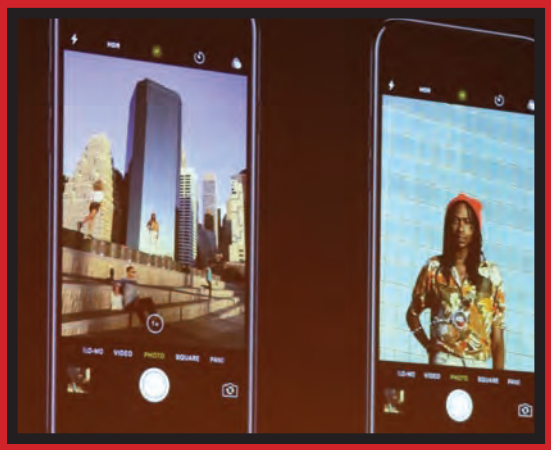
Electronic Imaging 2020

SCIENCE AND TECHNOLOGY

26-30 JANUARY • BURLINGAME, CA USA

FINAL PROGRAM



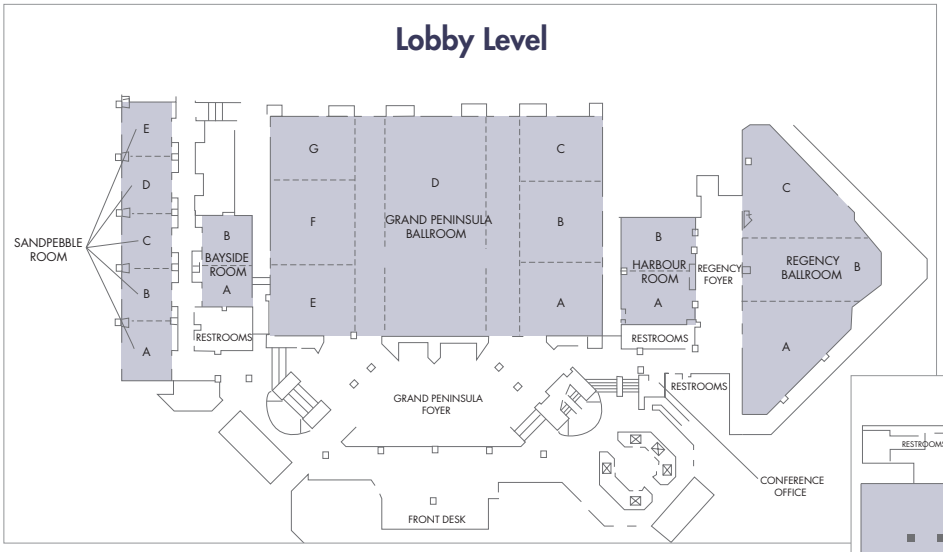


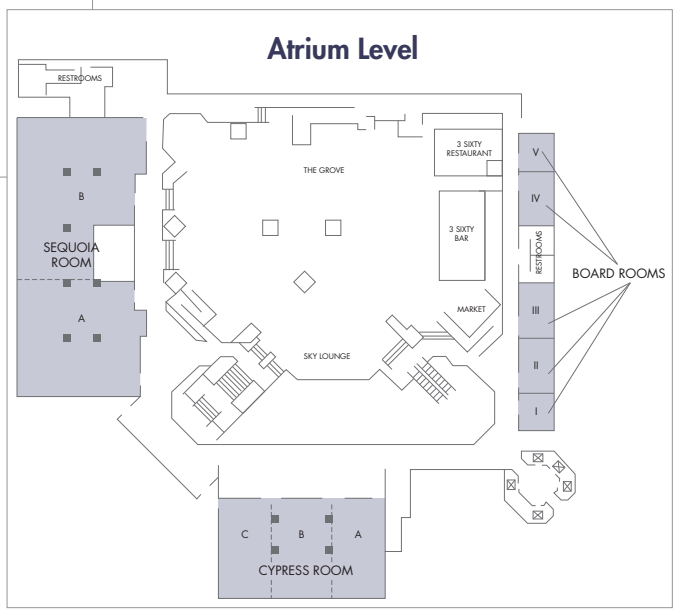
Where Industry and Academia Meet to discuss Imaging Across Applications

EI2020 Conference Acronym/Name

3DMP	3D Measurement and Data Processing
AVM	Automonous Vehicles and Machines
COLOR	Color Imaging XXV: Displaying, Processing, Hardcopy, and Applications
COIMG	Computational Imaging XVIII
ERVR	The Engineering Reality of Virtual Reality
FAIS	Food and Agricultural Imaging Systems
HVEI	Human Vision and Electronic Imaging
IPAS	Image Processing: Algorithms and Systems XVIII
IQSP	Image Quality and System Performance XVII
IMAWM	Imaging and Multimedia Analytics in a Web and Mobile World
IRIACV	Intelligent Robotics and Industrial Applications using Computer Vision
ISS	Imaging Sensors and Systems (formerly PMII and IMSE)
MAAP	Material Appearance
MOBMU	Mobile Devices and Multimedia: Enabling Technologies, Algorithms, and Applications
MWSF	Media Watermarking, Security, and Forensics
SD&A	Steroscopic Displays and Applications XXXI
VDA	Visualization and Data Analysis

Hyatt San Francisco Airport Floor Plans





IS&T International Symposium on

Electronic Imaging

SCIENCE AND TECHNOLOGY

26 – 30 January 2020

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

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Radka Tezaur
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2020 Symposium Co-Chair

Jonathan B. Phillips
Google, Inc. (US)

2020 Short Course Co-Chair

Elaine Jin
NVIDIA Corporation (US)

2020 Short Course Co-Chair

Stuart Perry
University of Technology Sydney (Australia)

2020 Short Course Co-Chair

Maribel Figuera
Microsoft Corporation (US)

Welcome

On behalf of the Society for Imaging Science and Technology (IS&T), we would like to welcome you to the 32nd annual International Symposium on Electronic Imaging (EI 2020).

The EI Symposium is a premier international meeting that brings together colleagues from academia and industry to discuss topics on the forefront of research and innovation in all areas and aspects of Electronic Imaging, from sensors and image capture, through image processing and computational imaging, computer vision, human visual perception and displays, to applications in science, medicine, autonomous driving, arts and entertainment, and other fields.

This year we are highlighting the themes of Frontiers in Computational Imaging, Automotive Imaging, and AR/VR Future Technology; these, along with the themes of 3D Imaging, Deep Learning, Medical/Diagnostic Imaging, Robotic Imaging, Security, and Remote Sensing are denoted in the Combined Paper Schedule beginning on page 23. In addition, there is a new Food and Agricultural Imaging Systems conference and a special session in MWSF on Digital vs Physical Document Security held jointly with Reconnaissance International's Optical Document Security Conference.

The whole week offers a great opportunity to learn from leading experts from around the world. You can attend talks in any of the 17 different technical conferences, take short courses (26 options), visit the exhibits, and so much more. We encourage you to take full advantage of the many special events and networking opportunities available at the symposium, including the plenary presentations, individual conference keynotes, special joint sessions, EI Reception, 3D Theatre, as well as other special events arranged by various conferences. Create your own program using the itinerary planner available on the EI website.

You can learn more about the work presented at EI 2020 by accessing EI Conference Proceedings, available via www.electronicimaging.org and on the IS&T Digital Library (ingentaconnect.com/content/ist/ei). Proceedings from the past years, since 2016, can be found at the same location, and they are all open access.

We look forward to seeing you and welcoming you to this unique event.

—Radka Tezaur and Jonathan Phillips, EI 2020 Symposium Co-chairs

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Andrew J. Woods, Curtin University (Australia)
Song Zhang, Mississippi State University (US)

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. EI would not be possible without the dedicated contributions of our participants and members.

Sponsored by
Society for Imaging Science and Technology (IS&T)
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703/642-9090 / 703/642-9094 fax / info@imaging.org / www.imaging.org

Table of Contents

Conferences and Papers Program by Session

Plan Now to Participate
Join us for Electronic Imaging 2021
January 17 – 21, 2021

Parc 55 Hotel
downtown San Francisco

Registration Desk

Onsite Registration and Badge Pick-Up Hours

Sunday, Jan. 26 — 7:00 am to 8:00 pm
Monday, Jan. 27 — 7:00 am to 5:00 pm
Tuesday, Jan. 28 — 8:00 am to 5:00 pm
Wednesday, Jan. 29 — 8:00 am to 5:00 pm
Thursday, Jan. 30 — 8:30 am to 4:00 pm

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SYMPOSIUM OVERVIEW

Engage with advances in electronic imaging

Imaging is integral to the human experience and to exciting technology advances taking shape around us—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, to capturing images of celestial formations, and the latest in image data security. At EI 2020, leading researchers, developers, and entrepreneurs from around the world discuss, learn about, and share the latest imaging developments from industry and academia.

EI 2020 includes theme day topics and virtual tracks, plenary speakers, 26 technical courses, 3D theatre, and 17 conferences including cross-topic joint sessions, keynote speakers, and peer-reviewed research presentations.

Symposium Silver Sponsors

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Frontiers in Computational Imaging
Monday, Jan 27

Plenary Session: Imaging the Unseen: Taking the First Picture of a Black Hole, Katie Bouman (California Institute of Technology)

Related Sessions: See Computational Imaging Conference program, beginning on page 51.

Automotive Imaging
Tuesday, Jan 28

Plenary Session: Imaging in the Autonomous Vehicle Revolution, Gary Hicok (NVIDIA)

Panel Session: Sensors Technologies for Autonomous Vehicles, see details page 18.

Short Courses:
- Fundamentals of Deep Learning, R. Ptucha (RIT)
- Optics and Hardware Calibration of Compact Camera Modules for AR/VR, Automotive, and Machine Vision Applications, Uwe Artmann (Image Engineering) and Kevin J. Matherson (Microsoft)

… and more, see course listing and descriptions, page 105.

AR/VR Future Technology
Wednesday, Jan 29

Plenary Session: Quality Screen Time: Leveraging Computational Displays for Spatial Computing, Douglas Lanman (Facebook Reality Labs)

Related Sessions: See The Engineering Reality of Virtual Reality 2020 (page 58) and the Stereoscopic Displays and Applications XXXI (page 99).

Short Course: Color and Calibration in Compact Camera Modules for AR, Machine Vision, Automotive, and Mobile Applications, Uwe Artmann (Image Engineering) and Kevin J. Matherson (Microsoft)

EI 2020 Exhibitors

Exhibit Hours
Tuesday 10:00 am – 7:00 pm
Wednesday 10:00 am – 3:30 pm

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EI 2020 SHORT COURSES AT-A-GLANCE (see Course Descriptions beginning on page 105)

Sunday Jan 26

8:00 - 12:15 SC01: Stereoscopic Imaging Fundamentals	**8:00 - 12:15** SC02: Advanced Image Enhancement and Deblurring	**8:00 - 12:15** SC03: Optics and Hardware Calibration of Compact Camera Modules for AR/VR, Automotive, and Machine Vision Applications	**8:00 - 12:15** SC04: 3D Point Cloud Processing	**8:00 - 12:15** SC05: Digital Camera Image Quality Tuning	**8:00 - 12:15** SC06: Computer Vision and Image Analysis of Art
1:30 - 5:45 SC07: Perceptual Metrics for Image and Video Quality: From Perceptual Transparency to Structural Equivalence	**1:30 - 5:45** SC08: Fundamentals BioInspired Image Processing	**1:30 - 3:30** SC09: Resolution in Mobile Imaging Devices ... **3:45 - 5:45** SC12: Color & Calibration in Compact Camera Modules ...	**3:45 - 5:45** SC13: Normal and Defective Color Vision Across ...	**1:30 - 5:45** SC10: Image Quality: Industry Standards for Mobile, Automotive and Machine Vision Applications	**1:30 - 3:30** SC11: Color Optimization for Displays **3:45 - 5:45** SC14: HDR Theory and Technology

Monday Jan 27

8:30 - 12:45 SC15: 3D Imaging	**8:30 - 12:45** SC16: Classical and Deep Learning-based Computer Vision	**8:30 - 10:30** SC17: Camera Noise Sources and its Characterization ... **10:45 - 12:45** SC19: Camera Image Quality Benchmarking	**8:30 - 12:45** SC18: Perception and Cognition for Imaging

Tuesday Jan 28

8:30 - 12:45 SC20: Fundamentals of Deep Learning	**8:30 - 12:45** SC21: Production Line Camera Color Calibration	**3:15 - 5:15** SC22: An Introduction to Blockchain	**3:15 - 5:15** SC23: Using Cognitive and Behavioral Sciences ... in AI...

Wed. Jan 29

8:30 - 12:45 SC24: Imaging Applications of Artificial Intelligence	**3:15 - 5:15** SC25: Smartphone Imaging for Secure Applications

Thurs. Jan 30

8:30 - 12:45 SC26: Introduction to Probabilistic Models for Machine Learning

PLENARY SPEAKERS

Imaging the Unseen: Taking the First Picture of a Black Hole

Monday, January 27, 2020
2:00 – 3:00 pm
Grand Peninsula Ballroom D

Katie Bouman, assistant professor, Computing and Mathematical Sciences Department, California Institute of Technology

This talk will present the methods and procedures used to produce the first image of a black hole from the Event Horizon Telescope. It has been theorized for decades that a black hole will leave a "shadow" on a background of hot gas. Taking a picture of this black hole shadow could help to address a number of important scientific questions, both on the nature of black holes and the validity of general relativity. Unfortunately, due to its small size, traditional imaging approaches require an Earth-sized radio telescope. In this talk, I discuss techniques we have developed to photograph a black hole using the Event Horizon Telescope, a network of telescopes scattered across the globe. Imaging a black hole's structure with this computational telescope requires us to reconstruct images from sparse measurements, heavily corrupted by atmospheric error. The resulting image is the distilled product of an observation campaign that collected approximately five petabytes of data over four evenings in 2017. I will summarize how the data from the 2017 observations were calibrated and imaged, explain some of the challenges that arise with a heterogeneous telescope array like the EHT, and discuss future directions and approaches for event horizon scale imaging.

Katie Bouman is an assistant professor in the Computing and Mathematical Sciences Department at the California Institute of Technology. Before joining Caltech, she was a postdoctoral fellow in the Harvard-Smithsonian Center for Astrophysics. She received her PhD in the Computer Science and Artificial Intelligence Laboratory (CSAIL) at MIT in EECS. Before coming to MIT, she received her bachelor's degree in electrical engineering from the University of Michigan. The focus of her research is on using emerging computational methods to push the boundaries of interdisciplinary imaging.

Imaging in the Autonomous Vehicle Revolution

Tuesday, January 28, 2020
2:00 – 3:00 pm
Grand Peninsula Ballroom D

Gary Hicok, senior vice president, hardware development, NVIDIA Corporation

To deliver on the myriad benefits of autonomous driving, the industry must be able to develop self-driving technology that is truly safe. Through redundant and diverse automotive sensors, algorithms, and high-performance computing, the industry is able to address this challenge. NVIDIA brings together AI deep learning, with data collection, model training, simulation, and a scalable, open autonomous vehicle computing platform to power high-performance, energy-efficient computing for functionally safe self-driving. Innovation of imaging capabilities for AVs has been rapidly improving to the point that the cornerstone AV sensors are cameras. Much like the human brain processes visual data taken in by the eyes, AVs must be able to make sense of this constant flow of information, which requires high-performance computing to respond to the flow of sensor data. This presentation will delve into how these developments in imaging are being used to train, test and operate safe autonomous vehicles. Attendees will walk away with a better understanding of how deep learning, sensor fusion, surround vision and accelerated computing are enabling this deployment.

Gary Hicok is senior vice president of hardware development at NVIDIA, and is responsible for Tegra System Engineering, which oversees Shield, Jetson, and DRIVE platforms. Prior to this role, Hicok served as senior vice president of NVIDIA's Mobile Business Unit. This vertical focused on NVIDIA's Tegra mobile processor, which was used to power next-generation mobile devices as well as in-car safety and infotainment systems. Before that, Hicok ran NVIDIA's Core Logic (MCP) Business Unit also as senior vice president. Throughout his tenure with NVIDIA, Hicok has also held a variety of management roles since joining the company in 1999, with responsibilities focused on console gaming and chipset engineering. He holds a BSEE degree from Arizona State University and has authored 33 issued patents.

Quality Screen Time: Leveraging Computational Displays for Spatial Computing

Wednesday, January 29, 2020
2:00 – 3:00 pm
Grand Peninsula Ballroom D

Douglas Lanman, director, Display Systems Research, Facebook Reality Labs

Displays pervade our lives and take myriad forms, spanning smart watches, mobile phones, laptops, monitors, televisions, and theaters. Yet, in all these embodiments, modern displays remain largely limited to two-dimensional representations. Correspondingly, our applications, entertainment, and user interfaces must work within the limits of a flat canvas. Head-mounted displays (HMDs) present a practical means to move forward, allowing compelling three-dimensional depictions to be merged seamlessly with our physical environment. As personal viewing devices, head-mounted displays offer a unique means to rapidly deliver richer visual experiences than past direct-view displays that must support a full audience. Viewing optics, display components, rendering algorithms, and sensing elements may all be tuned for a single user. It is the latter aspect that most differentiates from the past, with individualized eye tracking playing an important role in unlocking higher resolutions, wider fields of view, and more comfortable visuals than past displays. This talk will explore such "computational display" concepts and how they may impact VR/AR devices in the coming years.

Douglas Lanman is the director of Display Systems Research at Facebook Reality Labs, where he leads investigations into advanced display and imaging technologies for augmented and virtual reality. His prior research has focused on head-mounted displays, glasses-free 3D displays, light-field cameras, and active illumination for 3D reconstruction and interaction. He received a BS in applied physics with honors from Caltech (2002), and his MS and PhD in electrical engineering from Brown University (2006 and 2010, respectively). He was a senior research scientist at NVIDIA Research from 2012 to 2014, a postdoctoral associate at the MIT Media Lab from 2010 to 2012, and an assistant research staff member at MIT Lincoln Laboratory from 2002 to 2005. His most recent work has focused on developing Half Dome: an eye-tracked, wide-field-of-view varifocal HMD with AI-driven rendering.

SPECIAL EVENTS

Monday, January 27, 2020

All-Conference Welcome Reception

The Grove
5:00 pm – 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.

SD&A Conference 3D Theatre

Grand Peninsula Ballroom D
6:00 pm – 7:30 pm
Hosted by Andrew J. Woods, Curtin University (Australia)

The 3D Theatre Session of each year's Stereoscopic Displays and Applications C onference showcases the wide variety of 3D content that is being produced and exhibited around the world. All 3D footage screened in the 3D Theatre 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 28, 2020

Women in Electronic Imaging Breakfast

Location provided at Registration Desk
7:30 am – 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.

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.

Symposium Demonstration Session

Ballrooms E/F/G
5:30 pm – 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, January 29, 2020

Industry Exhibition

Grand Peninsula Foyer
10:00 am – 3:30 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.

Interactive Papers (Poster) Session

Sequoia
5:30 pm – 7:00 pm
Conference attendees are encouraged to attend the Interactive Papers (Poster) Session where authors display their posters and are available to answer questions and engage in in-depth discussions about their work. Please note that conference registration badges are required for entrance and that posters may be previewed by all attendees beginning on Monday afternoon.

Authors are asked to set up their posters starting at 10:00 am on Monday. Pushpins are provided. Authors must remove poster materials at the conclusion of the Interactive Session. Posters not removed after the session are considered unwanted and will be removed by staff and discarded. IS&T does not assume responsibility for posters displayed after the Interactive Session concludes.

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

Sequoia
5:30 pm - 7:00 pm
This annual event will bring invited students together with academic and industry representatives who may have opportunities to offer. Each student is asked to present and discuss their academic work via an interactive poster session. Student presenters may expand their professional network and explore employment opportunities with the audience of academic and industry representatives.

Conference attendees are encouraged to attend this Showcase to engage with these invited students about their work. Please note that conference registration badges are required for entrance.

Authors are asked to set up their Showcase posters starting at 10:00 am on Monday. Pushpins are provided. Authors must remove poster materials at the conclusion of the Showcase. Posters not removed are considered unwanted and will be removed by staff and discarded. IS&T does not assume responsibility for posters displayed after the Showcase concludes.

2020 Friends of HVEI Banquet

Location provided at Registration Desk
7:00 pm - 10:00 pm
This annual event brings the HVEI community together for great food and convivial conversation. Registration required, online or at the registration desk.

EI 2020 CONFERENCE KEYNOTES

Monday, January 27, 2020

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.

AVM-001

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

Brian Deegan is a senior expert at Valeo Vision Systems. The LED flicker work Deegan is involved with came about as part of the IEEE P2020 working group on Automotive Image Quality standards. One of the challenges facing the industry is the lack of agreed standards for assessing camera image quality performance. Deegan leads the working group specifically covering LED flicker. He holds a BS in computer engineering from the University of Limerick (2004), and an MSc in biomedical engineering from the University of Limerick (2005). Biomedical engineering has already made its way into the automotive sector. A good example would be driver monitoring. By analyzing a drivers patterns, facial expressions, eye movements etc, automotive systems can already tell if a driver has become drowsy and provide an alert.

Watermarking and Recycling

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

8:55 – 10:00 am
Cypress A

MWSF-017

Watermarking to turn plastic packaging from waste to asset through improved optical tagging, *Larry Logan, Digimarc Corporation (United States)*

Larry Logan is chief evangelist with Digimarc Corporation. Logan is a visionary and a risk taker with a talent for finding gamechanging products and building brand recognition that resonates with target audiences. He recognizes opportunities in niche spaces, capitalizing on investments made. He has a breadth of relationships and media contacts in diverse industries which expand his reach. Logan holds a BA from the University of Arkansas at Fayetteville.

3D Digitization and Optical Material Interactions

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

9:30 – 10:10 am
Regency C

MAAP-020

Capturing and 3D rendering of optical behavior: The physical approach to realism, *Martin Ritz, Fraunhofer Institute for Computer Graphics Research (Germany)*

Martin Ritz has been deputy head of Competence Center Cultural Heritage Digitization at the Fraunhofer Institute for Computer Graphics Research IGD since 2012, prior to which he was a research fellow there in the department of Industrial Applications (today: Interactive Engineering Technologies). In parallel to technical coordination, his research topics include acquisition of 3D geometry, as well as optical material properties, meaning light interaction of surfaces up to complete objects, for arbitrary combinations of light and observer directions. Challenges in both domains are equally design and implementation of algorithms as well as conceptualization and realization of novel scanning systems in hardware and software with the goal of complete automation in mind. He received his MS in Informatics (2009) from the Technische Universität Darmstadt where his focus in the domain of photogrammetry was the extension of "Multi-view Stereo" by the advantages of the "Photometric Stereo" approach to reach better results and more complete measurement data coverage during 3D reconstruction.

Visibility

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

3:30 – 4:10 pm
Regency B

AVM-057

The automated drive west: Results, *Sara Sargent, VSI Labs (United States)*

Sara Sargent is the engineering project manager with VSI Labs. In this role she is the bridge between the client and the VSI Labs team of autonomous solutions developers. She is engaged in all lab projects, leads the Sponsorship Vehicle program, and the internship program. She contributes to social media, marketing & business development. Sargent brings sixteen years of management experience, including roles as engineering project manager for automated vehicle projects, project manager for software application development, president of a high powered collegiate rocket team, and involvement in the Century College Engineering Club, and the St. Thomas IEEE student chapter. Sargent holds a BS in electrical engineering from the University of St. Thomas.

Immersive 3D Display Systems

Session Chair: Takashi Kawai, Waseda University (Japan)

3:30 – 4:30 pm
Grand Peninsula D

SD&A-065

High frame rate 3D-challenges, issues, and techniques for success, *Larry Paul, Christie Digital Systems (United States)*

Abstract: Larry Paul shares some of his more than 25 years of experience in the development of immersive 3D display systems and discusses the challenges, issues and successes in creating, displaying, and experiencing 3D content for audiences. Topics range from working in dome and curved screen projection systems to 3D in use at Los Alamos National Labs to working with Ang Lee on "Billy Lynn's Long Half Time Walk" and "Gemini Man" at 4K, 120Hz per eye 3D, as well as work with Doug Trumbull on the 3D Magi format. Paul explores the very important relationship between the perception of 3D in resolution, frame rate, viewing distance, field of view, motion blur, shutter angles, color, contrast, and "HDR" and image brightness and how all those things combined add to the complexity of making 3D work effectively. In addition, he discusses his expertise with active and polarized 3D systems and "color-comb" 6P 3D projection systems. He will also explain the additional value of expanded color volume and the inter-relationship with HDR on the reproduction of accurate color.

Larry Paul is a technologist with more than 25 years of experience in the design and deployment of high-end specialty themed entertainment, giant screens, visualization, and simulation projects. He has passion for and expertise with true high-frame rate, multi-channel high resolution 2D and 3D display solutions and is always focused on solving specific customer challenges and improving the visual experience. He has his name on 6 patents. A life-long transportation enthusiast, he was on a crew that restored a WWII flying wing. He has rebuilt numerous classic cars and driven over 300,000 miles in electric vehicles over the course of more than 21 years.

Tuesday, January 28, 2020

Human Interaction

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

8:50 – 9:30 am
Regency B

AVM-088

Regaining sight of humanity on the roadway towards automation, *Mónica López-González, La Petite Noiseuse Productions (United States)*

Mónica López-González is a multilingual cognitive scientist, educator, and practicing multidisciplinary artist. A firm believer in the intrinsic link between art and science, she is the cofounder and chief science and art officer at La Petite Noiseuse Productions. Her company's work merges questions, methods, data, and theory from the visual, literary, musical, and performing arts with the cognitive, brain, behavioral, health and data sciences. She has recently been a Fellow at the Salzburg Global Seminar in Salzburg, Austria. Prior to co-founding her company, she worked in the biotech industry as director of business development. López-González has pioneered a range of multidisciplinary STEamM (science, technology, engineering, art, mathematics, medicine) courses for students at Johns Hopkins University, Peabody Institute, and Maryland Institute College of Art. She has been an HVEI program committee member since 2015 and was co-founded its 'Art & Perception' session. She holds a BA in psychology and French and a MA and PhD in cognitive science, all from Johns Hopkins University.

Computation and Photography

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

8:50 – 9:30 am
Grand Peninsula B/C

COIMG-089

Computation and photography: How the mobile phone became a camera, *Peyman Milanfar, Google Research (United States)*

Peyman Milanfar is a principal scientist / director at Google Research, where he leads Computational Imaging. Previously, he was professor of electrical engineering at UC Santa Cruz (1999-2014). Most recently, Peyman's team at Google developed the "Super Res Zoom" pipeline for the Pixel phones. Peyman received his BS in electrical engineering and mathematics from UC Berkeley, and his MS and PhD in EECS from MIT. He founded MotionDSP, which was acquired by Cubic Inc. He is a Distinguished Lecturer of the IEEE Signal Processing Society, and a Fellow of the IEEE.

Technology in Context

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

9:00 – 10:00 am
Cypress A

MWSF-102

Technology in context: Solutions to foreign propaganda and disinformation, *Samaruddin Stewart, technology and media expert, Global Engagement Center, US State Department, and Justin Maddox, adjunct professor, Department of Information Sciences and Technology, George Mason University (United States)*

Samaruddin Stewart is a technology and media expert with the US Department of State, Global Engagement Center, based in the San Francisco Bay Area. Concurrently, he manages Journalism 360 with the Online News Association, a global network of storytellers accelerating the understanding and production of immersive journalism (AR/VR/XR). Journalism 360 is a partnership between the Google News Initiative, the Knight Foundation, and the Online News Association. From 2016 through mid-2019 he was an invited expert speaker/trainer with the US Department of State, speaking on combating disinformation, technical verification of content, and combating violent extremism. He holds a BA in journalism and an MA in mass communication both from Arizona State University, an MBA from Central European University, and received the John S. Knight Journalism Fellowship, for Journalism and Media Innovation, from Stanford University in 2012.

Justin Maddox is an adjunct professor in the Department of Information Sciences and Technology at George Mason University. Maddox is a counterterrorism expert with specialization in emerging technology applications. He is the CEO of Inventive Insights LLC, a research and analysis consultancy. He recently served as the deputy coordinator of the interagency Global Engagement Center, where he implemented cutting-edge technologies to counter terrorist propaganda. He has led counterterrorism activities at the CIA, the State Department, DHS, and NNSA, and has been a Special Operations Team Leader in the US Army. Since 2011, Maddox has taught National Security Challenges, a graduate-level course, requiring students to devise realistic solutions to key strategic threats. Maddox holds an MA from Georgetown University's National Security Studies Program and a BA in liberal arts from St. John's College, the "great books" school. He has lived and worked in Iraq, India, and Germany, and can order a drink in Russian, Urdu and German.

Sensor Design Technology

Session Chairs: Jon McElvain, Dolby Laboratories (United States) and Arnaud Peizerat, CEA (France)

10:30 – 11:10 am
Regency A

ISS-115

3D-IC smart image sensors, *Laurent Millet and Stephane Chevobbe, CEA/LETI (France)*

Laurent Millet received his MS in electronic engineering from PHELMA University, Grenoble, France (2008). Since then, he has been with CEA LETI, Grenoble, in the smart ICs for image sensor and display laboratory (L3I), where he leads projects in analog design on infra-red and visible imaging. His first work topic was high-speed pipeline analog to digital converter for infra-red image sensors. His current field of expertise is 3-D stacked integration technology applied to image sensors, in which he explores highly parallel topologies for high speed and very high-speed vision chips, by combining fast readout and near sensor digital processing.

Remote Sensing in Agriculture I — Joint Session

Session Chairs: Vijayan Asari, University of Dayton (United States) and Mohammed Yousefhussien, General Electric Global Research (United States)

10:50 – 11:40 am
Cypress B
This session is jointly sponsored by: Food and Agricultural Imaging Systems 2020, and Imaging and Multimedia Analytics in a Web and Mobile World 2020.

FAIS-127

Managing crops across spatial and temporal scales - The roles of UAS and satellite remote sensing, *Jan van Aardt, Rochester Institute of Technology (United States)*

Jan van Aardt obtained a BSc in forestry (biometry and silviculture specialization) from the University of Stellenbosch, South Africa (1996). He completed his MS and PhD in forestry, focused on remote sensing (imaging spectroscopy and light detection and ranging), at Virginia Polytechnic Institute and State University, (2000 and 2004, respectively). This was followed by post-doctoral work at the Katholieke Universiteit Leuven, Belgium, and a stint as research group leader at the Council for Scientific and Industrial Research, South Africa. Imaging spectroscopy and structural (lidar) sensing of natural resources form the core of his efforts, which vary between vegetation structural and system state (physiology) assessment. He has received funding from NSF, NASA, Google, and USDA, among others, and has published more than 70 peer-reviewed papers and more than 90 conference contributions. van Aardt is currently a professor in the Chester F. Carlson Center for Imaging Science at the Rochester Institute of Technology.

Quality Metrics

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

10:50 – 11:30 am
Regency B

AVM-124

Automated optimization of ISP hyperparameters to improve computer vision accuracy, *Doug Taylor, Avinash Sharma, Karl St. Arnaud, and Dave Tokic, Algolux (Canada)*

Remote Sensing in Agriculture II — Joint Session

Session Chairs: Vijayan Asari, University of Dayton (United States) and Mohammed Yousefhussien, General Electric Global Research (United States)

11:40 am – 12:30 pm
Cypress B
This session is jointly sponsored by: Food and Agricultural Imaging Systems 2020, and Imaging and Multimedia Analytics in a Web and Mobile World 2020.

FAIS-151

Practical applications and trends for UAV remote sensing in agriculture, *Kevin Lang, PrecisionHawk (United States)*

Kevin Lang is general manager of PrecisionHawk's agriculture business (Raleigh, North Carolina). PrecisionHawk is a commercial drone and data company that uses aerial mapping, modeling, and agronomy platform specifically designed for precision agriculture. Lang advises clients on how to capture value from aerial data collection, artificial intelligence, and advanced analytics in addition to delivering implementation programs. Lang holds a BS in mechanical engineering from Clemson University and an MBA from Wake Forest University.

Multiple Viewer Stereoscopic Displays

Session Chair: Gregg Favalora, The Charles Stark Draper Laboratory, Inc. (United States)

4:10 – 5:10 pm
Grand Peninsula D

SD&A-400

Challenges and solutions for multiple viewer stereoscopic displays, *Kurt Hoffmeister, Mechdyne Corp. (United States)*
Abstract: Many 3D experiences, such as movies, are designed for a single viewer perspective. Unfortunately this means that all viewers must share that one perspective view. Any viewer positioned away from the design eye point will see a skewed perspective and less comfortable stereoscopic viewing experience. For the many situations where multiple perspectives would be desired, we ideally want perspective viewpoints unique to each viewer's position and head orientation. Today there are several possible Multiviewer solutions available including personal Head Mounted Displays (HMDs), multiple overlapped projection displays, and high frame rate projection. Each type of solution and application unfortunately has its own pros and cons such that there is no one ideal solution. This presentation will discuss the need for multiviewer solutions as a key challenge for stereoscopic displays and multiple participant applications, it will review some historical approaches, the challenges of technologies used and their implementation, and finally some current solutions readily available. As we all live and work in a collaborative world it is only natural our Virtual Reality and data visualization experiences should account for multiple viewers. For collocated participants there are several available solutions now that have built on years of previous development, some of these solutions can also accommodate remote participants. The intent of this presentation is an enlightened look at multiple viewer stereoscopic display solutions.

As a co-founder of Mechdyne Corporation, Kurt Hoffmeiste r has been a pioneer and worldwide expert in large-screen virtual reality and simulation system design, installation, and integration. A licensed professional engineer with several patents, Hoffmeister was in charge of evaluating and implementing new AV/IT technology and components into Mechdyne's solutions. He has contributed to more than 500 Mechdyne projects, including more than 30 projects worth + $1 million investment. Today he consults

as a highly experienced resource for Mechdyne project teams. Hoffmeister has been involved in nearly every Mechdyne project for the past 20 years serving in a variety of capacities, including researcher, consultant, systems designer, and systems engineer. Before co-founding Mechdyne, he spent 10 years in technical and management roles with the Michelin Tire Company's North American Research Center, was an early employee and consultant at Engineering Animation, Inc. (now a division of Siemens), and was a researcher at Iowa State University. His current role at Mechdyne is technology consultant since retiring in 2018.

Wednesday, January 29, 2020

Imaging Systems and Processing — Joint Session

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

8:50 – 9:30 am

Regency A

This session is jointly sponsored by: The Engineering Reality of Virtual Reality 2020, Imaging Sensors and Systems 2020, and Stereoscopic Displays and Applications XXXI.

ISS-189

Mixed reality guided neuronavigation for non-invasive brain stimulation treatment, *Christoph Leuze, Stanford University (United States)*

Abstract: Medical imaging is used extensively world-wide to visualize the internal anatomy of the human body. Since medical imaging data is traditionally displayed on separate 2D screens, it needs an intermediary or well-trained clinician to translate the location of structures in the medical imaging data to the actual location in the patient's body. Mixed reality can solve this issue by allowing to visualize the internal anatomy in the most intuitive manner possible, by directly projecting it onto the actual organs inside the patient. At the Incubator for Medical Mixed and Extended Reality (IMMERS) in Stanford, we are connecting clinicians and engineers to develop techniques that allow to visualize medical imaging data directly overlaid on the relevant anatomy inside the patient, making navigation and guidance for the clinician both simpler and safer. In this presentation I will talk about different projects we are pursuing at IMMERS and go into detail about a project on mixed reality neuronavigation for non-invasive brain stimulation treatment of depression. Transcranial Magnetic Stimulation is a non-invasive brain stimulation technique that is used increasingly for treating depression and a variety of neuropsychiatric diseases. To be effective the clinician needs to accurately stimulate specific brain networks, requiring accurate stimulator positioning. In Stanford we have developed a method that allows the clinician to "look inside" the brain to see functional brain areas using a mixed reality device and I will show how we are currently using this method to perform mixed reality-guided brain stimulation experiments.

Christoph Leuze is a research scientist in the Incubator for Medical Mixed and Extended Reality at Stanford University where he focuses on techniques for visualization of MRI data using virtual and augmented reality devices. He published BrainVR, a virtual reality tour through his brain and is closely working with clinicians on techniques to visualize and register medical imaging data to the real world using optical see-through augmented reality devices such as the Microsoft Hololens and the Magic Leap One. Prior to joining Stanford, he worked on high-resolution brain MRI measurements at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, for which he was awarded the Otto Hahn medal by the Max Planck Society for outstanding young researchers.

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)*

Frédéric Guichard is the chief technology officer at DXOMARK. He brings an extensive scientific and technical expertise in imaging, cameras, image processing and computer vision. Prior to co-founding DxO Labs he was the chief scientist at Vision IQ and prior to that a researcher at Inrets. He did his postdoc internship at Cognitech, after completing his MS and PhD in mathematics at Ecole normale supérieure (1989-1993), and his PhD in applied mathematics from Université Paris Dauphine (1992 – 1994). Guichard earned his engineering degree from École des Ponts ParisTech (1994 – 1997).

Digital vs Physical Document Security

Session Chair: Gaurav Sharma, University of Rochester (United States)

9:00 – 10:00 am

Cypress A

MWSF-204

Digital vs physical: A watershed in document security, *Ian Lancaster, Lancaster Consulting (United Kingdom)*

Ian Lancaster is a specialist in holography and authentication and served as the general secretary to the International Hologram Manufacturers Association from its founding in 1994 until 2015. Having stepped into a part-time role as associate, he is responsible for special projects. Lancaster began his career as an arts administrator, working at the Gulbenkian Foundation, among other places. He received a Fellowship from the US State Department to survey the video and holographic arts fields in the US, which led him to help set up the UK's first open-access holography studio, where he learned to make holograms. In 1982, Lancaster founded the first successful display hologram producer, Third Dimension Ltd, later becoming the executive director of the Museum of Holography in New York. In 1990, he co-founded Reconnaissance International (www.reconnaissance.net), where he was managing director for 25 years. In that position he founded Holography News, Authentication News, Pharmaceutical AntiCounterfeiting News, and Currency News; directed Reconnaissance's anti-counterfeiting, product protection, and holography conferences; was chief analyst and writer of the company's holography industry reports; led the company into the pharmaceutical anti-counterfeiting field; and expanded the company into the currency and tax stamps fields. In 2015, he was awarded the Russian Optical Society's Denisyuk Medal for services to holography worldwide and the Chinese Security Identification Union's Blue Shield award for lifetime achievement in combating counterfeits. For more https://www.lancaster-consult.com/.

Personal Health Data and Surveillance

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

9:10 – 10:10 am
Cypress B

IMAVVM-211

Health surveillance, *Ramesh Jain, University of California, Irvine (United States)*

Ramesh Jain is a scientist and entrepreneur in the field of information and computer science. He is a Bren Professor in Information & Computer Sciences, Donald Bren School of Information and Computer Sciences, University of California, Irvine. Prior to this he was a professor at University of Michigan, Ann Arbor; University of California, San Diego; and Georgia Tech. His research interests started in cybernetic systems, then pattern recognition, computer vision, and artificial intelligence. He coauthored the first computer vision paper addressing analysis of real video sequence of a traffic scene. After working on several aspects of computer vision systems and machine vision, he realized that to solve hard computer vision problems one must include all available information from other signals and contextual sources, which led to work in developing multimedia computing systems. Jain participated in developing the concept of immersive as well as multiple perspective interactive videos, to use multiple video cameras to build 3D video where a person can decide what they want to experience. Since 2012, he has been engaged in developing a navigational approach to guide people to achieve personal health goals. He founded/co-founded multiple startup companies including Imageware, Virage, Praja, and Seraja. He has served as chairman of ACM SIG Multimedia; was founding editor-in-chief of IEEE MultiMedia magazine and the Machine Vision and Applications journal; and serves on the editorial boards of several journals. He is a Fellow of ACM, IEEE, IAPR, AAAI, AAAS, and SPIE, and has published more than 400 research papers. Jain holds a PhD from Indian Institute of Technology in India.

Image Processing

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

3:30 – 4:10 pm
Regency B

AVM-262

Deep image processing, *Vladlen Koltun, Intel Labs (United States)*

Vladlen Koltun is the chief scientist for Intelligent Systems at Intel. He directs the Intelligent Systems Lab, which conducts high-impact basic research in computer vision, machine learning, robotics, and related areas. He has mentored more than 50 PhD students, postdocs, research scientists, and PhD student interns, many of whom are now successful research leaders.

Visualization Facilities — Joint Session

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

4:10 – 5:10 pm
Grand Peninsula D

This session is jointly sponsored by: The Engineering Reality of Virtual Reality 2020, and Stereoscopic Displays and Applications XXXI.

The keynote will be co-presented by Derek Van Tonder and Andy McCutcheon.

ERVR-295

Social holographics: Addressing the forgotten human factor, *Derek Van Tonder and Andy McCutcheon, Euclideon Holographics (Australia)*

Abstract: With all the hype and excitement surrounding Virtual and Augmented Reality, many people forget that while powerful technology can change the way we work, the human factor seems to have been left out of the equation for many modern-day solutions. For example, most modern Virtual Reality HMDs completely isolate the user from their external environment, causing a wide variety of problems. "See-Through" technology is still in its infancy. In this submission we argue that the importance of the social factor outweighs the headlong rush towards better and more realistic graphics, particularly in the design, planning and related engineering disciplines. Large-scale design projects are never the work of a single person, but modern Virtual and Augmented Reality systems forcibly channel users into single-user simulations, with only very complex multi-user solutions slowly becoming available. In our presentation, we will present three different Holographic solutions to the problems of user isolation in Virtual Reality, and discuss the benefits and downsides of each new approach. With all the hype and excitement surrounding Virtual and Augmented Reality, many people forget that while powerful technology can change the way we work, the human factor seems to have been left out of the equation for many modern-day solutions. For example, most modern Virtual Reality HMDs completely isolate the user from their external environment, causing a wide variety of problems. "See-Through" technology is still in its infancy. In this submission we argue that the importance of the social factor outweighs the headlong rush towards better and more realistic graphics, particularly in the design, planning and related engineering disciplines. Large-scale design projects are never the work of a single person, but modern Virtual and Augmented Reality systems forcibly channel users into single-user simulations, with only very complex multi-user solutions slowly becoming available. In our presentation, we will present three different Holographic solutions to the problems of user isolation in Virtual Reality, and discuss the benefits and downsides of each new approach.

Derek Van Tonder is senior business development manager specializing in B2B product sales and project management with Euclideon Holographics in Brisbane Australia. Van Tonder began his career in console game development with I-Imagine, then was a senior developer with Pandemic Studios, a senior engine programmer with Tantalus Media and then Sega Studios, and a lecturer in game programming at Griffith University in Brisbane. In 2010, he founded Bayside Games to pursue development of an iOS game called "Robots Can't Jump" written from scratch in C++. In 2012 he joined Euclideon, transitioning from leading software development to technical business development. In 2015 he joined Taylors—applying VR technology to urban development. Currently Van Tonder is involved with several projects, including a Safe Site Pty Ltd developing a revolutionary new Immersive Training software platform, and a CSIRO Data61 Robotics and Autonomous Systems Group to produce a Windows port of the "Wildcat" robotics software framework, which functions as the "brains" of a range of different robotics platforms.

Andy McCutcheon is a former Special Forces Commando who transitioned

into commercial aviation as a pilot after leaving the military in 1990. He dove-tailed his specialized skill-set to become one of the world's most recognizable celebrity bodyguards, working with some of the biggest names in music and film before moving to Australia in 2001. In 2007, he pioneered the first new alcohol beverages category in 50 years with his unique patented 'Hard Iced Tea,' which was subsequently sold in 2013. He is the author of two books and is currently the Global Sales Manager, Aerospace & Defence for Brisbane based Euclideon Holographics, recently named 'Best Technology Company' in 2019.

2020 Friends of HVEI Banquet

Hosts: Damon Chandler, Shizuoka University (Japan); Mark McCourt, North Dakota State University (United States); and Jeffrey Mulligan, NASA Ames Research Center (United States)

7:00 – 10:00 pm

Offsite Restaurant

This annual event brings the HVEI community together for great food and convivial conversation. Registration required, online or at the registration desk. Location will be provided with registration.

HVEI-401

Perception as inference, *Bruno Olshausen, UC Berkeley (United States)*

Bruno Olshausen is a professor in the Helen Wills Neuroscience Institute, the School of Optometry, and has a below-the-line affiliated appointment in EECS. He holds a BS and a MS in electrical engineering from Stanford University, and a PhD in computation and neural systems from the California Institute of Technology. He did his postdoctoral work in the Department of Psychology at Cornell University and at the Center for Biological and Computational Learning at the Massachusetts Institute of Technology. From 1996-2005 he was on the faculty in the Center for Neuroscience at UC Davis, and in 2005 he moved to UC Berkeley. He also directs the Redwood Center for Theoretical Neuroscience, a multidisciplinary research group focusing on building mathematical and computational models of brain function (see http://redwood.berkeley.edu). Olshausen's research focuses on understanding the information processing strategies employed by the visual system for tasks such as object recognition and scene analysis. Computer scientists have long sought to emulate the abilities of the visual system in digital computers, but achieving performance anywhere close to that exhibited by biological vision systems has proven elusive. Olshausen's approach is based on studying the response properties of neurons in the brain and attempting to construct mathematical models that can describe what neurons are doing in terms of a functional theory of vision. The aim of this work is not only to advance our understanding of the brain but also to devise new algorithms for image analysis and recognition based on how brains work.

Thursday, January 30, 2020

Multisensory and Crossmodal Interactions

Session Chair: Lora Likova, Smith-Kettlewell Eye Research Institute (United States)

9:10 – 10:10 am

Grand Peninsula A

HVEI-354

Multisensory interactions and plasticity – Shooting hidden assumptions, revealing postdictive aspects, *Shinsuke Shimojo, California Institute of Technology (United States)*

Shinsuke Shimojo is professor of biology and principle investigator with the Shimojo Psychophysics Laboratory at California Institute of Technology, one of the few laboratories at Caltech that exclusively concentrates on the study of perception, cognition, and action in humans. The lab employs psychophysical paradigms and a variety of recording techniques such as eye tracking, functional magnetic resonance imaging (fMRI), and electroencephalogram (EEG), as well as, brain stimulation techniques such as transcranial magnetic stimulation (TMS), transcranial direct current stimulation (tDCS), and recently ultrasound neuromodulation (UNM). The research tries to bridge the gap between cognitive and neurosciences and to understand how the brain adapts real-world constraints to resolve perceptual ambiguity and to reach ecologically valid, unique solutions. In addition to continuing interest in surface representation, motion perception, attention, and action, the research also focuses on crossmodal integration (including VR environments), visual preference/attractiveness decision, social brain, flow and choke in the game-playing brains, individual differences related to "neural, dynamic fingerprint" of the brain.

Visualization and Cognition

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

2:00 – 3:00 pm

Regency C

VDA-386

Augmenting cognition through data visualization, *Alark Joshi, University of San Francisco (United States)*

Alark Joshi is a data visualization researcher and an associate professor of computer science at the University of San Francisco. He has published research papers in the field of data visualization and has been on award-winning panels at the top Data Visualization conferences. His research focuses on develop warded the Distinguished Teaching Award at the University of San Francisco in 2016. He received his postdoctoral training at Yale University and PhD in computer science from the University of Maryland Baltimore County.

JOINT SESSIONS

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.

AVM-001
LED flicker measurement: Challenges, considerations and updates from IEEE P2020 working group, *Brian Deegan, Valeo Vision Systems (Ireland)*

Brian Deegan is a senior expert at Valeo Vision Systems. The LED flicker work Deegan is involved with came about as part of the IEEE P2020 working group on Automotive Image Quality standards. One of the challenges facing the industry is the lack of agreed standards for assessing camera image quality performance. Deegan leads the working group specifically covering LED flicker. He holds a BS in computer engineering from the University of Limerick (2004), and an MSc in biomedical engineering from the University of Limerick (2005). Biomedical engineering has already made its way into the automotive sector. A good example would be driver monitoring. By analyzing a drivers patterns, facial expressions, eye movements etc, automotive systems can already tell if a driver has become drowsy and provide an alert.

Human Factors in Stereoscopic Displays — Joint Session

Session Chairs: Nicolas Holliman, University of Newcastle (United Kingdom) and Jeffrey Mulligan, NASA Ames Research Center (United States)

8:45 – 10:10 am
Grand Peninsula D
This session is jointly sponsored by: Human Vision and Electronic Imaging 2020, and Stereoscopic Displays and Applications XXXI.

8:50 HVEI-009
Stereoscopic 3D optic flow distortions caused by mismatches between image acquisition and display parameters (JIST-first), *Alex Hwang and Eli Peli, Harvard Medical School (United States)*

9:10 HVEI-010
The impact of radial distortions in VR headsets on perceived surface slant (JIST-first), *Jonathan Tong, Robert Allison, and Laurie Wilcox, York University (Canada)*

9:30 SD&A-011
Visual fatigue assessment based on multitask learning (JIST-first), *Danli Wang, Chinese Academy of Sciences (China)*

9:50 SD&A-012
Depth sensitivity investigation on multi-view glasses-free 3D display, *Di Zhang[1], Xinzhu Sang[2], and Peng Wang[2]; [1]Communication University of China and [2]Beijing University of Posts and Telecommunications (China)*

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)*

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)*

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 Irshad[1], Alessandro Silva[1,2], Sana Alamgeer[1], and Mylène Farias[1]; [1]University of Brasilia and [2]IFG (Brazil)*

3:50 IQSP-067

Perceptual image quality assessment for various viewing conditions and display systems, *Andrei Chubarau[1], Tara Akhavan[2], Hyunjin Yoo[2], Rafal Mantiuk[3], and James Clark[1]; [1]McGill University (Canada), [2]IRYStec Software Inc. (Canada), and [3]University 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 Robitza, and Alexander Raake, Technische Universität Ilmenau (Germany)*

Tuesday, January 28, 2020

Skin and Deep Learning — Joint Session

Session Chairs: Alessandro Rizzi, Università degli Studi di Milano (Italy) and Ingeborg Tastl, HP Labs, HP Inc. (United States)

8:45 – 9:30 am

Regency C

This session is jointly sponsored by: Color Imaging XXV: Displaying, Processing, Hardcopy, and Applications, and Material Appearance 2020.

8:50 MAAP-082

Beyond color correction: Skin color estimation in the wild through deep learning, *Robin Kips, Quoc Tran, Emmanuel Malherbe, and Matthieu Perrot, L'Oréal Research and Innovation (France)*

9:10 COLOR-083

SpectraNet: A deep model for skin oxygenation measurement from multi-spectral data, *Ahmed Mohammed, Mohib Ullah, and Jacob Bauer, Norwegian University of Science and Technology (Norway)*

Drone Imaging I — Joint Session

Session Chairs: Andreas Savakis, Rochester Institute of Technology (United States) and Grigorios Tsagkatakis, Foundation for Research and Technology (FORTH) (Greece)

8:45 – 10:10 am

Cypress

This session is jointly sponsored by: Food and Agricultural Imaging Systems 2020, and Imaging and Multimedia Analytics in a Web and Mobile World 2020.

8:50 IMAWM-084

A new training model for object detection in aerial images, *Geng Yang[1], Yu Geng[2], Qin Li[1], Jane You[3], and Mingpeng Cai[1]; [1]Shenzhen Institute of Information Technology (China), [2]Shenzhen Shangda Xinzhi Information Technology Co., Ltd. (China), and [3]The Hong Kong Polytechnic University (Hong Kong)*

9:10 IMAWM-085

Small object bird detection in infrared drone videos using mask R-CNN deep learning, *Yasmin Kassim[1], Michael Byrne[1], Cristy Burch[2], Kevin Mote[2], Jason Hardin[2], and Kannappan Palaniappan[1]; [1]University of Missouri and [2]Texas Parks and Wildlife (United States)*

9:30 IMAWM-086

High-quality multispectral image generation using conditional GANs, *Ayush Soni, Alexander Loui, Scott Brown, and Carl Salvaggio, Rochester Institute of Technology (United States)*

9:50 IMAWM-087

Deep Ram: Deep neural network architecture for oil/gas pipeline right-of-way automated monitoring, *Ruixu Liu, Theus Aspiras, and Vijayan Asari, University of Dayton (United States)*

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 Pinson[3]; [1]RISE Acreo AB (Sweden), [2]Mid Sweden University (Sweden), and [3]National 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 Hedlund[1], and Chris Snijders[2]; [1]RISE Research Institutes of Sweden AB (Sweden), [2]University of Technology Eindhoven (the Netherlands), and [3]Mid Sweden University (Sweden)*

9:30 HVEI-092
Open software framework for collaborative development of no reference image and video quality metrics, *Margaret Pinson[1], Philip Corriveau[2], Mikolaj Leszczuk[3], and Michael Colligan[4]; [1]US Department of Commerce (United States), [2]Intel Corporation (United States), [3]AGH University of Science and Technology (Poland), and [4]Spirent 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)*

Spectral Dataset — Joint Session

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

9:30 – 10:10 am

Regency C

This session is jointly sponsored by: Color Imaging XXV: Displaying, Processing, Hardcopy, and Applications, and Material Appearance 2020.

9:30 MAAP-106
Visible to near infrared reflectance hyperspectral images dataset for image sensors design, *Axel Clouet[1], Jérôme Vaillant[1], and Célia Viola[2]; [1]CEA-LETI and [2]CEA-LITEN (France)*

9:50 MAAP-107
A multispectral dataset of oil and watercolor paints, *Vahid Babaei[1], Azadeh Asadi Shahmirzadi[2], and Hans-Peter Seidel[1]; [1]Max-Planck-Institut für Informatik and [2]Consultant (Germany)*

Drone Imaging II — Joint Session

Session Chairs: Vijayan Asari, University of Dayton (United States) and Grigorios Tsagkatakis, Foundation for Research and Technology (FORTH) (Greece)

10:30 – 10:50 am

Cypress B

This session is jointly sponsored by: Food and Agricultural Imaging Systems 2020, and Imaging and Multimedia Analytics in a Web and Mobile World 2020.

IMAWM-114
LambdaNet: A fully convolutional architecture for directional change detection, *Bryan Blakeslee and Andreas Savakis, Rochester Institute of Technology (United States)*

Color and Appearance Reproduction — Joint Session

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

10:40 am – 12:30 pm

Regency C

This session is jointly sponsored by: Color Imaging XXV: Displaying, Processing, Hardcopy, and Applications, and Material Appearance 2020.

10:40 MAAP-396
From color and spectral reproduction to appearance, BRDF, and beyond, *Jon Yngve Hardeberg, Norwegian University of Science and Technology (NTNU) (Norway)*

11:10 MAAP-120
HP 3D color gamut – A reference system for HP's Jet Fusion 580 color 3D printers, *Ingeborg Tastl[1] and Alexandra Ju[2]; [1]HP Labs, HP Inc. and [2]HP Inc. (United States)*

11:30 COLOR-121
Spectral reproduction: Drivers, use cases, and workflow, *Tanzima Habib, Phil Green, and Peter Nussbaum, Norwegian University of Science and Technology (Norway)*

11:50 COLOR-122
Parameter estimation of PuRet algorithm for managing appearance of material objects on display devices (JIST-first), *Midori Tanaka, Ryusuke Arai, and Takahiko Horiuchi, Chiba University (Japan)*

12:10 COLOR-123
Colorimetrical performance estimation of a reference hyperspectral microscope for color tissue slides assessment, *Paul Lemaillet and Wei-Chung Cheng, US Food and Drug Administration (United States)*

KEYNOTE: Remote Sensing in Agriculture I — Joint Session

Session Chairs: Vijayan Asari, University of Dayton (United States) and Mohammed Yousefhussien, General Electric Global Research (United States)

10:50 – 11:40 am

Cypress B

This session is jointly sponsored by: Food and Agricultural Imaging Systems 2020, and Imaging and Multimedia Analytics in a Web and Mobile World 2020.

FAIS-127
Managing crops across spatial and temporal scales - The roles of UAS and satellite remote sensing, *Jan van Aardt, Rochester Institute of Technology (United States)*

Jan van Aardt obtained a BSc in forestry (biometry and silviculture specialization) from the University of Stellenbosch, Stellenbosch, South Africa (1996). He completed his MS and PhD in forestry, focused on remote sensing (imaging spectroscopy and light detection and ranging), at the Virginia Polytechnic Institute and State University, Blacksburg, Virginia (2000 and 2004, respectively). This was followed by post-doctoral work at the Katholieke Universiteit Leuven, Belgium, and a stint as research group leader at the Council for Scientific and Industrial Research, South Africa. Imaging spectroscopy and structural (lidar) sensing of natural resources form the core of his efforts, which vary between vegetation structural and system state (physiology) assessment. He has received funding from NSF, NASA, Google, and USDA, among others, and has published more than 70 peer-reviewed papers and more than 90 conference contributions. van Aardt is currently a professor in the Chester F. Carlson Center for Imaging Science at the Rochester Institute of Technology, New York.

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 Hajimirza[1], and Naeem Ramzan[2]; [1]Lumen Research Limited and [2]University of the West of Scotland (United Kingdom)*

11:30 HVEI-130
Predicting single observer's votes from objective measures using neural networks, *Lohic Fotio Tiotsop[1], Tomas Mizdos[2], Miroslav Uhrina[2], Peter Pocta[2], Marcus Barkowsky[3], and Enrico Masala[1]; [1]Politecnico di Torino (Italy), [2]Zilina University (Slovakia), and [3]Deggendorf Institute of Technology (DIT) (Germany)*

11:50 HVEI-131
A simple model for test subject behavior in subjective experiments, *Zhi Li[1], Ioannis Katsavounidis[2], Christos Bampis[1], and Lucjan Janowski[3]; [1]Netflix, Inc. (United States), [2]Facebook, Inc. (United States), and [3]AGH 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 Callet[2], Jim Skinner[3], and Ioannis Katsavounidis[3]; [1]CAPACITÉS (France), [2]Université de Nantes (France), and [3]Facebook, Inc. (United States)*

KEYNOTE: Remote Sensing in Agriculture II — Joint Session

Session Chairs: Vijayan Asari, University of Dayton (United States) and Mohammed Yousefhussien, General Electric Global Research (United States)

11:40 am – 12:30 pm

Cypress B

This session is jointly sponsored by: Food and Agricultural Imaging Systems 2020, and Imaging and Multimedia Analytics in a Web and Mobile World 2020.

FAIS-151
Practical applications and trends for UAV remote sensing in agriculture, *Kevin Lang, PrecisionHawk (United States)*

Kevin Lang is general manager of PrecisionHawk's agriculture business (Raleigh, North Carolina). PrecisionHawk is a commercial drone and data company that uses aerial mapping, modeling, and agronomy platform specifically designed for precision agriculture. Lang advises clients on how to capture value from aerial data collection, artificial intelligence, and advanced analytics in addition to delivering implementation programs. Lang holds a BS in mechanical engineering from Clemson University and an MBA from Wake Forest University.

PANEL: Sensors Technologies for Autonomous Vehicle — Joint Session

Panel Moderator: David Cardinal, Cardinal Photo & Extremetech.com (United States)
Panelists: Sanjai Kohli, Visible Sensors, Inc. (United States); Nikhil Naikal, Velodyne Lidar (United States); Greg Stanley, NXP Semiconductors (United States); Alberto Stochino, Perceptive Machines (United States); Nicolas Touchard, DXOMARK Image Labs (France); and Mike Walters, FLIR Systems (United States)

3:30 – 5:30 pm

Regency A

This session is jointly sponsored by: Autonomous Vehicles and Machines 2020, and Imaging Sensors and Systems 2020.

Imaging sensors are at the heart of any self-driving car project. However, selecting the right technologies isn't simple. Competitive products span a gamut of capabilities including traditional visible-light cameras, thermal cameras, lidar, and radar. Our session includes experts in all of these areas, and in emerging technologies, who will help us understand the strengths, weaknesses, and future directions of each. Presentations by the speakers listed below will be followed by a panel discussion.

Introduction: *David Cardinal, ExtremeTech.com, Moderator*

David Cardinal has had an extensive career in high-tech, including as a general manager at Sun Microsystems and co-founder and CTO of FirstFloor Software and Calic o Commerce. More recently he operates a technology consulting business and is a technology journalist, writing for publications including PC Magazine, Ars Technica, and ExtremeTech.com.

LiDAR for Self-driving Cars: *Nikhil Naikal, VP of Software Engineering, Velodyne*

Nikhil Naikal is the VP of software engineering at Velodyne Lidar. He joined the company through their acquisition of Mapper.ai where he was the founding CEO. At Mapper.ai, Naikal recruited a skilled team of scientists, engineers and designers inspired to build the next generation of high precision machine maps that are crucial for the success of self-driving vehicles. Naikal developed his passion for self driving technology while working with Carnegie Mellon University's Tartan Racing team that won the DARPA Urban Challenge in 2007 and honed his expertise in high precision navigation while working at Robert Bosch research and subsequently Flyby Media, which was acquired by Apple in 2015. Naikal holds a PhD in electrical engineering from UC Berkeley, and a MS in robotics from Carnegie Mellon University.

Challenges in Designing Cameras for Self-driving Cars: *Nicolas Touchard, VP of Marketing, DXOMARK*

Nicolas Touchard leads the development of new business opportunities for DXOMARK, including the recent launch of their new Audio Quality Benchmark, and innovative imaging applications including automotive. Starting in 2008 he led the creation of dxomark.com, now a reference for scoring the image quality of DSLRs and smartphones. Prior to DxO, Touchard spent 15+ years at Kodak managing international R&D teams, where he initiated and headed the company's worldwide mobile imaging R&D program.

Using Thermal Imaging to Help Cars See Better: *Mike Walters, VP of Product Management for Thermal Cameras, FLIR Systems*

Abstract: The existing suite of sensors deployed on autonomous vehicles today have proven to be insufficient for all conditions and roadway scenarios. That's why automakers and suppliers have begun to examine complementary sensor technology, including thermal imaging, or long-wave infrared (LWIR). This presentation will explore and show how thermal sensors detect a different part of the electromagnetic spectrum compared to other existing sensors, and thus are very effective at detecting living things, including pedestrians, and other important roadside objects in challenging conditions such as complete darkness, in cluttered city environments, in direct sun glare, or in inclement weather such as fog or rain.

Mike Walters has spent more than 35 years in Silicon Valley, holding various executive technology roles at HP, Agilent Technologies, Flex and now FLIR Systems Inc. Mike currently leads all product management for thermal camera development, including for autonomous automotive applications. Mike resides in San Jose and he holds a masters in electrical engineering from Stanford University.

Radar's Role: *Greg Stanley, Field Applications Engineer, NXP Semiconductors*

Abstract: While radar is already part of many automotive safety systems, there is still room for significant advances within the automotive radar space. The basics of automotive radar will be presented, including a description of radar and the reasons radar is different from visible camera, IR camera, ultrasonic and lidar. Where is radar used today, including L4 vehicles? How will radar improve in the no-too-distant future?

Greg Stanley is a field applications engineer at NXP Semiconductors. At NXP, Stanley supports NXP technologies as they are integrated into automated vehicle and electric vehicle applications. Prior to joining NXP, Stanley lived in Michigan where he worked in electronic product development roles at Tier 1 automotive suppliers, predominately developing sensor systems for both safety and emissions related automotive applications.

Tales from the Automotive Sensor Trenches: *Sanjai Kohli, CEO, Visible Sensors, Inc.*

Sanjai Kohli has been involved in creating multiple companies in the area of localization, communication, and sensing. Most recently Visible Sensors. He has been recognized for his contributions in the industry and is a Fellow of the IEEE.

Auto Sensors for the Future: *Alberto Stochino, Founder and CEO, Perceptive*

Abstract: The sensing requirements of Level 4 and 5 autonomy are orders of magnitude above the capability of today's available sensors. A more effective approach is needed to enable next-generation autonomous vehicles. Based on experience developing some of the world most precise sensors at LIGO, AI silicon at Google, and autonomous technology at Apple, Perceptive is reinventing sensing for Autonomy 2.0.

Alberto Stochino is the founder and CEO of Perceptive, a company that is bringing cutting edge technology first pioneered in gravitational wave observatories an hD in physics for his work on the LIGO observatories at MIT and Caltech. He also built instrumental ranging and timing technology for NASA spacecraft at Stanford and the Australian National University. Before starting Perceptive in 2017, Stochino developed autonomous technology at Apple.

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 Becerra[1], Mylène Farias[1], and Andrew Hines[2]; [1]University of Brasilia (Brazil) and [2]University College Dublin (Ireland)*

4:10 IQSP-168

No reference video quality assessment with authentic distortions using 3-D deep convolutional neural network, *Roger Nieto[1], Hernan Dario Benitez Restrepo[1], Roger Figueroa Quintero[1], and Alan Bovik[2]; [1]Pontificia University Javeriana, Cali (Colombia) and [2]The University of Texas at Austin (United States)*

4:30 IQSP-169

Quality aware feature selection for video object tracking, *Roger Nieto[1], Carlos Quiroga[2], Jose Ruiz-Munoz[3], and Hernan Benitez-Restrepo[1]; [1]Pontificia University Javeriana, Cali (Colombia), [2]Universidad del Valle (Colombia), and [3]University of Florida (United States)*

4:50 IQSP-170

Studies on the effects of megapixel sensor resolution on displayed image quality and relevant metrics, *Sophie Triantaphillidou[1], Jan Smejkal[1], Edward Fry[1], and Chuang Hsin Hung[2]; [1]University of Westminster (United Kingdom) and [2]Huawei (China)*

Wednesday, January 29, 2020

KEYNOTE: Imaging Systems and Processing — Joint Session

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

8:50 – 9:30 am

Regency A

This session is jointly sponsored by: The Engineering Reality of Virtual Reality 2020, Imaging Sensors and Systems 2020, and Stereoscopic Displays and Applications XXXI.

ISS-189

Mixed reality guided neuronavigation for non-invasive brain stimulation treatment, *Christoph Leuze, Stanford University (United States)*

Abstract: Medical imaging is used extensively world-wide to visualize the internal anatomy of the human body. Since medical imaging data is traditionally displayed on separate 2D screens, it needs an intermediary or well-trained clinician to translate the location of structures in the medical imaging data to the actual location in the patient's body. Mixed reality can solve this issue by allowing to visualize the internal anatomy in the most intuitive manner possible, by directly projecting it onto the actual organs inside the patient. At the Incubator for Medical Mixed and Extended Reality (IMMERS) in Stanford, we are connecting clinicians and engineers to develop techniques that allow to visualize medical imaging data directly overlaid on the relevant anatomy inside the patient, making navigation and guidance for the clinician both simpler and safer. In this presentation I will talk about different projects we are pursuing at IMMERS and go into detail about a project on mixed reality neuronavigation for non-invasive brain stimulation treatment of depression. Transcranial Magnetic Stimulation is a non-invasive brain stimulation technique that is used increasingly for treating depression and a variety of neuropsychiatric diseases. To be effective the clinician needs to accurately stimulate specific brain networks, requiring accurate stimulator positioning. In Stanford we have developed a method that allows the clinician to "look inside" the brain to see functional brain areas using a mixed reality device and I will show how we are currently using

this method to perform mixed reality-guided brain stimulation experiments.

Christoph Leuze is a research scientist in the Incubator for Medical Mixed and Extended Reality at Stanford University where he focuses on techniques for visualization of MRI data using virtual and augmented reality devices. He published BrainVR, a virtual reality tour through his brain and is closely working with clinicians on techniques to visualize and register medical imaging data to the real world using optical see-through augmented reality devices such as the Microsoft Hololens and the Magic Leap One. Prior to joining Stanford, he worked on high-resolution brain MRI measurements at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, for which he was awarded the Otto Hahn medal by the Max Planck Society for outstanding young researchers.

Augmented Reality in Built Environments — Joint Session

Session Chairs: Raja Bala, PARC (United States) and Matthew Shreve, Palo Alto Research Center (United States)

10:30 am – 12:40 pm

Cypress B

This session is jointly sponsored by: The Engineering Reality of Virtual Reality 2020, and Imaging and Multimedia Analytics in a Web and Mobile World 2020.

10:30 IMAWM-220
Augmented reality assistants for enterprise, *Matthew Shreve and Shiwali Mohan, Palo Alto Research Center (United States)*

11:00 IMAWM-221
Extra FAT: A photorealistic dataset for 6D object pose estimation, *Jianhang Chen[1], Daniel Mas Montserrat[1], Qian Lin[2], Edward Delp[1], and Jan Allebach[1]; [1]Purdue University and [2]HP Labs, HP Inc. (United States)*

11:20 IMAWM-222
Space and media: Augmented reality in urban environments, *Luisa Caldas, University of California, Berkeley (United States)*

12:00 ERVR-223
Active shooter response training environment for a building evacuation in a collaborative virtual environment, *Sharad Sharma and Sri Teja Bodempudi, Bowie State University (United States)*

12:20 ERVR-224
Identifying anomalous behavior in a building using HoloLens for emergency response, *Sharad Sharma and Sri Teja Bodempudi, Bowie State University (United States)*

Psychophysics and LED Flicker Artifacts — Joint Session

Session Chair: Jeffrey Mulligan, NASA Ames Research Center (United States)

10:50 – 11:30 am

Regency B

This session is jointly sponsored by: Autonomous Vehicles and Machines 2020, and Human Vision and Electronic Imaging 2020.

10:50 HVEI-233
Predicting visible flicker in temporally changing images, *Gyorgy Denes and Rafal Mantiuk, University of Cambridge (United Kingdom)*

11:10 HVEI-234
Psychophysics study on LED flicker artefacts for automotive digital mirror replacement systems, *Nicolai Behmann and Holger Blume, Leibniz University Hannover (Germany)*

Visualization Facilities — Joint Session

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

3:30 – 4:10 pm

Grand Peninsula

This session is jointly sponsored by: The Engineering Reality of Virtual Reality 2020, and Stereoscopic Displays and Applications XXXI.

3:30 SD&A-265
Immersive design engineering, *Bjorn Sommer, Chang Lee, and Savina Toirrisi, Royal College of Art (United Kingdom)*

3:50 SD&A-266
Using a random dot stereogram as a test image for 3D demonstrations, *Andrew Woods, Wesley Lamont, and Joshua Hollick, Curtin University (Australia)*

KEYNOTE: Visualization Facilities — Joint Session

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

4:10 – 5:10 pm

Grand Peninsula D

This session is jointly sponsored by: The Engineering Reality of Virtual Reality 2020, and Stereoscopic Displays and Applications XXXI.

The keynote will be co-presented by Derek Van Tonder and Andy McCutcheon.

ERVR-295
Social holographics: Addressing the forgotten human factor, *Derek Van Tonder and Andy McCutcheon, Euclideon Holographics (Australia)*

Abstract: With all the hype and excitement surrounding Virtual and Augmented Reality, many people forget that while powerful technology can change the way we work, the human factor seems to have been left out of the equation for many modern-day solutions. For example, most modern Virtual Reality HMDs completely isolate the user from their external environment, causing a wide variety of problems. "See-Through" technology is still in its infancy. In this submission we argue that the importance of the social factor outweighs the headlong rush towards better and more realistic graphics, particularly in the design, planning and related engineering disciplines. Large-scale design projects are never the work of a single person, but modern Virtual and Augmented Reality systems forcibly channel users into single-user simulations, with only very complex multi-user solutions slowly becoming available. In our presentation, we will present three different Holographic solutions to the problems of user isolation in Virtual Reality, and discuss the benefits and downsides of each new approach. With all the hype and excitement surrounding Virtual and Augmented Reality, many people forget that while powerful technology can change the way we work, the human factor seems to have been left out of the equation for many modern-day solutions. For example, most modern Virtual Reality HMDs completely isolate the user from their external environment, causing a wide variety of problems. "See-Through" technology is still in its infancy. In this submission we argue that the importance of the social factor outweighs the headlong rush towards better and more realistic graphics, particularly in the design, planning and related engineering disciplines. Large-scale design projects are never the work of a single person, but modern Virtual and Augmented Reality systems forcibly channel users into

single-user simulations, with only very complex multi-user solutions slowly becoming available. In our presentation, we will present three different Holographic solutions to the problems of user isolation in Virtual Reality, and discuss the benefits and downsides of each new approach.

Derek Van Tonder is senior business development manager specializing in B2B product sales and project management with Euclideon Holographics in Brisbane Australia. Van Tonder began his career in console game development with I-Imagine, then was a senior developer with Pandemic Studios, a senior engine programmer with Tantalus Media and then Sega Studios, and a lecturer in game programming at Griffith University in Brisbane. In 2010, he founded Bayside Games to pursue development of an iOS game called "Robots Can't Jump" written from scratch in C++. In 2012 he joined Euclideon, transitioning from leading software development to technical business development. In 2015 he joined Taylors—applying VR technology to urban development. Currently Van Tonder is involved with several projects, including a Safe Site Pty Ltd developing a revolutionary new Immersive Training software platform, and a CSIRO Data61 Robotics and Autonomous Systems Group to produce a Windows port of the "Wildcat" robotics software framework, which functions as the "brains" of a range of different robotics platforms.

Andy McCutcheon is a former Special Forces Commando who transitioned into commercial aviation as a pilot, after leaving the military in 1990. He dove-tailed his specialised skill-set to become one of the world's most recognisable celebrity bodyguards, working with some of the biggest names in music and film before moving to Australia in 2001. In 2007, he pioneered the first new alcohol beverages category in 50 years with his unique patented 'Hard Iced Tea,' which was subsequently sold in 2013. He is the author of two books and is currently the Global Sales Manager, Aerospace & Defence for Brisbane based Euclideon Holographics, recently named 'Best Technology Company' in 2019.

NOTES

PAPER SCHEDULE BY DAY/TIME

Monday, January 27, 2020

8:45 am

AVM-001	LED flicker measurement: Challenges, considerations and uwpdates from IEEE P2020 working group (Deegan)	Regency B

8:50 am

3DMP-002	Deadlift recognition and application based on multiple modalities using recurrent neural network (Chang)	Grand Peninsula A
COIMG-005	Plug-and-play amP for image recovery with Fourier-structured operators (Schniter)	Grand Peninsula B/C
HVEI-009	Stereoscopic 3D optic flow distortions caused by mismatches between image acquisition and display parameters (JIST-first) (Hwang)	Grand Peninsula D
IRIACV-013	Passive infrared markers for indoor robotic positioning and navigation (Chen)	Regency A

8:55 am

MWSF-017	Watermarking to turn plastic packaging from waste to asset through improved optical tagging (Logan)	Cypress A

9:10 am

3DMP-003	Learning a CNN on multiple sclerosis lesion segmentation with self-supervision (Fenneteau)	Grand Peninsula A
COIMG-006	A splitting-based iterative algorithm for GPU-accelerated statistical dual-energy x-ray CT reconstruction (Li)	Grand Peninsula B/C
HVEI-010	The impact of radial distortions in VR headsets on perceived surface slant (JIST-first) (Tong)	Grand Peninsula D
IRIACV-014	Improving multimodal localization through self-supervision (Relyea)	Regency A

9:30 am

3DMP-004	Action recognition using pose estimation with an artificial 3D coordinates and CNN (Kim)	Grand Peninsula A
COIMG-007	Proximal Newton Methods for x-ray imaging with non-smooth regularization (Ge)	Grand Peninsula B/C

Key

- EI2020 Theme: Automotive Imaging
- EI2020 Theme: AR/VR Future Technology
- EI2020 Theme: Frontiers in Computational Imaging
- EI2020 Virtual Track: 3D Imaging
- EI2020 Virtual Track: Deep Learning
- EI2020 Virtual Track: Medical Imaging
- EI2020 Virtual Track: Remote Sensing
- EI 2020 Virtual Track: Security

IQSP-018	A new dimension in geometric camera calibration (Wueller)	Regency B
IRIACV-015	Creation of a fusion image obtained in various electromagnetic ranges used in industrial robotic systems (Voronin)	Regency A
MAAP-020	Capturing and 3D rendering of optical behavior: The physical approach to realism (Ritz)	Regency C
SD&A-011	Visual fatigue assessment based on multitask learning (JIST-first) (Wang)	Grand Peninsula D

9:50 am

AVM-019	Automotive image quality concepts for the next SAE levels: Color separation probability and contrast detection probability (Geese)	Regency B
COIMG-008	Integrating learned data and image models through consensus equilibrium (Karl)	Grand Peninsula B/C
IRIACV-016	Locating mechanical switches using RGB-D sensor mounted on a disaster response robot (Kanda)	Regency A
SD&A-012	Depth sensitivity investigation on multi-view glasses-free 3D display (Zhang)	Grand Peninsula D

Schedule

10:30 am

MWSF-021	Reducing invertible embedding distortion using graph matching model (Wu)	Cypress A

10:50 am

3DMP-034	Variable precision depth encoding for 3D range geometry compression (Finley)	Grand Peninsula A
AVM-038	Describing and sampling the LED flicker signal (Sumner)	Regency B
COIMG-043	Learned priors for the joint ptycho-tomography reconstruction (Aslan)	Grand Peninsula B/C
IPAS-025	Pruning neural networks via gradient information (Molchanov)	Harbour A/B
IRIACV-048	A review and quantitative evaluation of small face detectors in deep learning (Xionog)	Regency A
MAAP-030	One-shot multi-angle measurement device for evaluating the sparkle impression (JIST-first) (Watanabe)	Regency C

10:55 am

MWSF-022	Watermarking in deep neural networks via error back-propagation (Wu)	Cypress A

11:10 am

3DMP-035	3D shape estimation for smooth surfaces using grid-like structured light patterns (Wang)	Grand Peninsula A
COIMG-044	A joint reconstruction and lambda tomography regularization technique for energy-resolved x-ray imaging (Webber)	Grand Peninsula B/C
IPAS-026	Real-world fence removal from a single-image via deep neural network (Matsui)	Harbour A/B
IQSP-039	Demonstration of a virtual reality driving simulation platform (Wang)	Regency B
IRIACV-049	Rare-class extraction using cascaded pretrained networks applied to crane classification (Klomp)	Regency A
MAAP-031	Appearance reproduction of material surface with strong specular reflection (Tominaga)	Regency C
SD&A-053	Morpholo: A hologram generator algorithm (Canessa)	Grand Peninsula D

11:20 am

MWSF-023	Signal rich art: Improvements and extensions (Kamath)	Cypress A

11:30 am

3DMP-036	Quality assessment for 3D reconstruction of building interiors (Raman Kumar)	Grand Peninsula A
AVM-040	Prediction and fast estimation of contrast detection probability (Jenkin)	Regency B
COIMG-045	Generalized tensor learning with applications to 4D-STEM image denoising (Zhang)	Grand Peninsula B/C
IPAS-027	Adaptive context encoding module for semantic segmentation (Wang)	Harbour A/B
IRIACV-050	Detection and characterization of rumble strips in roadway video logs (Aykac)	Regency A
MAAP-032	BTF image recovery based on U-Net and texture interpolation (Tada)	Regency C
SD&A-054	HoloExtension - AI-based 2D backwards compatible super-multiview display technology (Naske)	Grand Peninsula D

11:45 am

MWSF-024	Estimating watermark synchronization signal using partial pixel least squares (Lyons)	Cypress A

11:50 am

AVM-041	Object detection using an ideal observer model (Kane)	Regency B
COIMG-046	Computational imaging in infrared sensing of the atmosphere (Milstein)	Grand Peninsula B/C
IPAS-028	CNN-based classification of degraded images (Endo)	Harbour A/B
IRIACV-051	Real-time small-object change detection from ground vehicles using a Siamese convolutional neural network (JIST-first) (Klomp)	Regency A
MAAP-033	Caustics and translucency perception (Gigilashvili)	Regency C
SD&A-055	Application of a high resolution autostereoscopic display for medical purposes (Higuchi)	Grand Peninsula D

Automotive AR/VR Computational 3D Deep Learning Medical Remote Sensing Security

12:10 pm

AVM-042	Comparison of detectability index and contrast detection probability (JIST-first) (Jenkin)	Regency B
COIMG-047	Learning optimal sampling for computational imaging (Sun)	Grand Peninsula B/C
IPAS-029	A deep learning-based approach for defect detection and removing on archival photos (Voronin)	Harbour A/B
IRIACV-052	Perceptual license plate super-resolution with CTC loss (Bilkova)	Regency A
SD&A-403	Monolithic surface-emitting electroholographic optical modulator (Favalora)	Grand Peninsula D

2:00 pm

PLENARY-056	Imaging the unseen: Taking the first picture of a black hole (Bouman)	Grand Peninsula D

3:30 pm

AVM-057	The automated drive west: Results (Sargent)	Regency B
COIMG-058	Revealing subcellular structures with live-cell and 3D fluorescence nanoscopy (Huang)	Grand Peninsula B/C
IPAS-062	An active contour model for medical image segmentation using a quaternion framework (Voronin)	Harbour A/B
IQSP-066	Perceptual quality assessment of enhanced images using a crowd-sourcing framework (Irshad)	Grand Peninsula A
IRIACV-070	Estimating vehicle fuel economy from overhead camera imagery and application for traffic control (Tokola)	Regency A
MAAP-060	Changes in the visual appearance of polychrome wood caused by (accelerated) aging (Sidorov)	Regency C
MWSF-075	JPEG steganalysis detectors scalable with respect to compression quality (Yousfi)	Cypress A
SD&A-065	High frame rate 3D-challenges, issues and techniques for success (Paul)	Grand Peninsula D

3:50 pm

COIMG-059	Single-shot coded diffraction system for 3D object shape estimation (Galvis)	Grand Peninsula B/C
IPAS-063	Improving 3D medical image compression efficiency using spatiotemporal coherence (Zerva)	Harbour A/B
IQSP-067	Perceptual image quality assessment for various viewing conditions and display systems (Chubarau)	Grand Peninsula A
IRIACV-071	Tailored photometric stereo: Optimization of light source positions for different materials (Kapeller)	Regency A
MAAP-061	Image processing method for renewing old objects using deep learning (Takahashi)	Regency C

3:55 pm

MWSF-076	Detection of malicious spatial-domain steganography over noisy channels using convolutional neural networks (Hadar)	Cypress A

4:10 pm

AVM-079	VisibilityNet: Camera visibility detection and image restoration for autonomous driving (Yogamani)	Regency B
HVEI-068	Improved temporal pooling for perceptual video quality assessment using VMAF (Kondi)	Grand Peninsula A
IPAS-064	Pathology image-based lung cancer subtyping using deep-learning features and cell-density maps (Jaber)	Harbour A/B
IRIACV-072	Crowd congestion detection in videos (Ullah)	Regency A

4:20 pm

MWSF-077	Semi-blind image resampling factor estimation for PRNU computation (Darvish Morshedi Hosseini)	Cypress A

Automotive AR/VR Computational 3D Deep Learning Medical Remote Sensing Security

4:30 pm

AVM-080	Sun-glare detection using late fusion of CNN and image processing operators (Yahiaoui)	Regency B
HVEI-069	Quality assessment protocols for omnidirectional video quality evaluation (Singla)	Grand Peninsula A
IRIACV-074	Head-based tracking (Ullah)	Regency A

4:45 pm

MWSF-078	A CNN-based correlation predictor for PRNU-based image manipulation localization (Chakraborty)	Cypress A

4:50 pm

AVM-081	Single image haze removal using multiple scattering model for road scenes (Kim)	Regency B

Tuesday, January 28, 2020

8:50 am

AVM-088	Regaining sight of humanity on the roadway towards automation (López-González)	Regency B
COIMG-089	Computation and photography: How the mobile phone became a camera (Milanfar)	Grand Peninsula B/C
HVEI-090	The Video Quality Experts Group - Current activities and research (Brunnström)	Grand Peninsula A
IMAWM-084	A new training model for object detection in aerial images (You)	Cypress B
IPAS-094	Two-step cascading algorithm for camera-based night fire detection (Park)	Harbour A/B
MAAP-082	Beyond color correction: Skin color estimation in the wild through deep learning (Kips)	Regency C
SD&A-098	Dynamic zero-parallax-setting techniques for multi-view autostereoscopic display (Jiao)	Grand Peninsula D

9:00 am

MWSF-102	Technology in context: Solutions to foreign propaganda and disinformation (Stewart)	Cypress A

9:10 am

COLOR-083	SpectraNet: A deep model for skin oxygenation measurement from multi-spectral data (Bauer)	Regency C
HVEI-091	Quality of experience assessment of 360-degree video (Brunnström)	Grand Peninsula A
IMAWM-085	Small object bird detection in infrared drone videos using mask R-CNN deep learning (Palaniappan)	Cypress B
IPAS-095	Introducing scene understanding to person re-identification using a spatio-temporal multi-camera model (Liu)	Harbour A/B
ISS-103	A 4-tap global shutter pixel with enhanced IR sensitivity for VGA time-of-flight CMOS image sensors (Jung)	Regency A
SD&A-099	Projection type 3D display using spinning screen (Hayakawa)	Grand Peninsula D

9:30 am

AVM-109	VRUNet: Multitask learning model for intent prediction of vulnerable road users (Ranga)	Regency B
COIMG-111	Spectral shearing LADAR (Stafford)	Grand Peninsula B/C
HVEI-092	Open software framework for collaborative development of no reference image and video quality metrics (Pinson)	Grand Peninsula A
IMAWM-086	High-quality multispectral image generation using conditional GANs (Soni)	Cypress B
IPAS-096	Use of retroreflective markers for object detection in harsh sensing conditions (Gotchev)	Harbour A/B
ISS-104	Indirect time-of-flight CMOS image sensor using 4-tap charge-modulation pixels and range-shifting multi-zone technique (Mars)	Regency A
MAAP-106	Visible to near infrared reflectance hyperspectral images dataset for image sensors design (Clouet)	Regency C
SD&A-100	Full-parallax 3D display using time-multiplexing projection technology (Omura)	Grand Peninsula D

Automotive | AR/VR | Computational | 3D | Deep Learning | Medical | Remote Sensing | Security

9:50 am

AVM-108	Multiple pedestrian tracking using Siamese random forests and shallow convolutional neural networks (Lee)	Regency B
COIMG-112	3D computational phase microscopy with multiple-scattering samples (Waller)	Grand Peninsula B/C
HVEI-093	Investigating prediction accuracy of full reference objective video quality measures through the ITS4S dataset (Fotio Tiotsop)	Grand Peninsula A
IMAWM-087	Deep RAM: Deep neural network architecture for oil/gas pipeline right-of-way automated monitoring (Aspiras)	Cypress B
IPAS-097	A novel image recognition approach using multiscale saliency model and GoogLeNet (Yang)	Harbour A/B
ISS-105	Improving the disparity for depth extraction by decreasing the pixel height in monochrome CMOS image sensor with offset pixel apertures (Shin)	Regency A
MAAP-107	A multispectral dataset of oil and watercolor paints (Asadi Shahmirzadi)	Regency C
SD&A-101	Light field display using wavelength division multiplexing (Yamauchi)	Grand Peninsula D

10:10 am

AVM-110	End-to-end multitask learning for driver gaze and head pose estimation (Ewaisha)	Regency B
COIMG-113	Imaging through deep turbulence and emerging solutions (Spencer)	Grand Peninsula B/C

10:30 am

IMAWM-114	LambdaNet: A fully convolutional architecture for directional change detection (Savakis)	Cypress B
ISS-115	3D-IC smart image sensors (Millet)	Regency A
MWSF-116	Detecting "deepfakes" in H.264 video data using compression ghost artifacts (Zmudzinski)	Cypress A

10:40 am

MAAP-396	From color and spectral reproduction to appearance, BRDF, and beyond (Hardeberg)	Regency C

10:50 am

AVM-124	Automated optimization of ISP hyperparameters to improve computer vision accuracy (Taylor)	Regency B
COIMG-125	Holographic imaging through highly attenuating fog conditions (Watnik)	Grand Peninsula B/C
FAIS-127	Managing crops across spatial and temporal scales - The roles of UAS and satellite remote sensing (van Aardt)	Cypress B
HVEI-128	Quality evaluation of 3D objects in mixed reality for different lighting conditions (Le Callet)	Grand Peninsula A
IPAS-133	Edge detection using the Bhattacharyya distance with adjustable block space (Yoon)	Harbour A/B
SD&A-138	Objective and subjective evaluation of a multi-stereo 3D reconstruction system (Kapeller)	Grand Peninsula D

10:55 am

MWSF-117	A system for mitigating the problem of deepfake news videos using watermarking (Alattar)	Cypress A

11:10 am

COIMG-126	Intensity interferometry-based 3D ranging (Wagner)	Grand Peninsula B/C
HVEI-129	A comparative study to demonstrate the growing divide between 2D and 3D gaze tracking quality (Blakey)	Grand Peninsula A
IPAS-134	Color interpolation algorithm for a periodic white-dominant RGBW color filter array (Jeong)	Harbour A/B
ISS-143	An over 120dB dynamic range linear response single exposure CMOS image sensor with two-stage lateral overflow integration trench capacitors (Fujihara)	Regency A
MAAP-120	HP 3D color gamut – A reference system for HP's Jet Fusion 580 color 3D printers (Tastl)	Regency C
SD&A-139	Flow map guided correction to stereoscopic panorama (Wang)	Grand Peninsula D

Automotive | AR/VR | Computational | 3D | Deep Learning | Medical | Remote Sensing | Security

11:20 am

MWSF-118	Checking the integrity of images with signed thumbnail images (Berchtold)	Cypress A

11:30 am

AVM-148	Using the dead leaves pattern for more than spatial frequency response measurements (Artmann)	Regency B
COIMG-146	Constrained phase retrieval using a non-linear forward model for x-ray phase contrast tomography (Mohan)	Grand Peninsula B/C
COLOR-121	Spectral reproduction: Drivers, use cases, and workflow (Habib)	Regency C
HVEI-130	Predicting single observer's votes from objective measures using neural networks (Fotio Tiotsop)	Grand Peninsula A
IPAS-135	Computational color constancy under multiple light sources (Han)	Harbour A/B
ISS-144	Planar microlenses for near infrared CMOS image sensors (Dilhan)	Regency A
SD&A-140	Spatial distance-based interpolation algorithm for computer generated 2D+Z images (Jiao)	Grand Peninsula D

11:40 am

FAIS-151	Practical applications and trends for UAV remote sensing in agriculture (Lang)	Cypress B

11:45 am

MWSF-119	The effect of class definitions on the transferability of adversarial attacks against forensic CNNs (Zhao)	Cypress A

11:50 am

AVM-149	Simulating tests to test simulation (Braun)	Regency B
COIMG-147	Multi-wavelength remote digital holography: Seeing the unseen by imaging off scattering surfaces and imaging through scattering media (Willomitzer)	Grand Peninsula B/C
COLOR-122	Parameter estimation of PuRet algorithm for managing appearance of material objects on display devices (JIST-first) (Tanaka)	Regency C
HVEI-131	A simple model for test subject behavior in subjective experiments (Li)	Grand Peninsula A
IPAS-136	Per clip Lagrangian multiplier optimisation for HEVC (Ringis)	Harbour A/B
ISS-145	Event threshold modulation in dynamic vision spiking imagers for data throughput reduction (Cubero)	Regency A
SD&A-141	Processing legacy underwater stereophotography for new applications (Woods)	Grand Peninsula D

12:10 pm

AVM-150	Validation methods for geometric camera calibration (Romanczyk)	Regency B
COIMG-152	3D DiffuserCam: Computational microscopy with a lensless imager (Waller)	Grand Peninsula B/C
COLOR-123	Colorimetrical performance estimation of a reference hyperspectral microscope for color tissue slides assessment (Lemaillet)	Regency C
HVEI-132	Characterization of user generated content for perceptually-optimized video compression: Challenges, observations and perspectives (Ling)	Grand Peninsula A
IPAS-137	An expandable image database for evaluation of full-reference image visual quality metrics (Egiazarian)	Harbour A/B
SD&A-142	Multifunctional stereoscopic machine vision system with multiple 3D outputs (Ezhov)	Grand Peninsula D

2:00 pm

PLENARY-153	Imaging in the autonomous vehicle revolution (Hicok)	Grand Peninsula D

Automotive AR/VR Computational 3D Deep Learning Medical Remote Sensing Security

3:30 pm

COIMG-156	Computational nanoscale imaging with synchrotron radiation (Gursoy)		Grand Peninsula B/C
COLOR-161	Automated multicolored fabric image segmentation and associated psychophysical evaluation (Xiong)		Regency C
FAIS-171	Fish freshness estimation though analysis of multispectral images with convolutional neural networks (Tsagkatakis)		Regency B
IMAWM-183	Actual usage of AI to generate more interesting printed products (Invited) (Fageth)		Cypress B
IPAS-177	Fractional contrast stretching for image enhancement of aerials and satellite images (JIST-first) (Trongtirakul)		Harbour A/B
IQSP-166	DXOMARK objective video quality measurements (Baudin)		Grand Peninsula A
MWSF-215	Score-based likelihood ratios in camera device identification (Reinders)		Cypress A
SD&A-154	CubicSpace: A reliable model for proportional, comfortable and universal capture and display of stereoscopic content (Routhier)		Grand Peninsula D

3:50 pm

COIMG-157	Recent advances in 3D structured illumination microscopy with reduced data-acquisition (Preza)		Grand Peninsula B/C
COLOR-162	Comparing a spatial extension of ICtCp color representation with S-CIELAB and other recent color metrics for HDR and WCG quality assessment (Choudhury)		Regency C
FAIS-172	Deep learning based fruit freshness classification and detection with CMOS image sensors and edge processors (Ananthanarayana)		Regency B
IPAS-178	Image debanding using iterative adaptive sparse filtering (Gadgil)		Harbour A/B
IQSP-167	Analyzing the performance of autoencoder-based objective quality metrics on audio-visual content (Becerra)		Grand Peninsula A
SD&A-155	A camera array system based on DSLR cameras for autostereoscopic prints (Lin)		Grand Peninsula D

3:55 pm

MWSF-216	Camera unavoidable scene watermarks: A method for forcibly conveying information onto photographs (Demaree)		Cypress A

4:00 pm

IMAWM-184	Deep learning for printed mottle defect grading (Chen)		Cypress B

4:10 pm

COIMG-158	Method of moments for single-particle cryo-electron microscopy (Singer)		Grand Peninsula B/C
COLOR-163	An improved optimisation method for finding a color filter to make a camera more colorimetric (Finlayson)		Regency C
FAIS-173	Smartphone imaging for color analysis of tomatoes (Carpenter)		Regency B
IPAS-179	Hyperspectral complex-domain image denoising: Cube complex-domain BM3D (CCDBM3D) algorithm (Egiazarian)		Harbour A/B
IQSP-168	No reference video quality assessment with authentic distortions using 3-D deep convolutional neural network (Nieto)		Grand Peninsula A
SD&A-400	Challenges and solutions for multiple viewer stereoscopic displays (Hoffmeister)		Grand Peninsula D

4:20 pm

IMAWM-185	A local-global aggregate network for facial landmark localization (Mao)		Cypress B
MWSF-217	A deep learning approach to MRI scanner manufacturer and model identification (Fang)		Cypress A

Automotive | AR/VR | Computational | 3D | Deep Learning | Medical | Remote Sensing | Security

4:30 pm

COIMG-159	Computational imaging in transmission electron microscopy: Atomic electron tomography and phase contrast imaging (Ophus)		Grand Peninsula B/C
COLOR-164	Random spray Retinex extensions considering ROI and eye movements (JIST-first) (Tanaka)		Regency C
FAIS-174	Cattle identification and activity recognition by surveillance camera (Guan)		Regency B
IPAS-180	Color restoration of multispectral images: Near-infrared (NIR) filter-to-color (RGB) image (Agaian)		Harbour A/B
IQSP-169	Quality aware feature selection for video object tracking (Nieto)		Grand Peninsula A

4:40 pm

IMAWM-186	The blessing and the curse of the noise behind facial landmark annotations (Xiang)		Cypress B

4:45 pm

MWSF-218	Motion vector based robust video hash (Liu)		Cypress A

4:50 pm

COIMG-160	3D and 4D computational imaging of molecular orientation with multiview polarized fluorescence microscopy (Chandler)		Grand Peninsula B/C
COLOR-165	Teaching color and color science: The experience of an international Master course (Rossi)		Regency C
FAIS-175	High-speed imaging technology for online monitoring of food safety and quality attributes: Research trends and challenges (Yoon)		Regency B
IPAS-181	Non-blind image deconvolution based on "ringing" removal using convolutional neural network (Kudo)		Harbour A/B
IQSP-170	Studies on the effects of megapixel sensor resolution on displayed image quality and relevant metrics (Triantaphillidou)		Grand Peninsula A

5:00 pm

IMAWM-187	Gun source and muzzle head detection (Zhou)		Cypress B

5:10 pm

FAIS-176	A survey on deep learning in food imaging applications (Jaber)		Regency B
IPAS-182	OEC-CNN: A simple method for over-exposure correction in photographs (Chesnokov)		Harbour A/B

5:20 pm

IMAWM-188	Semi-supervised multi-task network for image aesthetic assessment (Xiang)		Cypress B

Wednesday, January 29, 2020

8:50 am

AVM-200	A tool for semi-automatic ground truth annotation of traffic videos (Groh)		Regency B
COIMG-191	Model comparison metrics require adaptive correction if parameters are discretized: Application to a transient neurotransmitter signal in PET data (Liu)		Grand Peninsula B/C
COLOR-195	New results for aperiodic, dispersed-dot halftoning (Liu)		Regency C
IQSP-190	Camera vs smartphone: How electronic imaging changed the game (Guichard)		Harbour A/B
ISS-189	Mixed reality guided neuronavigation for non-invasive brain stimulation treatment (Leuze)		Regency A

9:00 am

MWSF-204	Digital vs physical: A watershed in document security (Lancaster)		Cypress A

9:10 am

AVM-201	A low-cost approach to data collection and processing for autonomous vehicles with a realistic virtual environment (Fernandes)		Regency B
COIMG-192	Computational pipeline and optimization for automatic multimodal reconstruction of marmoset brain histology (Lee)		Grand Peninsula B/C

Automotive AR/VR Computational 3D Deep Learning Medical Remote Sensing Security

COLOR-196	Data bearing halftone image alignment and assessment on 3D surface (Zhao)		Regency C
HVEI-208	Neural edge integration model accounts for the staircase-Gelb and scrambled-Gelb effects in lightness perception (Rudd)		Grand Peninsula A
IMAWM-211	Health surveillance (Jain)		Cypress B
MOBMU-205	Strategies of using ACES look modification transforms (LMTs) in a VFX environment (Hasche)		Sandpebble A/B

9:30 am

AVM-202	Metrology impact of advanced driver assistance systems (Iacomussi)		Regency B
COIMG-193	Model-based approach to more accurate stopping power ratio estimation for proton therapy (Medrano)		Grand Peninsula B/C
COLOR-197	Using watermark visibility measurements to select an optimized pair of spot colors for use in a binary watermark (Reed)		Regency C
HVEI-209	Influence of texture structure on the perception of color composition (JPI-first) (Pappas)		Grand Peninsula A
ISS-212	Soft-prototyping imaging systems for oral cancer screening (Farrell)		Regency A
MOBMU-206	Creating high resolution 360° 15:1-content for a conference room using film compositing technologies (Hasche)		Sandpebble A/B

9:50 am

AVM-203	A study on training data selection for object detection in nighttime traffic scenes (Unger)		Regency B
COIMG-194	Deep learning based regularized image reconstruction for respiratory gated PET (Li)		Grand Peninsula B/C
COLOR-198	Rendering data in the blue channel (Ulichney)		Regency C
HVEI-210	Evaluation of tablet-based methods for assessment of contrast sensitivity (Mulligan)		Grand Peninsula A
IQSP-214	Comparing common still image quality metrics in recent High Dynamic Range (HDR) and Wide Color Gamut (WCG) representations (Choudhury)		Harbour A/B
ISS-213	Calibration empowered minimalistic multi-exposure image processing technique for camera linear dynamic range extension (Riza)		Regency A
MOBMU-207	JAB code - A versatile polychrome 2D barcode (Berchtold)		Sandpebble A/B

10:30 am

IMAWM-220	Augmented reality assistants for enterprise (Shreve)		Cypress B
ISS-225	Anisotropic subsurface scattering acquisition through a light field based apparatus (Piadyk)		Regency A
MWSF-398	Smartphone systems for secure documents (Hodgson)		Cypress A

10:50 am

COIMG-247	Adversarial training incorporating physics-based regularization for digital microstructure synthesis (Niezgoda)		Grand Peninsula B/C
COLOR-235	Individual differences in feelings about the color red (Ichihara)		Regency C
HVEI-233	Predicting visible flicker in temporally changing images (Denes)		Regency B
IQSP-239	Validation of modulation transfer functions and noise power spectra from natural scenes (JIST-first) (Fry)		Harbour A/B
ISS-226	CAOS smart camera-based robust low contrast image recovery over 90 dB scene linear dynamic range (Riza)		Regency A
MOBMU-232	The human factor and social engineering - Personality traits and personality types as a basis for security awareness (Creutzburg)		Sandpebble A/B
SD&A-243	Evaluating the stereoscopic display of visual entropy glyphs in complex environments (Holliman)		Grand Peninsula D

Automotive AR/VR Computational 3D Deep Learning Medical Remote Sensing Security

10:55 am

MWSF-397	Embedding data in the blue channel* (Ulichney)	Cypress A

11:00 am

IMAWM-221	Extra FAT: A photorealistic dataset for 6D object pose estimation (Chen)	Cypress B

11:10 am

COIMG-248	Crystallographic symmetry for data augmentation in detecting dendrite cores (Fu)	Grand Peninsula B/C
COLOR-236	Colors before and after cataract surgery: A study of color constancy and discrimination (McCann)	Regency C
HVEI-234	Psychophysics study on LED flicker artefacts for automotive digital mirror replacement systems (Behmann)	Regency B
IQSP-240	Application of ISO standard methods to optical design for image capture (Burns)	Harbour A/B
ISS-227	TunnelCam - A HDR spherical camera array for structural integrity assessments of dam interiors (Meyer)	Regency A
MOBMU-252	Measuring IT security, compliance, and digital sovereignty within small and medium-sized IT enterprises (Johannsen)	Sandpebble A/B
SD&A-244	Evaluating user experience of 180 and 360 degree images (Banchi)	Grand Peninsula D

11:20 am

IMAWM-222	Space and media: Augmented reality in urban environments (Caldas)	Cypress B
MWSF-399	Physical object security title TBA (Sharma)	Cypress A

11:30 am

AVM-255	Multi-sensor fusion in dynamic environments using evidential grid mapping (Godaliyadda)	Regency B
COIMG-249	Multi-resolution data fusion for super resolution imaging of biological materials (Reid)	Grand Peninsula B/C
COLOR-237	Daltonization by spectral filtering (Green)	Regency C
IQSP-241	Camera system performance derived from natural scenes (van Zwanenberg)	Harbour A/B
ISS-228	Characterization of camera shake (Dietz)	Regency A
MOBMU-253	Investigation of risks for critical infrastructures due to the exposure of SCADA systems and industrial controls on the Internet based on the search engine Shodan (Creutzburg)	Sandpebble A/B
SD&A-245	Visual quality in VR head mounted device: Lessons learned making professional headsets (Mendiburu)	Grand Peninsula D

11:45 am

MWSF-219	High-entropy optically variable device characterization – Facilitating multimodal authentication and capture of deep learning data (Lindstrand)	Cypress A

11:50 am

AVM-257	LiDAR-camera fusion for 3D object detection (Bhanushali)	Regency B
COIMG-250	Void detection and fiber extraction for statistical characterization of fiber-reinforced polymers (Aguilar Herrera)	Grand Peninsula B/C
COLOR-238	Psychophysical evaluation of grey scale functions performance (Baah)	Regency C
IQSP-242	Correcting misleading image quality measurements (Koren)	Harbour A/B
ISS-229	Expanding dynamic range in a single-shot image through a sparse grid of low exposure pixels (Eisemann)	Regency A
MOBMU-254	Towards sector-specific security operation (Creutzburg)	Sandpebble A/B
SD&A-246	The single image stereoscopic auto-pseudogram – Classification and theory (Benoit)	Grand Peninsula D

12:00 pm

ERVR-223	Active shooter response training environment for a building evacuation in a collaborative virtual environment (Sharma)	Cypress B

Automotive | AR/VR | Computational | 3D | Deep Learning | Medical | Remote Sensing | Security

12:10 pm

AVM-258	Active stereo vision for precise autonomous vehicle control (Feller)		Regency B
COIMG-251	Applications of denoising, structure optimization, and deep learning in high resolution electron microscopy (Voyles)		Grand Peninsula B/C
COLOR-259	Visual fidelity improvement in virtual reality through spectral textures applied to lighting simulations (Díaz-Barrancas)		Regency C
ISS-230	Deep image demosaicing for submicron image sensors (JIST-first) (Kim)		Regency A
MOBMU-402	Situational Strategic Awareness Monitoring Surveillance System (SSamSS) - Microcomputer and microcomputer clustering used for intelligent, economical, scalable, and deployable approach for materials (JIST-first) (Maldonado)		Sandpebble A/B

12:20 pm

COLOR-260	Application of spectral computing technics for color vision testing using virtual reality devices (Cwierz)		Regency C
ERVR-224	Identifying anomalous behavior in a building using HoloLens for emergency response (Sharma)		Cypress B

12:30 pm

ISS-231	Sun tracker sensor for attitude control of space navigation systems (Leñero-Bardallo)		Regency A

2:00 pm

PLENARY-261	Quality screen time: Leveraging computational displays for spatial computing (Lanman)		Grand Peninsula D

3:30 pm

AVM-262	Deep image processing (Koltun)		Regency B
COIMG-263	Mueller matrix imaging for classifying similar diffuse materials (Li)		Grand Peninsula B/C
COLOR-279	Increases in scattered light causes increased darkness (McCann)		Regency C
HVEI-267	Conventions and temporal differences in painted faces: A study of posture and color distribution (Van Zuijlen)		Grand Peninsula A
IMAWM-269	Identification of utility images with a mobile device (Shankar)		Cypress B
IQSP-284	Subjective and viewport-based objective quality assessment of 360-degree videos (Janatra)		Harbour A/B
ISS-272	A short-pulse based time-of-flight image sensor using 4-tap charge-modulation pixels with accelerated carrier response (Inoue)		Regency A
MOBMU-275	Security and privacy investigation of Wi-Fi connected and app-controlled IoT-based consumer market smart light bulbs (Creutzburg)		Sandpebble A/B
MWSF-289	Minimum perturbation cost modulation for side-informed steganography (Butora)		Cypress A
SD&A-265	Immersive design engineering (Sommer)		Grand Peninsula D

3:50 pm

COIMG-264	Modeling multivariate tail behavior in materials data (Aguilar)		Grand Peninsula B/C
COLOR-280	Do you see what I see? (Green)		Regency C
HVEI-268	Biological and biomimetic perception: A comparative study through gender recognition from human gait (JPI-pending) (Pelah)		Grand Peninsula A
IMAWM-270	PSO and genetic modeling of deep features for road passibility analysis during floods (Ullah)		Cypress B
IQSP-285	Statistical characterization of tile decoding time of HEVC-encoded 360° video (Farias)		Harbour A/B
ISS-273	Single-shot multi-frequency pulse-TOF depth imaging with sub-clock shifting for multi-path interference separation (Kokado)		Regency A
MOBMU-276	New methodology and checklist of Wi-Fi connected and app-controlled IoT-based consumer market smart home devices (Creutzburg)		Sandpebble A/B
SD&A-266	Using a random dot stereogram as a test image for 3D demonstrations (Woods)		Grand Peninsula D

Automotive AR/VR Computational 3D Deep Learning Medical Remote Sensing Security

3:55 pm

MWSF-290	Synchronizing embedding changes in side-informed steganography (Boroumand)		Cypress A

4:10 pm

AVM-296	End-to-end deep path planning and automatic emergency braking camera cocoon-based solution (Abdou)		Regency B
COIMG-293	A spectrum-adaptive decomposition method for effective atomic number estimation using dual energy CT (Manerikar)		Grand Peninsula B/C
COLOR-281	Replacing test charts with pictures (Triantaphillidou)		Regency C
ERVR-295	Social holographics: Addressing the forgotten human factor (Van Tonder)		Grand Peninsula D
IMAWM-271	A deep neural network-based indoor positioning algorithm by cascade of image and WiFi (Cui)		Cypress B
IQSP-286	Complexity optimization for the upcoming versatile video coding standard (Larabi)		Harbour A/B
ISS-274	A high-linearity time-of-flight image sensor using a time-domain feedback technique (Kim)		Regency A
MOBMU-277	Conception and implementation of a course for professional training and education in the field of IoT and smart home security (Creutzburg)		Sandpebble A/B

4:20 pm

MWSF-291	Generative text steganography based on adaptive arithmetic coding and LSTM network (Wu)		Cypress A

4:30 pm

AVM-297	Federated semantic mapping and localization for autonomous driving (Yogamani)		Regency B
COIMG-294	Metal artifact reduction in dual-energy CT with synthesized monochromatic basis for baggage screening (Devadithya)		Grand Peninsula B/C
COLOR-282	Colors challanges in navigating autonomous vehicles (Wueller)		Regency C
IMAWM-300	Shazam for food: Learning diet with visual data (Invited) (Zhu)		Cypress B
IQSP-287	On the improvement of 2D quality metrics for the assessment of 360-deg images (Larabi)		Harbour A/B
MOBMU-278	Conception and implementation of professional laboratory exercises in the field of open source intelligence (OSINT) (Creutzburg)		Sandpebble A/B

4:45 pm

MWSF-292	Analyzing the decoding rate of circular coding in a noisy transmission channel (Sun)		Cypress A

4:50 pm

AVM-298	Progress on the AUTOSAR adaptive platform for intelligent vehicles (Derrick)		Regency B
COLOR-283	Does computer vision need color science? (Allebach)		Regency C
IMAWM-301	Visual processing of dietary data: A nutrition science perspective (Eicher-Miller)		Cypress B
IQSP-288	The cone model: Recognizing gaze uncertainty in virtual environments (Jogeshwar)		Harbour A/B
MOBMU-303	Mobile head tracking for eCommerce and beyond (Cicek)		Sandpebble A/B

5:10 pm

AVM-299	Object tracking continuity through track and trace method (Williams)		Regency B
IMAWM-302	Image analytics for food safety (Zhao)		Cypress B
MOBMU-304	International biobanking interface service - Health sciences in the digital age (Creutzburg)		Sandpebble A/B

Automotive AR/VR Computational 3D Deep Learning Medical Remote Sensing Security

5:30 pm

COIMG-305	Connected-tube MPP model for unsupervised 3D fiber detection (Li)		Sequoia
COIMG-306	Imaging through scattering media with a learning based prior (Schiffers)		Sequoia
COIMG-307	Reconstruction of 2D seismic wavefields from nonuniformly sampled sources (Galvis)		Sequoia
IMAWM-309	Real-time whiteboard coding on mobile devices (Pan)		Sequoia
IPAS-310	Comparing training variability of CNN and optimal linear data reduction on image textures (Omer)		Sequoia
IPAS-311	Elastic graph-based semi-supervised embedding with adaptive loss regression (Dornaika)		Sequoia
IPAS-312	Generative adversarial networks: A short review (Ullah)		Sequoia
IPAS-313	Multiscale convolutional descriptor aggregation for visual place recognition (Imbriaco)		Sequoia
IQSP-314	A comprehensive system for analyzing the presence of print quality defects (Zhang)		Sequoia
IQSP-315	DNN-based ISP parameter inference algorithm for automatic image quality optimization (Kim)		Sequoia
IQSP-316	Effective ISP tuning framework based on user preference feedback (Yang)		Sequoia
IQSP-317	Evaluation of optical performance characteristics of endoscopes (Wang)		Sequoia
IQSP-318	Human preference on chroma boosting in images (Jiang)		Sequoia
IQSP-319	Prediction of performance of 2D DCT-based filter and adaptive selection of its parameter (Egiazarian)		Sequoia
IQSP-320	Quantification method for video motion correction performance in mobile image sensor (Cha)		Sequoia
IQSP-321	Region of interest extraction for image quality assessment (Zhang)		Sequoia
IQSP-322	Relation between image quality and resolution - Part I (Hu)		Sequoia
IQSP-323	Relation between image quality and resolution - Part II (Hu)		Sequoia
IRIACV-325	An evaluation of embedded GPU systems for visual SLam algorithms (Peng)		Sequoia
IRIACV-326	An evaluation of visual SLam methods on NVIDIA Jetson Systems (Peng)		Sequoia
ISS-327	Camera support for use of unchipped manual lenses (Dietz)		Sequoia
ISS-328	CIS band noise prediction methodology using co-simulation of camera module (Lee)		Sequoia
ISS-329	From photons to digital values: A comprehensive simulator for image sensor design (de Gouvello)		Sequoia
ISS-330	Non-uniform integration of TDCI captures (Eberhart)		Sequoia
MOBMU-331	AI-based anomaly detection for cyberattacks on Windows systems - Creation of a prototype for automated monitoring of the process environment (Creutzburg)		Sequoia
MOBMU-332	An implementation of drone-projector: Stabilization of projected images (Choi)		Sequoia
MOBMU-333	Cybersecurity and forensic challenges - A bibliographic review 2020 (Creutzburg)		Sequoia
MOBMU-334	MessageSpace. Messaging systems for health research (Vo)		Sequoia
MOBMU-335	Performance analysis of mobile cloud architectures for mHealth app (Inupakutika)		Sequoia
MOBMU-336	Secure remote service box (Creutzburg)		Sequoia

7:00 pm

HVEI-401	Perception as inference (Olshausen)		Offsite Restaurant

Automotive AR/VR Computational 3D Deep Learning Medical Remote Sensing Security

Thursday, January 30, 2020

8:50 am

COIMG-341	2D label free microscopy imaging analysis using machine learning (Hu)		Grand Peninsula B/C
COLOR-350	Developing an inkjet printer I: RGB image to CMY ink amounts – Image preprocessing and color management (Wang)		Regency C
ERVR-337	Using virtual reality for spinal cord injury rehabilitation (Woods)		Regency A
IQSP-345	Noise power spectrum scene-dependency in simulated image capture systems (Fry)		Harbour A/B

9:10 am

COIMG-342	ProPaCoL-Net: A novel recursive stereo SR net with progressive parallax coherency learning (Kim)		Grand Peninsula B/C
COLOR-351	Developing an inkjet printer II: CMY ink amounts to multibit CMY halftones (Choi)		Regency C
ERVR-338	Heads-up LiDAR imaging with sensor fusion (Cai)		Regency A
HVEI-354	Multisensory interactions and plasticity – Shooting hidden assumptions, revealing postdictive aspects (Shimojo)		Grand Peninsula A
IQSP-346	Verification of long-range MTF testing through intermediary optics (Schwartz)		Harbour A/B

9:30 am

COIMG-343	Deep learning method for height estimation of sorghum in the field using LiDAR (Waliman)		Grand Peninsula B/C
COLOR-352	Developing an inkjet printer III: Multibit CMY halftones to hardware-ready bits (Hu)		Regency C
ERVR-339	Enhancing lifeguard training through virtual reality (Miller)		Regency A
IQSP-347	Measuring camera Shannon information capacity with a Siemens star image (Koren)		Harbour A/B

9:50 am

COIMG-344	Background subtraction in diffraction x-ray images using deep CNN (Agam)		Grand Peninsula B/C
COLOR-349	Developing an inkjet printer IV: Printer mechanism control for best print quality (Kenzhebalin)		Regency C
ERVR-340	Transparent type virtual image display using small mirror array (Temochi)		Regency A
IQSP-348	Scene-and-process-dependent spatial image quality metrics (JIST-first) (Fry)		Harbour A/B

10:10 am

COLOR-353	Using acoustic information to diagnose the health of a printer (Chen)		Regency C

10:50 am

COIMG-355	Estimation of the background illumination in optical reflectance microscopy (Hirakawa)		Grand Peninsula B/C
ERVR-360	Designing a VR arena: Integrating virtual environments and physical spaces for social, sensorial data-driven virtual experiences (West)		Regency A
HVEI-365	Multisensory contributions to learning face-name associations (Murray)		Grand Peninsula A
IQSP-370	Depth map quality evaluation for photographic applications (Thomas)		Harbour A/B

11:10 am

COIMG-356	Programming paradigm for streaming reconfigurable architectures (Nousias)		Grand Peninsula B/C
ERVR-361	Leaving the windows open: Indeterminate situations through composite 360-degree photography (Williams)		Regency A
HVEI-366	Face perception as a multisensory process (Likova)		Grand Peninsula A
IQSP-371	Prediction of Lee filter performance for Sentinel-1 SAR images (Egiazarian)		Harbour A/B
VDA-374	A gaze-contingent system for foveated multiresolution visualization of vector and volumetric data (Joshi)		Regency C

Automotive AR/VR Computational 3D Deep Learning Medical Remote Sensing Security

11:30 am

COIMG-357	Skin chromophore and melanin estimation from mobile selfie images using constrained independent component analysis (Polania)		Grand Peninsula B/C
ERVR-362	User experience evaluation in virtual reality based on subjective feelings and physiological signals (JIST-first) (Niu)		Regency A
HVEI-367	Changes in auditory-visual perception induced by partial vision loss: Use of novel multisensory illusions (Stiles)		Grand Peninsula A
IQSP-372	Evaluating whole-slide imaging viewers used in digital pathology (Lemaillet)		Harbour A/B
VDA-375	A visualization system for performance analysis of image classification models (Park)		Regency C

11:50 am

COIMG-358	Computational imaging: Algorithm/hardware co-design considerations (Goma)		Grand Peninsula B/C
ERVR-363	Interactive multi-user 3D visual analytics in augmented reality (Schulze)		Regency A
HVEI-368	Multisensory temporal processing in early deaf individuals (Jiang)		Grand Peninsula A
IQSP-373	Ink quality ruler experiments and print uniformity predictor (Yang)		Harbour A/B
VDA-376	HashFight: A platform-portable hash table for multi-core and many-core architectures (Lessley)		Regency C

12:10 pm

COIMG-359	Statistical inversion methods in mobile imaging (Siddiqui)		Grand Peninsula B/C
ERVR-364	CalAR: A C++ engine for augmented reality applications on Android mobile devices (Schulze)		Regency A
HVEI-369	Inter- and intra-individual variability in multisensory integration in autism spectrum development: A behavioral and electrophysiological study (Saron)		Grand Peninsula A

2:00 pm

COIMG-377	Efficient multilevel architecture for depth estimation from a single image (Savakis)		Grand Peninsula B/C
ERVR-380	Development and evaluation of immersive educational system to improve driver's risk prediction ability in traffic accident situation (Suto)		Regency A
HVEI-383	Auditory capture of visual motion: Effect of audio-visual stimulus onset asynchrony (McCourt)		Grand Peninsula A
VDA-386	Augmenting cognition through data visualization (Joshi)		Regency C

2:20 pm

COIMG-378	Sky segmentation for enhanced depth reconstruction and Bokeh rendering with efficient architectures (Nuanes)		Grand Peninsula B/C
ERVR-381	WARHOL: Wearable holographic object labeler (Shreve)		Regency A
HVEI-384	Auditory and audiovisual processing in visual cortex (Green)		Grand Peninsula A

2:40 pm

COIMG-379	A dataset for deep image deblurring aided by inertial sensor data (Zhang)		Grand Peninsula B/C
ERVR-382	RaViS: Real-time accelerated view synthesizer for immersive video 6DoF VR (Bonatto)		Regency A
HVEI-385	Perception of a stable visual environment during head motion depends on motor signals (MacNeilage)		Grand Peninsula A

3:30 pm

COIMG-390	On the distinction between phase images and two-view light field for PDAF of mobile imaging (Chen)		Grand Peninsula B/C
HVEI-393	Multisensory aesthetics: Visual, tactile and auditory preferences for fractal-scaling characteristics (Spehar)		Grand Peninsula A
VDA-387	A visualization tool for analyzing the suitability of software libraries via their code repositories (Haber)		Regency C

Automotive AR/VR Computational 3D Deep Learning Medical Remote Sensing Security

Schedule

3:50 pm

COIMG-391	Indoor layout estimation by 2D LiDAR and camera fusion (Li)		Grand Peninsula B/C
HVEI-394	Introducing Vis+Tact(TM) iPhone app (Mahoney)		Grand Peninsula A
VDA-388	Visualization of search results of large document sets (Anderson)		Regency C

4:10 pm

COIMG-392	Senscape: Modeling and presentation of uncertainty in fused sensor data live image streams (Dietz)		Grand Peninsula B/C
HVEI-395	An accelerated Minkowski summation rule for multisensory cue combination (Tyler)		Grand Peninsula A
VDA-389	Human-computer interface based on tongue and lips movements and its application for speech therapy system (Bilkova)		Regency C

Schedule

Automotive AR/VR Computational 3D Deep Learning Medical Remote Sensing Security

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3D Measurement and Data Processing 2020

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.

3D MEASUREMENT AND DATA PROCESSING 2020

Monday, January 27, 2020

3D/4D NN-based Data Processing

Session Chair: Tyler Bell, University of Iowa (United States)

8:45 – 10:10 am
Grand Peninsula A

8:45
Conference Welcome

8:50 3DMP-002
Deadlift recognition and application based on multiple modalities using recurrent neural network, *Shih-Wei Sun[1], Ting-Chen Mou[2], and Pao-Chi Chang[2]; [1]Taipei National University of the Arts and [2]National Central University (Taiwan)*

9:10 3DMP-003
Learning a CNN on multiple sclerosis lesion segmentation with self-supervision, *Alexandre Fenneteau[1], Pascal Bourdon[1,2,3], David Helbert[1,2,3], and Christophe Habas[4]; [1]University of Poitiers, [2]I3M, Common Laboratory CNRS-Siemens, University and Hospital of Poitiers, [3]XLIM Laboratory, and [4]Quinze-Vingts Hospital (France)*

9:30 3DMP-004
Action recognition using pose estimation with an artificial 3D coordinates and CNN, *Jisu Kim and Deokwoo Lee, Keimyung University (Republic of Korea)*

9:50
3DMP Q&A Session Discussion

10:10 – 10:50 am Coffee Break

3D/4D Measurement and Processing

Session Chair: Tyler Bell, University of Iowa (United States)

10:50 am – 12:10 pm
Grand Peninsula A

10:50 3DMP-034
Variable precision depth encoding for 3D range geometry compression, *Matthew Finley and Tyler Bell, University of Iowa (United States)*

11:10 3DMP-035
3D shape estimation for smooth surfaces using grid-like structured light patterns, *Yin Wang and Jan Allebach, Purdue University (United States)*

11:30 3DMP-036
Quality assessment for 3D reconstruction of building interiors, *Umamaheswaran Raman Kumar, Inge Coudron, Steven Puttemans, and Patrick Vandewalle, Katholieke Universiteit Leuven (Belgium)*

11:50
3DMP Q&A Session Discussion

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

Autonomous Vehicles and Machines 2020

Conference overview

Advancements in sensing, computing, imaging processing, and computer vision technologies are enabling unprecedented growth and interest in autonomous vehicles and intelligent machines, from self-driving cars to unmanned drones and 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.

Successfully launched in 2017, Autonomous Vehicles and Machines (AVM) considers 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. AVM welcomes both academic researchers and industrial experts to join the discussion. In addition to the main technical program, AVM will include interactive and open forum sessions between AVM speakers, committee members, and conference participants.

Awards

Best Paper Award and Best Student Paper Award

Conference Sponsor

AutoSens

AUTONOMOUS VEHICLES AND MACHINES 2020

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

KEYNOTE: Visibility

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

3:30 – 4:10 pm
Regency B

AVM-057
The automated drive west: Results, *Sara Sargent, engineering project manager, VSI Labs (United States)*

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

Visibility

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

4:10 – 5:10 pm
Regency B

4:10 AVM-079
VisibilityNet: Camera visibility detection and image restoration for autonomous driving, *Hazem Rashed, Senthil Yogamani, and Michal Uricar, Valeo Group (Egypt)*

4:30 AVM-080
Sun-glare detection using late fusion of CNN and image processing operators, *Lucie Yahiaoui and Senthil Yogamani, Valeo Vision Systems (Ireland)*

4:50 AVM-081
Single image haze removal using multiple scattering model for road scenes, *Minsub Kim, Soonyoung Hong, and Moon Gi Kang, Yonsei University (Republic of Korea)*

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

KEYNOTE: Human Interaction

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

8:50 – 9:30 am
Regency B

AVM-088
Regaining sight of humanity on the roadway towards automation, *Mónica López-González, La Petite Noiseuse Productions (United States)*

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

Human Interaction

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

9:30 – 10:30 am
Regency B

9:30 AVM-109
VRUNet: Multitask learning model for intent prediction of vulnerable road users, *Adithya Pravarun Reddy Ranga[1], Filippo Giruzzi[2], Jagdish Bhanushali[1], Emilie Wirbel[3], Patrick Pérez[4], Tuan-Hung VU[4], and Xavier Perrotton[3]; [1]Valeo NA Inc. (United States), [2]MINES Paristech (France), [3]Valeo France (France), and [4]Valeo.ai (France)*

9:50 AVM-108
Multiple pedestrian tracking using Siamese random forests and shallow convolutional neural networks, *Jimi Lee, Jaeyeal Nam, and ByoungChul Ko, Keimyung University (Republic of Korea)*

10:10 AVM-110
End-to-end multitask learning for driver gaze and head pose estimation, *Marwa El Shawarby[1], Mahmoud Ewaisha[1], Hazem Abbas[1], and Ibrahim Sobh[2]; [1]Ain Shams University and [2]Valeo Group (Egypt)*

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

10:10 – 10:50 am Coffee Break

KEYNOTE: Quality Metrics

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

10:50 – 11:30 am
Regency B

AVM-124
Automated optimization of ISP hyperparameters to improve computer vision accuracy, *Doug Taylor, Avinash Sharma, Karl St. Arnaud, and Dave Tokic, Algolux (Canada)*

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

Quality Metrics

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

11:30 am – 12:30 pm
Regency B

11:30 AVM-148
Using the dead leaves pattern for more than spatial frequency response measurements, *Uwe Artmann, Image Engineering GmbH & Co. KG (Germany)*

11:50 AVM-149
Simulating tests to test simulation, *Patrick Müller, Matthias Lehmann, and Alexander Braun, Düsseldorf University of Applied Sciences (Germany)*

12:10 AVM-150
Validation methods for geometric camera calibration, *Paul Romanczyk, Imatest, LLC (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

PANEL: Sensors Technologies for Autonomous Vehicles — Joint Session

Panel Moderator: David Cardinal, Cardinal Photo & Extremetech.com (United States)
Panelists: Sanjai Kohli, Visible Sensors, Inc. (United States); Nikhil Naikal, Velodyne Lidar (United States); Greg Stanley, NXP Semiconductors (United States); Alberto Stochino, Perceptive Machines (United States); Nicolas Touchard, DXOMARK (France); and Mike Walters, FLIR Systems (United States)

3:30 – 5:30 pm
Regency A

This session is jointly sponsored by: Autonomous Vehicles and Machines 2020, and Imaging Sensors and Systems 2020.

Imaging sensors are at the heart of any self-driving car project. However, selecting the right technologies isn't simple. Competitive products span a gamut of capabilities including traditional visible-light cameras, thermal cameras, lidar, and radar. This session includes experts in all of these areas, and in emerging technologies, who will help attendees understand the strengths, weaknesses, and future directions of each. Presentations are followed by a panel discussion. Introduction, David Cardinal, consultant and technology journalist (United States); LiDAR for Self-driving Cars, Nikhil Naikal, VP of software engineering, Velodyne Lidar (United States); Challenges in Designing Cameras for Self-driving Cars, Nicolas Touchard, VP of marketing, DXOMARK (France); Using Thermal Imaging to Help Cars See Better, Mike Walters, VP of product management for thermal cameras, FLIR Systems, Inc. (United States); Radar's Role, Greg Stanley, field applications engineer, NXP Semiconductors (the Netherlands); Tales from the Automotive Sensor Trenches, Sanjai Kohli, CEO, Visible Sensors, Inc. (United States); Auto Sensors for the Future, Alberto Stochino, founder and CEO, Perceptive (United States)

Biographies and/or abstracts are found on pages 15–21

5:30 – 7:30 pm Symposium Demonstration Session

Wednesday, January 29, 2020

Data Collection and Generation

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

8:50 – 10:10 am
Regency B

8:50 AVM-200
A tool for semi-automatic ground truth annotation of traffic videos, *Florian Groh, Margrit Gelautz, and Dominik Schörkhuber, TU Wien (Austria)*

9:10 AVM-201
A low-cost approach to data collection and processing for autonomous vehicles with a realistic virtual environment, *Victor Fernandes[1], Verônica Silva[2], and Thais Rêgo[1]; [1]Federal University of Paraiba and [2]Ufersa (Brazil)*

9:30 AVM-202
Metrology impact of advanced driver assistance systems, *Paola Iacomussi, INRIM (Italy)*

9:50 AVM-203
A study on training data selection for object detection in nighttime traffic scenes, *Astrid Unger[1,2], Margrit Gelautz[1], Florian Seitner[2], and Michael Hödlmoser[2]; [1]TU Wien and [2]Emotion3D (Austria)*

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

10:10 – 10:50 am Coffee Break

Psychophysics and LED Flicker Artifacts — Joint Session

Session Chair: Jeffrey Mulligan, NASA Ames Research Center (United States)

10:50 – 11:30 am
Regency B

This session is jointly sponsored by: Autonomous Vehicles and Machines 2020, and Human Vision and Electronic Imaging 2020.

10:50 HVEI-233
Predicting visible flicker in temporally changing images, *Gyorgy Denes and Rafal Mantiuk, University of Cambridge (United Kingdom)*

11:10 HVEI-234
Psychophysics study on LED flicker artefacts for automotive digital mirror replacement systems, *Nicolai Behmann and Holger Blume, Leibniz University Hannover (Germany)*

Multi-Sensor

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

11:30 am – 12:30 pm
Regency B

11:30 AVM-255
Multi-sensor fusion in dynamic environments using evidential grid mapping, *Dilshan Godaliyadda, Vijay Pothukuchi, and JuneChul Roh, Texas Instruments (United States)*

11:50 AVM-257
LiDAR-camera fusion for 3D object detection, *Darshan Ramesh Bhanushali, Robert Relyea, Karan Manghi, Abhishek Vashist, Clark Hochgraf, Amlan Ganguly, Michael Kuhl, Andres Kwasinski, and Ray Ptucha, Rochester Institute of Technology (United States)*

12:10 AVM-258
Active stereo vision for precise autonomous vehicle control, *Song Zhang and Michael Feller, Purdue University (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

KEYNOTE: Image Processing

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

3:30 – 4:10 pm
Regency B

AVM-262

Deep image processing, *Vladlen Koltun, chief scientist for Intelligent Systems, Intel Labs (United States)*

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

Image Processing

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

4:10 – 5:30 pm
Regency B

4:10 AVM-296
End-to-end deep path planning and automatic emergency braking camera cocoon-based solution, *Mohammed Abdou and Eslam Bakr, Valeo Group (Egypt)*

4:30 AVM-298
Progress on the AUTOSAR adaptive platform for intelligent vehicles, *Keith Derrick, AUTOSAR (Germany)*

4:50 AVM-299
Object tracking continuity through track and trace method, *Haney Williams and Steven Simske, Colorado State University (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

Color Imaging XXV: 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.

In addition, the conference covers 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.

COLOR IMAGING XXV: DISPLAYING, PROCESSING, HARDCOPY, AND APPLICATIONS

Tuesday, January 28, 2020

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

Skin and Deep Learning — Joint Session

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

8:45 – 9:30 am
Regency C

This session is jointly sponsored by: Color Imaging XXV: Displaying, Processing, Hardcopy, and Applications, and Material Appearance 2020.

8:45
Conference Welcome

8:50 MAAP-082
Beyond color correction: Skin color estimation in the wild through deep learning, *Robin Kips, Quoc Tran, Emmanuel Malherbe, and Matthieu Perrot, L'Oréal Research and Innovation (France)*

9:10 COLOR-083
SpectraNet: A deep model for skin oxygenation measurement from multi-spectral data, *Ahmed Mohammed, Mohib Ullah, and Jacob Bauer, Norwegian University of Science and Technology (Norway)*

Spectral Dataset — Joint Session

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

9:30 – 10:10 am
Regency C

This session is jointly sponsored by: Color Imaging XXV: Displaying, Processing, Hardcopy, and Applications, and Material Appearance 2020.

9:30 MAAP-106
Visible to near infrared reflectance hyperspectral images dataset for image sensors design, *Axel Clouet[1], Jérôme Vaillant[1], and Célia Viola[2]; [1]CEA-LETI and [2]CEA-LITEN (France)*

9:50 MAAP-107
A multispectral dataset of oil and watercolor paints, *Vahid Babaei[1], Azadeh Asadi Shahmirzadi[2], and Hans-Peter Seidel[1]; [1]Max-Planck-Institut für Informatik and [2]Consultant (Germany)*

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

10:10 – 10:40 am Coffee Break

Color and Appearance Reproduction — Joint Session

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

10:40 am – 12:30 pm
Regency C

This session is jointly sponsored by: Color Imaging XXV: Displaying, Processing, Hardcopy, and Applications, and Material Appearance 2020.

10:40 MAAP-396
From color and spectral reproduction to appearance, BRDF, and beyond, *Jon Yngve Hardeberg, Norwegian University of Science and Technology (NTNU) (Norway)*

11:10 MAAP-120
HP 3D color gamut – A reference system for HP's Jet Fusion 580 color 3D printers, *Ingeborg Tastl[1] and Alexandra Ju[2]; [1]HP Labs, HP Inc. and [2]HP Inc. (United States)*

11:30 COLOR-121
Spectral reproduction: Drivers, use cases, and workflow, *Tanzima Habib, Phil Green, and Peter Nussbaum, Norwegian University of Science and Technology (Norway)*

11:50 COLOR-122
Parameter estimation of PuRet algorithm for managing appearance of material objects on display devices (JIST-first), *Midori Tanaka, Ryusuke Arai, and Takahiko Horiuchi, Chiba University (Japan)*

12:10 COLOR-123
Colorimetrical performance estimation of a reference hyperspectral microscope for color tissue slides assessment, *Paul Lemaillet and Wei-Chung Cheng, US Food and Drug Administration (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

Color Understanding

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

3:30 – 5:10 pm
Regency C

3:30 COLOR-161
Automated multicolored fabric image segmentation and associated psychophysical evaluation, *Nian Xiong, North Carolina State University (United States)*

3:50 COLOR-162
Comparing a spatial extension of ICtCp color representation with S-CIELAB and other recent color metrics for HDR and WCG quality assessment, *Anustup Choudhury and Scott Daly, Dolby Laboratories, Inc. (United States)*

4:10 COLOR-163
An improved optimisation method for finding a color filter to make a camera more colorimetric, *Graham Finlayson and Yuteng Zhu, University of East Anglia (United Kingdom)*

4:30 COLOR-164
Random spray Retinex extensions considering ROI and eye movements (JIST-first), *Midori Tanaka[1], Matteo Lanaro[2], Takahiko Horiuchi[1], and Alessandro Rizzi[2]; [1]Chiba University (Japan) and [2]Università degli Studi di Milano (Italy)*

4:50 COLOR-165
Teaching color and color science: The experience of an international Master course, *Maurizio Rossi[1], Alice Plutino[2], Andrea Siniscalco[1], and Alessandro Rizzi[2]; [1]Politecnico di Milano and [2]Università degli Studi di Milano (Italy)*

5:30 – 7:30 pm Symposium Demonstration Session

Wednesday, January 29, 2020

Color Halftoning

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

8:50 – 10:10 am
Regency C

8:50 COLOR-195
New results for aperiodic, dispersed-dot halftoning, *Jiayin Liu[1], Altyngul Jumabayeva[1], Yujian Xu[1], Yin Wang[1], Tal Frank[2], Shani Gat[2], Orel Bat Mor[2], Ben-Shoshan Yotam[2], Robert Ulichney[3], and Jan Allebach[1]; [1]Purdue University (United States), [2]HP Indigo (Israel), and [3]HP Labs, HP Inc. (United States)*

9:10 COLOR-196
Data bearing halftone image alignment and assessment on 3D surface, *Ziyi Zhao[1], Yujian Xu[1], Robert Ulichney[2], Matthew Gaubatz[2], Stephen Pollard[3], and Jan Allebach[1]; [1]Purdue University (United States), [2]HP Labs, HP Inc. (United States), and [3]HP Inc. UK Ltd. (United Kingdom)*

9:30 COLOR-197
Using watermark visibility measurements to select an optimized pair of spot colors for use in a binary watermark, *Alastair Reed[1], Vlado Kitanovski[2], Kristyn Falkenstern[1], and Marius Pedersen[2]; [1]Digimarc Corporation (United States) and [2]Norwegian University of Science and Technology (Norway)*

9:50 COLOR-198
Rendering data in the blue channel, *Robert Ulichney and Matthew Gaubatz, HP Labs, HP Inc. (United States)*

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

10:10 – 10:50 am Coffee Break

Color and Human Vision

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

10:50 am – 12:10 pm
Regency C

10:50 COLOR-235
Individual differences in feelings about the color red, *Yasuyo Ichihara, Kogakuin University (Japan)*

11:10 COLOR-236
Colors before and after cataract surgery: A study of color constancy and discrimination, *John McCann, McCann Imaging (United States)*

11:30 COLOR-237
Daltonization by spectral filtering, *Phil Green and Peter Nussbaum, Norwegian University of Science and Technology (Norway)*

11:50 COLOR-238
Psychophysical evaluation of grey scale functions performance, *Kwame Baah, University of the Arts London (United Kingdom)*

Color Imaging XXV: Displaying, Processing, Hardcopy, and Applications Interactive Papers Oral Previews

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

12:10 – 12:30 pm
Regency C

In this session interactive poster authors will each provide a brief oral overview of their poster presentation, which will be presented in the Color Imaging XXV: Displaying, Processing, Hardcopy, and Applications 2020 Interactive Papers Session at 5:30 pm on Wednesday.

12:10 COLOR-259
Visual fidelity improvement in virtual reality through spectral textures applied to lighting simulations, *Francisco Díaz-Barrancas, Halina Cwierz, Pedro José Pardo, Ángel Luis Pérez, and María Isabel Suero, University of Extremadura (Spain)*

12:20 COLOR-260
Application of spectral computing technics for color vision testing using virtual reality devices, *Halina Cwierz, Francisco Díaz-Barrancas, Pedro José Pardo, Ángel Luis Pérez, and María Isabel Suero, University of Extremadura (Spain)*

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

Dark Side of Color

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

3:30 – 5:10 pm
Regency C

3:30 COLOR-279
Increases in scattered light causes increased darkness, *John McCann, McCann Imaging (United States)*

3:50 COLOR-280
Do you see what I see?, *Phil Green, Norwegian University of Science and Technology (Norway)*

4:10 COLOR-281
Replacing test charts with pictures, *Sophie Triantaphillidou, Edward Fry, and Oliver van Zwanenberg, University of Westminster (United Kingdom)*

4:30 COLOR-282
Colors challanges in navigating autonomous vehicles, *Dietmar Wueller, Image Engineering GmbH & Co. KG (Germany)*

4:50 COLOR-283
Does computer vision need color science?, *Jan Allebach, Purdue University (United States)*

Color Imaging XXV: Displaying, Processing, Hardcopy, and Applications Interactive Posters Session

5:30 – 7:00 pm
Sequoia

The Color Imaging XXV: Displaying, Processing, Hardcopy, and Applications Conference works to be presented at the EI 2020 Symposium Interactive Posters Session are listed in the Color Imaging XXV: Displaying, Processing, Hardcopy, and Applications Interactive Papers Oral Previews session just before Wednesday lunch.

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

Inkjet Printer Development and Diagnostic

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

8:50 – 10:30 am
Regency C

8:50 COLOR-350
Developing an inkjet printer I: RGB image to CMY ink amounts -- Image preprocessing and color management, *Yin Wang[1], Baekdu Choi[1], Daulet Kenzhebalin[1], Sige Hu[1], George Chiu[1], Zillion Lin[2], Davi He[2], and Jan Allebach[1]; [1]Purdue University (United States) and [2]Sunvalleytek International Inc. (China)*

9:10 COLOR-351
Developing an inkjet printer II: CMY ink amounts to multibit CMY halftones, *Baekdu Choi[1], Daulet Kenzhebalin[1], Sige Hu[1], George Chiu[1], Davi He[2], Zillion Lin[2], and Jan Allebach[1]; [1]Purdue University and [2]Sunvalleytek International Inc. (United States)*

9:30 COLOR-352
Developing an inkjet printer III: Multibit CMY halftones to hardware-ready bits, *Sige Hu[1], Daulet Kenzhebalin[1], George Chiu[1], Zillion Lin[2], Davi He[2], and Jan Allebach[1]; [1]Purdue University (United States) and [2]Sunvalleytek International Inc. (China)*

9:50 COLOR-349
Developing an inkjet printer IV: Printer mechanism control for best print quality, *Daulet Kenzhebalin[1], Baekdu Choi[1], Sige Hu[1], George Chiu[1], Zillion Lin[2], Davi He[2], and Jan Allebach[1]; [1]Purdue University (United States) and [2]Sunvalley Group (China)*

10:10 COLOR-353
Using acoustic information to diagnose the health of a printer, *Chin-Ning Chen[1], Katy Ferguson[2], Anton Wiranata[2], Mark Shaw[2], Wan-Eih Huang[1], George Chiu[1], Patricia Davis[1], and Jan Allebach[1]; [1]Purdue University and [2]HP Inc. (United States)*

10:30 – 11:00 am Coffee Break

COLOR

Computational Imaging XVIII

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.

Special Sessions

This year Computational Imaging hosts four special sessions on Algorithm/Hardware Co-Design for Computational Imaging, Computational Imaging Applications to Materials Characterization, Recent Progress in Computational Microscopy, and Optically-Coherent and Interferometric Imaging, presented by researchers from academia, national laboratories, and industry.

Conference Chairs: **Charles A. Bouman,** Purdue University (United States); **Gregery T. Buzzard,** Purdue University (United States); and **Robert Stevenson,** University of Notre Dame (United States)

Program Committee: **Clem Karl,** Boston University (United States); **Eric Miller,** Tufts University (United States); **Joseph A. O'Sullivan,** Washington University in St. Louis (United States); **Hector J. Santos-Villalobos,** Oak Ridge National Laboratory (United States); and **Ken D. Sauer,** University of Notre Dame (United States)

Computational Microscopy Special Session Organizers: **Singanallur V. Venkatakrishnan,** Oak Ridge National Laboratory (United States), and **Ulugbek S. Kamilov,** Washington University in St. Louis (United States)

Optically-Coherent and Interferometric Imaging Special Session Organizer: **Casey Pellizzari,** United States Air Force Academy (United States)

Computational Imaging Applications to Materials Characterization Special Session Organizers: **Jeff Simmons,** Air Force Research Laboratory (United States), and **Stephen Niezgoda,** The Ohio State University (United States)

Algorithm/Hardware Co-Design for Computational Imaging Special Session Organizers: **Sergio Goma,** Qualcomm Technologies Inc. (United States), and **Hasib Saddiqui,** Qualcomm Technologies Inc. (United States)

Conference Sponsor

Qualcomm

COMPUTATIONAL IMAGING XVII

Monday, January 27, 2020

Plug and Play Approaches

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

8:45 – 10:10 am
Grand Peninsula B/C

8:45
Conference Welcome

8:50 COIMG-005
Plug-and-play amP for image recovery with Fourier-structured operators, *Subrata Sarkar, Rizwan Ahmad, and Philip Schniter, The Ohio State University (United States)*

9:10 COIMG-006
A splitting-based iterative algorithm for GPU-accelerated statistical dual-energy x-ray CT reconstruction, *Fangda Li, Ankit Manerikar, Tanmay Prakash, and Avinash Kak, Purdue University (United States)*

9:30 COIMG-007
Proximal Newton Methods for x-ray imaging with non-smooth regularization, *Tao Ge, Umberto Villa, Ulugbek Kamilov, and Joseph O'Sullivan, Washington University in St. Louis (United States)*

9:50 COIMG-008
Integrating learned data and image models through consensus equilibrium, *W. Clem Karl and Muhammad Usman Ghani, Boston University (United States)*

10:10 – 10:50 am Coffee Break

Scientific Imaging I

Session Chair: Eric Miller, Tufts University (United States)

10:50 am – 12:30 pm
Grand Peninsula B/C

10:50 COIMG-043
Learned priors for the joint ptycho-tomography reconstruction, *Selin Aslan, Argonne National Laboratory (United States)*

11:10 COIMG-044
A joint reconstruction and lambda tomography regularization technique for energy-resolved x-ray imaging, *James Webber, Eric Quinto, and Eric Miller, Tufts University (United States)*

11:30 COIMG-045
Generalized tensor learning with applications to 4D-STEM image denoising, *Rungang Han[1], Rebecca Willett[2], and Anru Zhang[1]; [1]University of Wisconsin-Madison and [2]University of Chicago (United States)*

11:50 COIMG-046
Computational imaging in infrared sensing of the atmosphere, *Adam Milstein, Yaron Rachlin, Corrie Smeaton, Charles Wynn, Ryan Sullenberger, Philip Chapnik, Steven Leman, and William Blackwell, MIT Lincoln Laboratory (United States)*

12:10 COIMG-047
Learning optimal sampling for computational imaging, *He Sun[1], Adrian Dalca[2], and Katherine Bouman[1]; [1]California Institute of Technology and [2]Harvard Medical School (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

Scientific Imaging II

Session Chair: Brendt Wohlberg, Los Alamos National Laboratory (United States)

3:30 – 4:10 pm
Grand Peninsula B/C

3:30 COIMG-058
Revealing subcellular structures with live-cell and 3D fluorescence nanoscopy, *Fang Huang, Purdue University (United States)*

3:50 COIMG-059
Single-shot coded diffraction system for 3D object shape estimation, *Samuel Pinilla[1], Laura Galvis[1], Karen Egiazarian[2], and Henry Arguello[1]; [1]Universidad Industrial de Santander (Colombia) and [2]Tampere University (Finland)*

PANEL: The Future of Computational Imaging

Panel Moderator: Charles Bouman, Purdue University (United States)

4:10 – 4:50 pm
Grand Peninsula B/C
Panelists TBA.

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

KEYNOTE: Computation and Photography

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

8:50 – 9:30 am
Grand Peninsula B/C

COIMG-089
Computation and photography: How the mobile phone became a camera, *Peyman Milanfar, principal scientist/director, Google Research (United States)*

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

Optically-Coherent and Interferometric Imaging I

Session Chair: Casey Pellizzari, United States Air Force Academy (United States)

9:30 – 10:30 am
Grand Peninsula B/C

Optically-coherent and interferometric imaging sensors provide a means to measure both the amplitude and phase of incoming light. These sensors depend on computational-based methods to convert real-valued intensity measurements into amplitude and phase information for image reconstruction. Additionally, computational methods have helped overcome many of the practical issues associated with these sensors as well as enabled new imaging modalities. This session explores the coupling between optically-coherent and interferometric sensors and the computational methods that enable and extend their use. Example topic areas include both coherent and incoherent holography, coherent lidar, microscopy, metrology, and astronomy.

9:30 COIMG-111
Spectral shearing LADAR, *Jason Stafford[1], David Rabb[1], Kyle Watson[2], Brett Spivey[2], and Ryan Galloway[3]; [1]United States Air Force Research Laboratory, [2]JASR Systems, and [3]Montana State University (United States)*

9:50 COIMG-112
3D computational phase microscopy with multiple-scattering samples, *Laura Waller[1], Shwetadwip Chowdhury[1], Michael Chen[1], Yonghuan David Ren[1], Regina Eckert[1], Michael Kellman[1], and Eemrah Bostan[2]; [1]University of California, Berkeley (United States) and [2]University of Amsterdam (the Netherlands)*

10:10 COIMG-113
Imaging through deep turbulence and emerging solutions, *Mark Spencer[1], Casey Pellizzari[2], and Charles Bouman[3]; [1]Air Force Research Laboratory, [2]United States Air Force Academy, and [3]Purdue University (United States)*

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

10:10 – 10:50 am Coffee Break

Optically-Coherent and Interferometric Imaging II

Session Chair: Casey Pellizzari, United States Air Force Academy (United States)

10:50 – 11:30 am
Grand Peninsula B/C

Optically-coherent and interferometric imaging sensors provide a means to measure both the amplitude and phase of incoming light. These sensors depend on computational-based methods to convert real-valued intensity measurements into amplitude and phase information for image reconstruction. Additionally, computational methods have helped overcome many of the practical issues associated with these sensors as well as enabled new imaging modalities. This session explores the coupling between optically-coherent and interferometric sensors and the computational methods that enable and extend their use. Example topic areas include both coherent and incoherent holography, coherent lidar, microscopy, metrology, and astronomy.

10:50 COIMG-125
Holographic imaging through highly attenuating fog conditions, *Abbie Watnik[1], Samuel Park[1], James Lindle[2], and Paul Lebow[3]; [1]United States Naval Research Laboratory, [2]DCS Corporation, and [3]Alaire Technologies (United States)*

11:10 COIMG-126
Intensity interferometry-based 3D ranging, *Fabian Wagner[1], Florian Schiffers[1], Florian Willomitzer[1], Oliver Cossairt[1], and Andreas Velten[2]; [1]Northwestern University and [2]University of Wisconsin-Madison (United States)*

Phase Coherent Imaging

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

11:30 am – 12:10 pm
Grand Peninsula B/C

11:30 COIMG-146
Constrained phase retrieval using a non-linear forward model for x-ray phase contrast tomography, *K. Aditya Mohan, Jean-Baptiste Forien, and Jefferson Cuadra, Lawrence Livermore National Laboratory (United States)*

11:50 COIMG-147
Multi-wavelength remote digital holography: Seeing the unseen by imaging off scattering surfaces and imaging through scattering media, *Florian Willomitzer[1], Prasanna Rangarajan[2], Fengqiang Li[1], Muralidhar Madabhushi Balaji[2], and Oliver Cossairt[1]; [1]Northwestern University and [2]Southern Methodist University (United States)*

Recent Progress in Computational Microscopy I

Session Chair: Singanallur Venkatakrishnan, Oak Ridge National Laboratory (United States)

12:10 – 12:30 pm
Grand Peninsula B/C

Microscopy is currently experiencing an exciting era of new methodological developments with computation at its core. The recent progress in compressive imaging, numerical physical models, regularization techniques, large-scale optimization methods, and machine learning are leading to a faster, quantitative, and reliable microscopic imaging. Though many computational methods are being developed independently for different

modalities, their combination may be seen as example of a new paradigm of rapid, comprehensive, and information-rich computational microscopy. This session will explore cross-cutting themes in several modalities such as optical, neutron, x-ray, and electron microscopy and will attempt to promote transfer of ideas between investigators in these different areas.

12:10 COIMG-152
3D DiffuserCam: Computational microscopy with a lensless imager, *Laura Waller, University of California, Berkeley (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

Recent Progress in Computational Microscopy II

Session Chair: Singanallur Venkatakrishnan, Oak Ridge National Laboratory (United States)

3:30 – 5:10 pm
Grand Peninsula B/C

Microscopy is currently experiencing an exciting era of new methodological developments with computation at its core. The recent progress in compressive imaging, numerical physical models, regularization techniques, large-scale optimization methods, and machine learning are leading to a faster, quantitative, and reliable microscopic imaging. Though many computational methods are being developed independently for different modalities, their combination may be seen as example of a new paradigm of rapid, comprehensive, and information-rich computational microscopy. This session will explore cross-cutting themes in several modalities such as optical, neutron, x-ray, and electron microscopy and will attempt to promote transfer of ideas between investigators in these different areas.

3:30 COIMG-156
Computational nanoscale imaging with synchrotron radiation, *Doga Gursoy, Argonne National Laboratory (United States)*

3:50 COIMG-157
Recent advances in 3D structured illumination microscopy with reduced data-acquisition, *Chrysanthe Preza, The University of Memphis (United States)*

4:10 COIMG-158
Method of moments for single-particle cryo-electron microscopy, *Amit Singer, Princeton University (United States)*

4:30 COIMG-159
Computational imaging in transmission electron microscopy: Atomic electron tomography and phase contrast imaging, *Colin Ophus, Lawrence Berkeley National Laboratory (United States)*

4:50 COIMG-160
3D and 4D computational imaging of molecular orientation with multiview polarized fluorescence microscopy, *Talon Chandler[1], Min Guo[2], Rudolf Oldenbourg[3], Hari Shroff[2], and Patrick La Riviere[1]; [1]The University of Chicago, [2]National Institutes of Health, and [3]Marine Biological Laboratory (United States)*

DISCUSSION: Tuesday Tech Mixer

Hosts: Charles Bouman, Purdue University (United States); Gregery Buzzard, Purdue University (United States); and Robert Stevenson, University of Notre Dame (United States)

5:10 – 5:40 pm
Grand Peninsula B/C

Computational Imaging Conference Tuesday wrap-up discussion and refreshments.

5:30 – 7:30 pm Symposium Demonstration Session

Wednesday, January 29, 2020

Medical Imaging

Session Chair: Evan Morris, Yale University (United States)

8:50 – 10:10 am
Grand Peninsula B/C

8:50 COIMG-191
Model comparison metrics require adaptive correction if parameters are discretized: Application to a transient neurotransmitter signal in PET data, *Heather Liu and Evan Morris, Yale University (United States)*

9:10 COIMG-192
Computational pipeline and optimization for automatic multimodal reconstruction of marmoset brain histology, *Brian Lee[1], Meng Lin[2], Junichi Hata[2], Partha Mitra[3], and Michael Miller[1]; [1]Johns Hopkins University (United States), [2]RIKEN Brain Science Institute (Japan), and [3]Cold Spring Harbor Laboratory (United States)*

9:30 COIMG-193
Model-based approach to more accurate stopping power ratio estimation for proton therapy, *Maria Medrano[1], Jeffrey Williamson[2], Bruce Whiting[3], David Politte[4], Shuanyue Zhang[1], Tyler Webb[1], Tianyu Zhao[4], Ruirui Liu[4], Mariela Porras-Chaverri[2], Tao Ge[1], Rui Liao[1], and Joseph O'Sullivan[1]; [1]Washington University in St. Louis (United States), [2]University of Costa Rica (Costa Rica), [3]University of Pittsburg (United States), and [4]Washington University School of Medicine (United States)*

9:50 COIMG-194
Deep learning based regularized image reconstruction for respiratory gated PET, *Tiantian Li[1], Mengxi Zhang[1], Wenyuan Qi[2], Evren Asma[2], and Jinyi Qi[1]; [1]University of California, Davis and [2]Canon Medical Research (United States), Inc. (United States)*

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

10:10 – 10:50 am Coffee Break

Computational Imaging Applications to Materials Characterization

Session Chair: Jeffrey Simmons, Air Force Research Laboratory (United States)

10:50 am – 12:30 pm
Grand Peninsula B/C

Materials science, like physics, focuses on forward modeling almost exclusively for analysis. This creates opportunities for imaging scientists to make significant advances by introducing modern, inversion-based methods for analysis of microscope imagery. Materials Science emerged as a true ``scientific'' discipline, with the development of microscopy because it allowed the materials scientist to observe the ``microstructure,'' that is, the texture produced by the processes used for preparing the material. For this reason, materials science and microscopy have always been intimately linked, with the major connection being microstructure as a means of controlling properties. Until quite recently materials characterization was largely ``photons-on-film.'' With the digital transition of microscopy from film to data file, microscopy became a computational imaging problem. With the automation of data collection, it became imperative to develop algorithms requiring less human interaction. This session highlights recent advances in materials science as a direct consequence of cross-disciplinary approaches between computational imaging and materials science. This session covers, but is not limited to, forward modeling of material-probe-detector interactions, segmentation, anomaly detection, data fusion, denoising, learning approaches, detection and tracking, and super-resolution.

10:50 COIMG-247
Adversarial training incorporating physics-based regularization for digital microstructure synthesis, *Stephen Niezgoda, The Ohio State University (United States)*

11:10 COIMG-248
Crystallographic symmetry for data augmentation in detecting dendrite cores, *Lan Fu[1], Hongkai Yu[2], Megna Shah[3], Jeffrey Simmons[3], and Song Wang[1]; [1]University of South Carolina, [2]University of Texas, and [3]Air Force Research Laboratory (United States)*

11:30 COIMG-249
Multi-resolution data fusion for super resolution imaging of biological materials, *Emma Reid[1], Cheri Hampton[2], Asif Mehmood[2], Gregery Buzzard[1], Lawrence Drummy[2], and Charles Bouman[1]; [1]Purdue University and [2]Air Force Research Laboratory (United States)*

11:50 COIMG-250
Void detection and fiber extraction for statistical characterization of fiber-reinforced polymers, *Camilo Aguilar Herrera and Mary Comer, Purdue University (United States)*

12:10 COIMG-251
Applications of denoising, structure optimization, and deep learning in high resolution electron microscopy, *Chenyu Zhang and Paul Voyles, University of Wisconsin-Madison (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

Materials Imaging

Session Chair: David Castañón, Boston University (United States)

3:30 – 4:10 pm
Grand Peninsula B/C

3:30 COIMG-263
Mueller matrix imaging for classifying similar diffuse materials, *Lisa Li, Meredith Kupinski, Madellyn Brown, and Russell Chipman, The University of Arizona (United States)*

3:50 COIMG-264
Modeling multivariate tail behavior in materials data, *Lucas Costa, Tomas Comer, Daniel Greiwe, Camilo Aguilar Herrera, and Mary Comer, Purdue University (United States)*

Security Imaging

Session Chair: David Castañón, Boston University (United States)

4:10 – 4:50 pm
Grand Peninsula B/C

4:10 COIMG-293
A spectrum-adaptive decomposition method for effective atomic number estimation using dual energy CT, *Ankit Manerikar, Fangda Li, Tanmay Prakash, and Avinash Kak, Purdue University (United States)*

4:30 COIMG-294
Metal artifact reduction in dual-energy CT with synthesized monochromatic basis for baggage screening, *Sandamali Devadithya and David Castañón, Boston University (United States)*

DISCUSSION: Wednesday Tech Mixer

Hosts: Charles Bouman, Purdue University (United States); Gregery Buzzard, Purdue University (United States); and Robert Stevenson, University of Notre Dame (United States)

4:50 – 5:30 pm
Grand Peninsula B/C

Computational Imaging Conference Wednesday wrap-up discussion and refreshments.

Computational Imaging XVIII Interactive Posters Session

5:30 – 7:00 pm
Sequoia
The following works will be presented at the EI 2020 Symposium Interactive Posters Session.

COIMG-305
Connected-tube MPP model for unsupervised 3D fiber detection, *Tianyu Li, Mary Comer, and Michael Sangid, Purdue University (United States)*

COIMG-306
Imaging through scattering media with a learning based prior, *Florian Schiffers, Lionel Fiske, Pablo Ruiz, Aggelos K. Katsaggelos, and Oliver Cossairt, Northwestern University (United States)*

COIMG-307
Reconstruction of 2D seismic wavefields from nonuniformly sampled sources, *Laura Galvis[1], Juan Ramirez[1], Edwin Vargas[1], Ofelia Villarreal[2], William Agudelo[3], and Henry Arguello[1]; [1]Universidad Industrial de Santander, [2]Cooperativa de Tecnólogos e Ingenieros de la Industria del Petróleo y Afines, TIP, and [3]Instituto Colombiano del Petróleo, ICP, Ecopetrol S.A. (Colombia)*

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

Deep Learning in Computational Imaging

Session Chair: Gregery Buzzard, Purdue University (United States)

8:50 – 10:10 am
Grand Peninsula B/C

8:50 COIMG-341
2D label free microscopy imaging analysis using machine learning, *Han Hu[1], Yang Lei[2], Daisy Xin[2], Viktor Shkolnikov[2], Steven Barcelo[2], Jan Allebach[1], and Edward Delp[1]; [1]Purdue University and [2]HP Labs, HP Inc. (United States)*

9:10 COIMG-342
ProPaCoL-Net: A novel recursive stereo SR net with progressive parallax coherency learning, *Jeonghun Kim and Munchurl Kim, Korea Advanced Institute of Science and Technology (Republic of Korea)*

9:30 COIMG-343
Deep learning method for height estimation of sorghum in the field using LiDAR, *Matthew Waliman and Avideh Zakhor, University of California, Berkeley (United States)*

9:50 COIMG-344
Background subtraction in diffraction x-ray images using deep CNN, *Gady Agam, Illinois Institute of Technology (United States)*

10:10 – 10:50 am Coffee Break

Algorithm/Hardware Co-Design for Computational Imaging

Session Chair: Sergio Goma, Qualcomm Technologies, Inc. (United States)

10:50 am – 12:30 pm
Grand Peninsula B/C
The aim of this session is to take computational imaging concepts a step further and to set a stepping stone towards an optimal, technology dependent implementation of computational imaging: algorithm-hardware co-design. Complex algorithms thrive on clean data sets therefore sensors that are designed in conjunction with supporting algorithms can offer significantly improved results. This session is soliciting original contributions that relate to the joint design of sensors and/or technology in conjunction with algorithms.

10:50 COIMG-355
Estimation of the background illumination in optical reflectance microscopy, *Charles Brookshire[1], Michael Uchic[2], Victoria Kramb[1], Tyler Lesthaeghe[3], and Keigo Hirakawa[1]; [1]University of Dayton, [2]Air Force Research Laboratory, and [3]University of Dayton Research Institute (United States)*

11:10 COIMG-357
Skin chromophore and melanin estimation from mobile selfie images using constrained independent component analysis, *Raja Bala[1], Luisa Polania[2], Ankur Purwar[3], Paul Matts[4], and Martin Maltz[5]; [1]Palo Alto Research Center (United States), [2]Target Corporation (United States), [3]Procter & Gamble (Singapore), [4]Procter & Gamble (United Kingdom), and [5]Xerox Corporation (United States)*

11:30 COIMG-358
Computational imaging: Algorithm/hardware co-design considerations, *Sergio Goma, Qualcomm Technologies, Inc. (United States)*

11:50 COIMG-359
Statistical inversion methods in mobile imaging, *Hasib Siddiqui, Qualcomm Technologies, Inc. (United States)*

12:10 – 2:00 pm Lunch

Computer Vision I

Session Chair: Robert Stevenson, University of Notre Dame (United States)

2:00 – 3:00 pm
Grand Peninsula B/C

2:00 COIMG-377
Efficient multilevel architecture for depth estimation from a single image, *Nilesh Pandey, Bruno Artacho, and Andreas Savakis, Rochester Institute of Technology (United States)*

2:20 COIMG-378
Sky segmentation for enhanced depth reconstruction and Bokeh rendering with efficient architectures, *Tyler Nuanes[1,2], Matt Elsey[2], Radek Grzeszczuk[2], and John Shen[1]; [1]Carnegie Mellon University and [2]Light (United States)*

2:40 COIMG-379
A dataset for deep image deblurring aided by inertial sensor data, *Shuang Zhang, Ada Zhen, and Robert Stevenson, University of Notre Dame (United States)*

3:00 – 3:30 pm Coffee Break

Computer Vision II

Session Chair: Robert Stevenson, University of Notre Dame (United States)

3:30 – 4:30 pm
Grand Peninsula B/C

3:30 COIMG-390
On the distinction between phase images and two-view light field for PDAF of mobile imaging, *Chi-Jui (Jerry) Ho and Homer Chen, National Taiwan University (Taiwan)*

3:50 COIMG-391
Indoor layout estimation by 2D LiDAR and camera fusion, *Jieyu Li and Robert Stevenson, University of Notre Dame (United States)*

4:10 COIMG-392
Senscape: Modeling and presentation of uncertainty in fused sensor data live image streams, *Henry Dietz and Paul Eberhart, University of Kentucky (United States)*

The Engineering Reality of Virtual Reality 2020

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.

Highlights

Early Wednesday morning ERVR will join in the Imaging Sensors and Systems Conference keynote, "Mixed-reality guided neuronavigation for non-invasive brain simulation treatment." Mid-morning on Wednesday, ERVR is co-hosting a Joint Session on urban and enterprise applications of augmented reality with the Imaging and Multimedia Analytics in a Web and Mobile World 2020 Conference. Wednesday afternoon, ERVR is co-hosting the "Visualization Facilities" Joint Session with Stereoscopic Displays and Applications XXXI Conference.

On Thursday, the core ERVR conference sessions kick off with sessions exploring applications of augmented reality, immersive and virtual reality environments, and LiDAR sensor fusion.

THE ENGINEERING REALITY OF VIRTUAL REALITY 2020

Wednesday, January 29, 2020

KEYNOTE: Imaging Systems and Processing — Joint Session

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

8:50 – 9:30 am
Regency A
This session is jointly sponsored by: The Engineering Reality of Virtual Reality 2020, Imaging Sensors and Systems 2020, and Stereoscopic Displays and Applications XXXI.

ISS-189
Mixed reality guided neuronavigation for non-invasive brain stimulation treatment, *Christoph Leuze, research scientist in the Incubator for Medical Mixed and Extended Reality, Stanford University (United States)*

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

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

10:10 – 10:30 am Coffee Break

Augmented Reality in Built Environments — Joint Session

Session Chairs: Raja Bala, PARC (United States) and Matthew Shreve, Palo Alto Research Center (United States)

10:30 am – 12:40 pm
Cypress B
This session is jointly sponsored by: The Engineering Reality of Virtual Reality 2020, and Imaging and Multimedia Analytics in a Web and Mobile World 2020.

10:30 IMAVVM-220
Augmented reality assistants for enterprise, *Matthew Shreve and Shiwali Mohan, Palo Alto Research Center (United States)*

11:00 IMAVVM-221
Extra FAT: A photorealistic dataset for 6D object pose estimation, *Jianhang Chen[1], Daniel Mas Montserrat[1], Qian Lin[2], Edward Delp[1], and Jan Allebach[1]; [1]Purdue University and [2]HP Labs, HP Inc. (United States)*

11:20 IMAVVM-222
Space and media: Augmented reality in urban environments, *Luisa Caldas, University of California, Berkeley (United States)*

12:00 ERVR-223
Active shooter response training environment for a building evacuation in a collaborative virtual environment, *Sharad Sharma and Sri Teja Bodempudi, Bowie State University (United States)*

12:20 ERVR-224
Identifying anomalous behavior in a building using HoloLens for emergency response, *Sharad Sharma and Sri Teja Bodempudi, Bowie State University (United States)*

12:40 – 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

Visualization Facilities — Joint Session

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

3:30 – 4:10 pm
Grand Peninsula D
This session is jointly sponsored by: The Engineering Reality of Virtual Reality 2020, and Stereoscopic Displays and Applications XXXI.

3:30 SD&A-265
Immersive design engineering, *Bjorn Sommer, Chang Lee, and Savina Toirrisi, Royal College of Art (United Kingdom)*

3:50 SD&A-266
Using a random dot stereogram as a test image for 3D demonstrations, *Andrew Woods, Wesley Lamont, and Joshua Hollick, Curtin University (Australia)*

KEYNOTE: Visualization Facilities — Joint Session

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

4:10 – 5:10 pm
Grand Peninsula D
This session is jointly sponsored by: The Engineering Reality of Virtual Reality 2020, and Stereoscopic Displays and Applications XXXI.

ERVR-295
Social holographics: Addressing the forgotten human factor, *Derek Van Tonder, business development manager, and Andy McCutcheon, global sales manager for Aerospace & Defence, Euclideon Holographics (Australia)*

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

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

Flourishing Virtual & Augmented Worlds

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

8:45 – 10:10 am
Regency A

8:45
Conference Welcome

8:50 ERVR-337
Using virtual reality for spinal cord injury rehabilitation, *Marina Ciccarelli, Susan Morris, Michael Wiebrands, and Andrew Woods, Curtin University (Australia)*

9:10 ERVR-338
Heads-up LiDAR imaging with sensor fusion, *Yang Cai, CMU (United States)*

9:30 ERVR-339
Enhancing lifeguard training through virtual reality, *Lucas Wright[1], Lara Chunko[2], Kelsey Benjamin[3], Emmanuelle Hernandez-Morales[4], Jack Miller[5], Melynda Hoover[5], and Eliot Winer[5]; [1]Hamilton College, [2]University of Colorado, [3]Prairie View A&M University, [4]University of Puerto Rico, and [5]Iowa State University (United States)*

9:50 ERVR-340
Transparent type virtual image display using small mirror array, *Akane Temochi and Tomohiro Yendo, Nagaoka University of Technology (Japan)*

10:10 – 10:50 am Coffee Break

Experiencing Virtual Reality

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

10:50 am – 12:30 pm
Regency A

10:50 ERVR-360
Designing a VR arena: Integrating virtual environments and physical spaces for social, sensorial data-driven virtual experiences, *Ruth West[1], Eitan Mendelowitz[2], Zach Thomas[1], Christopher Poovey[1], and Luke Hillard[1]; [1]University of North Texas and [2]Mount Holyoke College (United States)*

11:10 ERVR-361
Leaving the windows open: Indeterminate situations through composite 360-degree photography, *Peter Williams[1] and Sala Wong[2]; [1]California State University, Sacramento and [2]Indiana State University (United States)*

11:30 ERVR-362
User experience evaluation in virtual reality based on subjective feelings and physiological signals (JIST-first), *YunFang Niu[1], Danli Wang[1], ZiWei Wang[1], Fang Sun[2], Kang Yue[1], and Nan Zheng[1]; [1]Institute of Automation, Chinese Academy of Sciences and [2]Liaoning Normal University (China)*

11:50 ERVR-363
Interactive multi-user 3D visual analytics in augmented reality, *Wanze Xie[1], Yining Liang[1], Janet Johnson[1], Andrea Mower[2], Samuel Burns[2], Colleen Chelini[2], Paul D'Alessandro[2], Nadir Weibel[1], and Jürgen Schulze[1]; [1]University of California, San Diego and [2]PwC (United States)*

12:10 ERVR-364
CalAR: A C++ engine for augmented reality applications on Android mobile devices, *Menghe Zhang, Karen Lucknavalai, Weichen Liu, and Jürgen Schulze, University of California, San Diego (United States)*

12:30 – 2:00 pm Lunch

Developing Virtual Reality

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

2:00 – 3:00 pm
Regency A

2:00 ERVR-380
Development and evaluation of immersive educational system to improve driver's risk prediction ability in traffic accident situation, *Hiroto Suto[1], Xingguo Zhang[2], Xun Shen[2], Pongsathorn Raksincharoensak[2], and Norimichi Tsumura[1]; [1]Chiba University and [2]Tokyo University of Agriculture and Technology (Japan)*

2:20 ERVR-381
WARHOL: Wearable holographic object labeler, *Matthew Shreve, Bob Price, Les Nelson, Raja Bala, Jin Sun, and Srichiran Kumar, Palo Alto Research Center (United States)*

2:40 ERVR-382
RaViS: Real-time accelerated view synthesizer for immersive video 6DoF VR, *Daniele Bonatto, Sarah Fachada, and Gauthier Lafruit, Université Libre de Bruxelles (Belgium)*

Food and Agricultural Imaging Systems 2020

Workshop Chairs: **Mustafa Jaber**, NantOmics, LLC (United States); **Grigorios Tsagkatakis**, Institute of Computer Science, FORTH (Greece); and **Mohammed Yousefhussien**, General Electric Global Research (United States)

Workshop overview

Guaranteeing food security, understanding the impact of climate change in agriculture, quantifying the impact of extreme weather events on food production, and automating the process of food quality control are a few topics where modern imaging technologies can provide much needed solutions. This workshop welcomes contributions on innovative imaging systems, computer vision, machine/deep learning research, and augmented reality focusing on applications in food and agriculture. Workshop topics consider how novel imaging technologies can address issues related to the impact of climate change, handling and fusion of remote sensing and in-situ data, crop yield prediction, intelligent farming, and livestock management among others. Topics related to food and beverage industry that include food recognition, calorie estimation, food waste management (among others) are included.

Highlights

The workshop hosts two guest speakers, Dr. Jan van Aardt, professor, Chester F. Carlson Center for Imaging Science, Rochester Institute of Technology (United States), and Kevin Lang, general manager, PrecisionHawk (United States).

Jan van Aardt obtained a BSc in forestry (biometry and silviculture specialization) from the University of Stellenbosch, Stellenbosch, South Africa (1996). He completed his MS and PhD in forestry, focused on remote sensing (imaging spectroscopy and light detection and ranging), at the Virginia Polytechnic Institute and State University, Blacksburg, Virginia (2000 and 2004, respectively). This was followed by post-doctoral work at the Katholieke Universiteit Leuven, Belgium, and a stint as research group leader at the Council for Scientific and Industrial Research, South Africa. Imaging spectroscopy and structural (lidar) sensing of natural resources form the core of his efforts, which vary between vegetation structural and system state (physiology) assessment. He has received funding from NSF, NASA, Google, and USDA, among others, and has published more than 70 peer-reviewed papers and more than 90 conference contributions. VanAardt is currently a professor in the Chester F. Carlson Center for Imaging Science at the Rochester Institute of Technology, New York.

Dr. van Aardt is speaking on, *"Managing crops across spatial and temporal scales - the roles of UAS and satellite remote sensing."*

Kevin Lang is general manager of PrecisionHawk's agriculture business (Raleigh, North Carolina). PrecisionHawk is a commercial drone and data company that uses aerial mapping, modeling, and agronomy platform specifically designed for precision agriculture. Mr. Lang advises clients on how to capture value from aerial data collection, artificial intelligence and advanced analytics in addition to delivering implementation programs. Lang holds a BS in mechanical engineering from Clemson University and an MBA from Wake Forest University.

Kevin Lang is speaking on, *"Practical applications and trends for UAV remote sensing in agriculture."*

FOOD AND AGRICULTURAL IMAGING SYSTEMS 2020

Tuesday, January 28, 2020

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

Drone Imaging I — Joint Session

Session Chairs: Andreas Savakis, Rochester Institute of Technology (United States) and Grigorios Tsagkatakis, Foundation for Research and Technology (FORTH) (Greece)

8:45 – 10:10 am
Cypress B
This session is jointly sponsored by: Food and Agricultural Imaging Systems 2020, and Imaging and Multimedia Analytics in a Web and Mobile World 2020.

8:45
Conference Welcome

8:50 IMAWM-084
A new training model for object detection in aerial images, *Geng Yang[1], Yu Geng[2], Qin Li[1], Jane You[3], and Mingpeng Cai[1]; [1]Shenzhen Institute of Information Technology (China), [2]Shenzhen Shangda Xinzhi Information Technology Co., Ltd. (China), and [3]The Hong Kong Polytechnic University (Hong Kong)*

9:10 IMAWM-085
Small object bird detection in infrared drone videos using mask R-CNN deep learning, *Yasmin Kassim[1], Michael Byrne[1], Cristy Burch[2], Kevin Mote[2], Jason Hardin[2], and Kannappan Palaniappan[1]; [1]University of Missouri and [2]Texas Parks and Wildlife (United States)*

9:30 IMAWM-086
High-quality multispectral image generation using conditional GANs, *Ayush Soni, Alexander Loui, Scott Brown, and Carl Salvaggio, Rochester Institute of Technology (United States)*

9:50 IMAWM-087
Deep Ram: Deep neural network architecture for oil/gas pipeline right-of-way automated monitoring, *Ruixu Liu, Theus Aspiras, and Vijayan Asari, University of Dayton (United States)*

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

10:10 – 10:30 am Coffee Break

Drone Imaging II — Joint Session

Session Chairs: Vijayan Asari, University of Dayton (United States) and Grigorios Tsagkatakis, Foundation for Research and Technology (FORTH) (Greece)

10:30 – 10:50 am
Cypress B
This session is jointly sponsored by: Food and Agricultural Imaging Systems 2020, and Imaging and Multimedia Analytics in a Web and Mobile World 2020.

IMAWM-114
LambdaNet: A fully convolutional architecture for directional change detection, *Bryan Blakeslee and Andreas Savakis, Rochester Institute of Technology (United States)*

KEYNOTE: Remote Sensing in Agriculture I — Joint Session

Session Chairs: Vijayan Asari, University of Dayton (United States) and Mohammed Yousefhussien, General Electric Global Research (United States)

10:50 – 11:40 am
Cypress B
This session is jointly sponsored by: Food and Agricultural Imaging Systems 2020, and Imaging and Multimedia Analytics in a Web and Mobile World 2020.

FAIS-127
Managing crops across spatial and temporal scales - The roles of UAS and satellite remote sensing, *Jan van Aardt, professor, Chester F. Carlson Center for Imaging Science, Rochester Institute of Technology (United States)*

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

KEYNOTE: Remote Sensing in Agriculture II — Joint Session

Session Chairs: Vijayan Asari, University of Dayton (United States) and Mohammed Yousefhussien, General Electric Global Research (United States)

11:40 am – 12:30 pm
Cypress B
This session is jointly sponsored by: Food and Agricultural Imaging Systems 2020, and Imaging and Multimedia Analytics in a Web and Mobile World 2020.

FAIS-151
Practical applications and trends for UAV remote sensing in agriculture, *Kevin Lang, general manager, Agriculture, PrecisionHawk (United States)*

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

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 of hardware development, NVIDIA Corporation (United States)*

For abstract and speaker biography, see page 7

3:10 – 3:30 pm Coffee Break

Food and Agricultural Imaging

Session Chairs: Mustafa Jaber, NantVision Inc. (United States); Grigorios Tsagkatakis, Foundation for Research and Technology (FORTH) (Greece); and Mohammed Yousefhussien, General Electric Global Research (United States)

3:30 – 5:30 pm
Regency B

3:30 FAIS-171
Fish freshness estimation though analysis of multispectral images with convolutional neural networks, *Grigorios Tsagkatakis[1], Savas Nikolidakis[2], Eleni Petra[3], Argyris Kapantagakis[2], Kriton Grigorakis[2], George Katselis[4], Nikos Vlahos[4], and Panagiotis Tsakalides[1]; [1]Foundation for Research and Technology (FORTH), [2]Hellenic Centre for Marine Research, [3]Athena Research & Innovation Center, and [4]University of Patras (Greece)*

3:50 FAIS-172
Deep learning based fruit freshness classification and detection with CMOS image sensors and edge processors, *Tejaswini Ananthanarayana[1,2], Ray Ptucha[1], and Sean Kelly[2]; [1]Rochester Institute of Technology and [2]ON Semiconductor (United States)*

4:10 FAIS-173
Smartphone imaging for color analysis of tomatoes, *Katherine Carpenter and Susan Farnand, Rochester Institute of Technology (United States)*

4:30 FAIS-174
Cattle identification and activity recognition by surveillance camera, *Haike Guan, Naoki Motohashi, Takashi Maki, and Toshifumi Yamaai, Ricoh Company, Ltd. (Japan)*

4:50 FAIS-175
High-speed imaging technology for online monitoring of food safety and quality attributes: Research trends and challenges, *Seung-Chul Yoon, US Department of Agriculture-Agricultural Research Service (United States)*

5:10 FAIS-176
A survey on deep learning in food imaging applications, *Mustafa Jaber[1], Grigorios Tsagkatakis[2], and Mohammed Yousefhussien[3]; [1]NantOmics (United States), [2]Foundation for Research and Technology (FORTH) (Greece), and [3]General Electric Global Research (United States)*

5:30 – 7:30 pm Symposium Demonstration Session

Wednesday, January 29, 2020

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

10:10 – 11:00 am Coffee Break

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

Food and Computer Vision

Session Chair: Mustafa Jaber, NantVision Inc. (United States)

4:30 – 5:30 pm
Cypress B

This is a shared listing for a related Imaging and Multimedia Analytics in a Web and Mobile World 2020 Conference sesssion. Refer to the IMAWM Conference program for details.

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

Human Vision and Electronic Imaging 2020

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. It brings 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 (https://jbmulligan.github.io/HVEI/) includes additional information and updates.

Award

Best Paper Award

Events

Daily End-of-Day Discussions
Wednesday evening HVEI Banquet and Talk

HVEI

Conference Sponsors

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Qualcomm

Conference Chairs: **Damon Chandler,** Shizuoka University (Japan); **Mark McCourt,** North Dakota State University (United States); and **Jeffrey Mulligan,** NASA Ames Research Center (United States)

Program Committee: **Albert Ahumada**, NASA Ames Research Center (United States); **Kjell Brunnström,** Acreo AB (Sweden); **Claus-Christian Carbon,** University of Bamberg (Germany); **Scott Daly,** Dolby Laboratories, Inc. (United States); **Huib de Ridder,** Technische Universiteit Delft (the Netherlands); **Ulrich Engelke,** Commonwealth Scientific and Industrial Research Organisation (Australia); **Elena Fedorovskaya,** Rochester Institute of Technology (United States); **James Ferwerda,** Rochester Institute of Technology (United States); **Jennifer Gille,** Oculus VR (United States); **Sergio Goma,** Qualcomm Technologies, Inc. (United States); **Hari Kalva,** Florida Atlantic University (United States); **Stanley Klein,** University of California, Berkeley (United States); **Patrick Le Callet,** Université de Nantes (France); **Lora Likova,** Smith-Kettlewell Eye Research Institute (United States); **Mónica López-González,** La Petite Noiseuse Productions (United States); **Laura McNamara,** Sandia National Laboratories (United States); **Thrasyvoulos Pappas,** Northwestern University (United States); **Adar Pelah,** University of York (United Kingdom); **Eliezer Peli,** Schepens Eye Research Institute (United States); **Sylvia Pont,** Technische Universiteit Delft (the Netherlands); **Judith Redi,** Exact (the Netherlands); **Hawley Rising,** Consultant (United States); **Bernice Rogowitz,** Visual Perspectives (United States); **Sabine Süsstrunk,** École Polytechnique Fédérale de Lausanne (Switzerland); **Christopher Tyler,** Smith-Kettlewell Eye Research Institute (United States); **Andrew Watson,** Apple Inc. (United States); and **Michael Webster,** University of Nevada, Reno (United States)

HUMAN VISION AND ELECTRONIC IMAGING 2020

Monday, January 27, 2020

Human Factors in Stereoscopic Displays — Joint Session

Session Chairs: Nicolas Holliman, University of Newcastle (United Kingdom), and Jeffrey Mulligan, NASA Ames Research Center (United States)

8:45 – 10:10 am
Grand Peninsula D

This session is jointly sponsored by: Human Vision and Electronic Imaging 2020, and Stereoscopic Displays and Applications XXXI.

8:45
Conference Welcome

8:50 HVEI-009
Stereoscopic 3D optic flow distortions caused by mismatches between image acquisition and display parameters (JIST-first), *Alex Hwang and Eli Peli, Harvard Medical School (United States)*

9:10 HVEI-010
The impact of radial distortions in VR headsets on perceived surface slant (JIST-first), *Jonathan Tong, Robert Allison, and Laurie Wilcox, York University (Canada)*

9:30 SD&A-011
Visual fatigue assessment based on multitask learning (JIST-first), *Danli Wang, Chinese Academy of Sciences (China)*

9:50 SD&A-012
Depth sensitivity investigation on multi-view glasses-free 3D display, *Di Zhang[1], Xinzhu Sang[2], and Peng Wang[2]; [1]Communication University of China and [2]Beijing University of Posts and Telecommunications (China)*

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 Irshad[1], Alessandro Silva[1,2], Sana Alamgeer[1], and Mylène Farias[1]; [1]University of Brasilia and [2]IFG (Brazil)*

3:50 IQSP-067
Perceptual image quality assessment for various viewing conditions and display systems, *Andrei Chubarau[1], Tara Akhavan[2], Hyunjin Yoo[2], Rafal Mantiuk[3], and James Clark[1]; [1]McGill University (Canada), [2]IRYStec Software Inc. (Canada), and [3]University 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 Robitza, 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 Pinson[3]; [1]RISE Acreo AB (Sweden), [2]Mid Sweden University (Sweden), and [3]National 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 Hedlund[1], and Chris Snijders[2]; [1]RISE Research Institutes of Sweden AB (Sweden), [2]University of Technology Eindhoven (the Netherlands), and [3]Mid Sweden University (Sweden)*

9:30 HVEI-092
Open software framework for collaborative development of no reference image and video quality metrics, *Margaret Pinson[1], Philip Corriveau[2], Mikolaj Leszczuk[3], and Michael Colligan[4]; [1]US Department of Commerce (United States), [2]Intel Corporation (United States), [3]AGH University of Science and Technology (Poland), and [4]Spirent 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 Hajimirza[1], and Naeem Ramzan[2]; [1]Lumen Research Limited and [2]University of the West of Scotland (United Kingdom)*

11:30 HVEI-130
Predicting single observer's votes from objective measures using neural networks, *Lohic Fotio Tiotsop[1], Tomas Mizdos[2], Miroslav Uhrina[2], Peter Pocta[2], Marcus Barkowsky[3], and Enrico Masala[1]; [1]Politecnico di Torino (Italy), [2]Zilina University (Slovakia), and [3]Deggendorf Institute of Technology (DIT) (Germany)*

11:50 HVEI-131
A simple model for test subject behavior in subjective experiments, *Zhi Li[1], Ioannis Katsavounidis[2], Christos Bampis[1], and Lucjan Janowski[3]; [1]Netflix, Inc. (United States), [2]Facebook, Inc. (United States), and [3]AGH 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 Callet[2], Jim Skinner[3], and Ioannis Katsavounidis[3]; [1]CAPACITÉS (France), [2]Université de Nantes (France), and [3]Facebook, 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 Becerra[1], Mylène Farias[1], and Andrew Hines[2]; [1]University of Brasilia (Brazil) and [2]University College Dublin (Ireland)*

4:10 IQSP-168
No reference video quality assessment with authentic distortions using 3-D deep convolutional neural network, *Roger Nieto[1], Hernan Dario Benitez Restrepo[1], Roger Figueroa Quintero[1], and Alan Bovik[2]; [1]Pontificia University Javeriana, Cali (Colombia) and [2]The University of Texas at Austin (United States)*

4:30 IQSP-169
Quality aware feature selection for video object tracking, *Roger Nieto[1], Carlos Quiroga[2], Jose Ruiz-Munoz[3], and Hernan Benitez-Restrepo[1]; [1]Pontificia University Javeriana, Cali (Colombia), [2]Universidad del Valle (Colombia), and [3]University of Florida (United States)*

4:50 IQSP-170
Studies on the effects of megapixel sensor resolution on displayed image quality and relevant metrics, *Sophie Triantaphillidou[1], Jan Smejkal[1], Edward Fry[1], and Chuang Hsin Hung[2]; [1]University of Westminster (United Kingdom) and [2]Huawei (China)*

DISCUSSION: HVEI Tuesday Wrap-up Q&A

Session Chairs: Damon Chandler, Shizuoka University (Japan); Mark McCourt, North Dakota State University (United States); and Jeffrey Mulligan, NASA Ames Research Center (United States)

5:10 – 5:40 pm
Grand Peninsula A

5:30 – 7:30 pm Symposium Demonstration Session

Wednesday, January 29, 2020

Image Processing and Perception

Session Chair: Damon Chandler, Shizuoka University (Japan)

9:10 – 10:10 am
Grand Peninsula A

9:10 HVEI-208
Neural edge integration model accounts for the staircase-Gelb and scrambled-Gelb effects in lightness perception, *Michael Rudd, University of Washington (United States)*

9:30 HVEI-209
Influence of texture structure on the perception of color composition (JPI-first), *Jing Wang[1], Jana Zujovic[2], June Choi[3], Basabdutta Chakraborty[4], Rene van Egmond[5], Huib de Ridder[5], and Thrasyvoulos Pappas[1]; [1]Northwestern University (United States), [2]Google, Inc. (United States), [3]Accenture (United States), [4]Amway (United States), and [5]Delft University of Technology (the Netherlands)*

9:50 HVEI-210
Evaluation of tablet-based methods for assessment of contrast sensitivity, *Jeffrey Mulligan, NASA Ames Research Center (United States)*

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

10:10 – 10:50 am Coffee Break

Psychophysics and LED Flicker Artifacts — Joint Session

Session Chair: Jeffrey Mulligan, NASA Ames Research Center (United States)

10:50 – 11:30 am
Regency B
This session is jointly sponsored by: Autonomous Vehicles and Machines 2020, and Human Vision and Electronic Imaging 2020.

10:50 HVEI-233
Predicting visible flicker in temporally changing images, *Gyorgy Denes and Rafal Mantiuk, University of Cambridge (United Kingdom)*

11:10 HVEI-234
Psychophysics study on LED flicker artefacts for automotive digital mirror replacement systems, *Nicolai Behmann and Holger Blume, Leibniz University Hannover (Germany)*

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

Faces in Art / Human Feature Use

Session Chair: Mark McCourt, North Dakota State University (United States)

3:30 – 4:10 pm
Grand Peninsula A

3:30 HVEI-267
Conventions and temporal differences in painted faces: A study of posture and color distribution, *Mitchell van Zuijlen, Sylvia Pont, and Maarten Wijntjes, Delft University of Technology (the Netherlands)*

3:50 HVEI-268
Biological and biomimetic perception: A comparative study through gender recognition from human gait (JPI-pending), *Viswadeep Sarangi[1], Adar Pelah[1], William Hahn[2], and Elan Barenholtz[2]; [1]University of York (United Kingdom) and [2]Florida Atlantic University (United States)*

DISCUSSION: HVEI Wednesday Wrap-up Q&A

Session Chairs: Damon Chandler, Shizuoka University (Japan); Mark McCourt, North Dakota State University (United States); and Jeffrey Mulligan, NASA Ames Research Center (United States)

4:10 – 5:00 pm
Grand Peninsula A

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

2020 Friends of HVEI Banquet

7:00 – 10:00 pm
Offsite Restaurant
This annual event brings the HVEI community together for great food and convivial conversation. The presenter is Prof. Bruno Olshausen (UC Berkeley), speaking on "Perception as inference." See the Keynotes section for details. Registration required, online or at the registration desk. Location will be provided with registration.

Thursday, January 30, 2020

KEYNOTE: Multisensory and Crossmodal Interactions

Session Chair: Lora Likova, Smith-Kettlewell Eye Research Institute (United States)

9:10 – 10:10 am
Grand Peninsula A

HVEI-354

Multisensory interactions and plasticity – Shooting hidden assumptions, revealing postdictive aspects, *Shinsuke Shimojo, professor and principle investigator, California Institute of Technology (United States)*

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

10:10 – 10:50 am Coffee Break

Multisensory and Crossmodal Interactions I

Session Chair: Mark McCourt, North Dakota State University (United States)

10:50 am – 12:30 pm
Grand Peninsula A

10:50 HVEI-365
Multisensory contributions to learning face-name associations, *Carolyn Murray, Sarah May Tarlow, and Ladan Shams, University of California, Los Angeles (United States)*

11:10 HVEI-366
Face perception as a multisensory process, *Lora Likova, Smith-Kettlewell Eye Research Institute (United States)*

11:30 HVEI-367
Changes in auditory-visual perception induced by partial vision loss: Use of novel multisensory illusions, *Noelle Stiles[1,2], Armand Tanguay[2,3], Ishani Ganguly[2], Carmel Levitan[4], and Shinsuke Shimojo[2]; [1]Keck School of Medicine, University of Southern California, [2]California Institute of Technology, [3]University of Southern California, and [4]Occidental College (United States)*

11:50 HVEI-368
Multisensory temporal processing in early deaf individuals, *Fang Jiang, University of Nevada, Reno (United States)*

12:10 HVEI-369
Inter- and intra-individual variability in multisensory integration in autism spectrum development: A behavioral and electrophysiological study, *Clifford Saron[1], Yukari Takarae[2], Iman Mohammadrezazadeh[3], and Susan Rivera[1]; [1]University of California, Davis, [2]University of California, San Diego, and [3]HRL Laboratories (United States)*

12:30 – 2:00 pm Lunch

Multisensory and Crossmodal Interactions II

Session Chair: Lora Likova, Smith-Kettlewell Eye Research Institute (United States)

2:00 – 3:00 pm
Grand Peninsula A

2:00 HVEI-383
Auditory capture of visual motion: Effect of audio-visual stimulus onset asynchrony, *Mark McCourt, Emily Boehm, and Ganesh Padmanabhan, North Dakota State University (United States)*

2:20 HVEI-384
Auditory and audiovisual processing in visual cortex, *Jessica Green, University of South Carolina (United States)*

2:40 HVEI-385
Perception of a stable visual environment during head motion depends on motor signals, *Paul MacNeilage, University of Nevada, Reno (United States)*

3:00 – 3:30 pm Coffee Break

Multisensory and Crossmodal Interactions III

Session Chair: Mark McCourt, North Dakota State University (United States)

3:30 – 5:00 pm
Grand Peninsula A

3:30 HVEI-393
Multisensory aesthetics: Visual, tactile and auditory preferences for fractal-scaling characteristics, *Branka Spehar, University of New South Wales (Australia)*

3:50 HVEI-394
Introducing Vis+Tact(TM) iPhone app, *Jeannette Mahoney, Albert Einstein College of Medicine (United States)*

4:10 HVEI-395
An accelerated Minkowski summation rule for multisensory cue combination, *Christopher Tyler, Smith-Kettlewell Eye Research Institute (United States)*

4:30
Multisensory Discussion

Image Processing: Algorithms and Systems XVIII

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

IMAGE PROCESSING: ALGORITHMS AND SYSTEMS XVII

Monday, January 27, 2020

10:10 – 10:45 am Coffee Break

Image Processing with Machine Learning

Session Chairs: Sos Agaian, CSI City University of New York and The Graduate Center (CUNY) (United States); Karen Egiazarian, Tampere University (Finland); and Atanas Gotchev, Tampere University (Finland)

10:45 am – 12:30 pm
Harbour A/B

10:45
Conference Welcome

10:50 IPAS-025
Pruning neural networks via gradient information, *Pavlo Molchanov, NVIDIA Corporation (United States)*

11:10 IPAS-026
Real-world fence removal from a single-image via deep neural network, *Takuro Matsui, Takuro Yamaguchi, and Masaaki Ikehara, Keio University (Japan)*

11:30 IPAS-027
Adaptive context encoding module for semantic segmentation, *Congcong Wang[1], Faouzi Alaya Cheikh[1], Azeddine Beghdadi[2], and Ole Jakob Elle[3,4]; [1]Norwegian University of Science and Technology (Norway), [2]Universite Paris 13 (France), [3]Oslo University Hospital (Norway), and [4]University of Oslo (Norway)*

11:50 IPAS-028
CNN-based classification of degraded images, *Kazuki Endo[1], Masayuki Tanaka[1,2], and Masatoshi Okutomi[1]; [1]Tokyo Institute of Technology and [2]National Institute of Advanced Industrial Science and Technology (Japan)*

12:10 IPAS-029
A deep learning-based approach for defect detection and removing on archival photos, *Roman Sizyakin[1], Viacheslav Voronin[1,2], Nikolay Gapon[1], Evgeny Semenishchev[1,2], and Alexander Zelenskii[2]; [1]Don State Technical University and [2]Moscow State University of Technology "STANKIN" (Russian Federation)*

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

Medical Image Processing

Session Chairs: Sos Agaian, CSI City University of New York and The Graduate Center (CUNY) (United States), and Atanas Gotchev, Tampere University (Finland)

3:30 – 4:30 pm
Harbour A/B

3:30 IPAS-062
An active contour model for medical image segmentation using a quaternion framework, *Viacheslav Voronin[1,2], Evgeny Semenishchev[1,2], Alexander Zelenskii[2], Marina Zhdanova[2], and Sos Agaian[3]; [1]Don State Technical University (Russian Federation), [2]Moscow State University of Technology "STANKIN" (Russian Federation), and [3]CSI City University of New York and The Graduate Center (CUNY) (United States)*

3:50 IPAS-063
Improving 3D medical image compression efficiency using spatiotemporal coherence, *Matina Zerva, Michalis Vrigkas, Lisimachos Kondi, and Christophoros Nikou, University of Ioannina (Greece)*

4:10 IPAS-064
Pathology image-based lung cancer subtyping using deep-learning features and cell-density maps, *Mustafa Jaber[1], Christopher Szeto[2], Bing Song[2], Liudmila Beziaeva[3], Stephen Benz[2], and Shahrooz Rabizadeh[2]; [1]NantOmics, [2]ImmunityBio, and [3]NantHealth (United States)*

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

Scene Understanding

Session Chairs: Sos Agaian, CSI City University of New York and The Graduate Center (CUNY) (United States), and Karen Egiazarian, Tampere University (Finland)

8:50 – 10:10 am
Harbour A/B

8:50 IPAS-094
Two-step cascading algorithm for camera-based night fire detection, *Minji Park, Donghyun Son, and ByoungChul Ko, Keimyung University (Republic of Korea)*

9:10 IPAS-095
Introducing scene understanding to person re-identification using a spatio-temporal multi-camera model, *Xin Liu, Herman Groot, Egor Bondarev, and Peter de With, Eindhoven University of Technology (the Netherlands)*

9:30 IPAS-096
Use of retroreflective markers for object detection in harsh sensing conditions, *Laura Goncalves Ribeiro, Olli Suominen, Sari Peltonen, and Atanas Gotchev, Tampere University (Finland)*

9:50 IPAS-097
A novel image recognition approach using multiscale saliency model and GoogLeNet, *Guoan Yang, Xi'an Jiaotong University (China)*

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

10:10 – 10:50 am Coffee Break

Image and Video Processing

Session Chairs: Sos Agaian, CSI City University of New York and The Graduate Center (CUNY) (United States); Karen Egiazarian, Tampere University (Finland); and Atanas Gotchev, Tampere University (Finland)

10:50 am – 12:30 pm
Harbour A/B

10:50 IPAS-133
Edge detection using the Bhattacharyya distance with adjustable block space, *Jiho Yoon and Chulhee Lee, Yonsei University (Republic of Korea)*

11:10 IPAS-134
Color interpolation algorithm for a periodic white-dominant RGBW color filter array, *Kyeonghoon Jeong, Jonghyun Kim, and Moon Gi Kang, Yonsei University (Republic of Korea)*

11:30 IPAS-135
Computational color constancy under multiple light sources, *Jaeduk Han, Soonyoung Hong, and Moon Gi Kang, Yonsei University (Republic of Korea)*

11:50 IPAS-136
Per clip Lagrangian multiplier optimisation for HEVC, *Daniel Ringis, François Pitié, and Anil Kokaram, Trinity College (Ireland)*

12:10 IPAS-137
An expandable image database for evaluation of full-reference image visual quality metrics, *Mykola Ponomarenko[1], Oleg Ieremeiev[2], Vladimir Lukin[2], and Karen Egiazarian[1]; [1]Tampere University (Finland) and [2]National Aerospace University (Ukraine)*

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 Filtering and Enhancement

Session Chairs: Karen Egiazarian, Tampere University (Finland), and Atanas Gotchev, Tampere University (Finland)

3:30 – 5:30 pm
Harbour A/B

3:30 IPAS-177
Fractional contrast stretching for image enhancement of aerials and satellite images (JIST-first), *Thaweesak Trongtirakul[1], Werapon Chiracharit[1], and Sos Agaian[2]; [1]King Mongkut's University of Technology Thonburi (Thailand) and [2]CSI City University of New York and The Graduate Center (CUNY) (United States)*

3:50 IPAS-178
Image debanding using iterative adaptive sparse filtering, *Neeraj Gadgil, Qing Song, and Guan-Ming Su, Dolby Laboratories (United States)*

4:10 IPAS-179
Hyperspectral complex-domain image denoising: Cube complex-domain BM3D (CCDBM3D) algorithm, *Vladimir Katkovnik, Mykola Ponomarenko, Karen Egiazarian, Igor Shevkunov, and Peter Kocsis, Tampere University (Finland)*

4:30 IPAS-180
Color restoration of multispectral images: Near-infrared (NIR) filter-to-color (RGB) image, *Thaweesak Trongtirakul[1], Werapon Chiracharit[1], and Sos Agaian[2]; [1]King Mongkut's University of Technology Thonburi (Thailand) and [2]CSI City University of New York and The Graduate Center (CUNY) (United States)*

4:50 IPAS-181
Non-blind image deconvolution based on "ringing" removal using convolutional neural network, *Takahiro Kudo, Takanori Fujisawa, and Masaaki Ikehara, Keio University (Japan)*

5:10 IPAS-182
OEC-CNN: A simple method for over-exposure correction in photographs, *Zhao Gao[1], Eran Edirisinghe[1], and Viacheslav Chesnokov[2]; [1]Loughborough University and [2]ARM Limited (United Kingdom)*

5:30 – 7:30 pm Symposium Demonstration Session

Wednesday, January 29, 2020

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

10:10 – 11:00 am Coffee Break

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 Processing: Algorithms and Systems XVIII Interactive Papers Session

5:30 – 7:00 pm
Sequoia
The following works will be presented at the EI 2020 Symposium Interactive Papers Session.

IPAS-310

Comparing training variability of CNN and optimal linear data reduction on image textures, *Khalid Omer, Luca Caucci, and Meredith Kupinski, The University of Arizona (United States)*

IPAS-311

Elastic graph-based semi-supervised embedding with adaptive loss regression, *Fadi Dornaika and Youssof El Traboulsi, University of the Basque Country (Spain)*

IPAS-312

Generative adversarial networks: A short review, *Habib Ullah[1], Sultan Daud Khan[1], Mohib Ullah[2], and Faouzi Alaya Cheikh[2]; [1]University of Ha'il (Saudi Arabia) and [2]Norwegian University of Science and Technology (Norway)*

IPAS-313

Multiscale convolutional descriptor aggregation for visual place recognition, *Raffaele Imbriaco, Egor Bondarev, and Peter de With, Eindhoven University of Technology (the Netherlands)*

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

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

Conference Sponsor

IQSP

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 Irshad[1], Alessandro Silva[1,2], Sana Alamgeer[1], and Mylène Farias[1]; [1]University of Brasilia and [2]IFG (Brazil)*

3:50 IQSP-067
Perceptual image quality assessment for various viewing conditions and display systems, *Andrei Chubarau[1], Tara Akhavan[2], Hyunjin Yoo[2], Rafal Mantiuk[3], and James Clark[1]; [1]McGill University (Canada), [2]IRYStec Software Inc. (Canada), and [3]University 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 Robitza, 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 Pinson[3]; [1]RISE Acreo AB (Sweden), [2]Mid Sweden University (Sweden), and [3]National 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 Hedlund[1], and Chris Snijders[2]; [1]RISE Research Institutes of Sweden AB (Sweden), [2]University of Technology Eindhoven (the Netherlands), and [3]Mid Sweden University (Sweden)*

9:30 HVEI-092
Open software framework for collaborative development of no reference image and video quality metrics, *Margaret Pinson[1], Philip Corriveau[2], Mikolaj Leszczuk[3], and Michael Colligan[4]; [1]US Department of Commerce (United States), [2]Intel Corporation (United States), [3]AGH University of Science and Technology (Poland), and [4]Spirent 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 Hajimirza[1], and Naeem Ramzan[2]; [1]Lumen Research Limited and [2]University of the West of Scotland (United Kingdom)*

11:30 HVEI-130
Predicting single observer's votes from objective measures using neural networks, *Lohic Fotio Tiotsop[1], Tomas Mizdos[2], Miroslav Uhrina[2], Peter Pocta[2], Marcus Barkowsky[3], and Enrico Masala[1]; [1]Politecnico di Torino (Italy), [2]Zilina University (Slovakia), and [3]Deggendorf Institute of Technology (DIT) (Germany)*

11:50 HVEI-131
A simple model for test subject behavior in subjective experiments, *Zhi Li[1], Ioannis Katsavounidis[2], Christos Bampis[1], and Lucjan Janowski[3]; [1]Netflix, Inc. (United States), [2]Facebook, Inc. (United States), and [3]AGH 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 Callet[2], Jim Skinner[3], and Ioannis Katsavounidis[3]; [1]CAPACITÉS (France), [2]Université de Nantes (France), and [3]Facebook, 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 Becerra[1], Mylène Farias[1], and Andrew Hines[2]; [1]University of Brasilia (Brazil) and [2]University College Dublin (Ireland)*

4:10 IQSP-168
No reference video quality assessment with authentic distortions using 3-D deep convolutional neural network, *Roger Nieto[1], Hernan Dario Benitez Restrepo[1], Roger Figueroa Quintero[1], and Alan Bovik[2]; [1]Pontificia University Javeriana, Cali (Colombia) and [2]The University of Texas at Austin (United States)*

IQSP

4:30 IQSP-169
Quality aware feature selection for video object tracking, *Roger Nieto[1], Carlos Quiroga[2], Jose Ruiz-Munoz[3], and Hernan Benitez-Restrepo[1]; [1]Pontificia University Javeriana, Cali (Colombia), [2]Universidad del Valle (Colombia), and [3]University of Florida (United States)*

4:50 IQSP-170
Studies on the effects of megapixel sensor resolution on displayed image quality and relevant metrics, *Sophie Triantaphillidou[1], Jan Smejkal[1], Edward Fry[1], and Chuang Hsin Hung[2]; [1]University of Westminster (United Kingdom) and [2]Huawei (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

10:50 IQSP-239
Validation of modulation transfer functions and noise power spectra from natural scenes (JIST-first), *Edward Fry[1], Sophie Triantaphillidou[1], Robin Jenkin[2], and Ralph Jacobson[1]; [1]University of Westminster (United Kingdom) and [2]NVIDIA Corporation (United States)*

11:10 IQSP-240
Application of ISO standard methods to optical design for image capture, *Peter Burns[1], Don Williams[2], Heidi Hall[3], John Griffith[3], and Scott Cahall[3]; [1]Burns Digital Imaging, [2]Image Science Associates, and [3]Moondog Optics (United States)*

11:30 IQSP-241
Camera system performance derived from natural scenes, *Oliver van Zwanenberg[1], Sophie Triantaphillidou[1], Robin Jenkin[2], and Alexandra Psarrou[1]; [1]University of Westminster (United Kingdom) and [2]NVIDIA Corporation (United States)*

11:50 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 Environnement

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

3:30 – 5:10 pm
Harbour A/B

3:30 IQSP-284
Subjective and viewport-based objective quality assessment of 360-degree videos, *Roberto Azevedo[1], Neil Birkbeck[2], Ivan Janatra[2], Balu Adsumilli[2], and Pascal Frossard[1]; [1]Ecole Polytechnique Fédérale de Lausanne (Switzerland) and [2]YouTube (United States)*

3:50 IQSP-285
Statistical characterization of tile decoding time of HEVC-encoded 360° video, *Henrique Garcia[1], Mylène Farias[1], Ravi Prakash[2], and Marcelo Carvalho[1]; [1]University of Brasilia (Brazil) and [2]The University of Texas at Dallas (United States)*

4:10 IQSP-286
Complexity optimization for the upcoming versatile video coding standard, *Mohamed Chaker Larabi, Université de Poitiers (France)*

4:30 IQSP-287
On the improvement of 2D quality metrics for the assessment of 360-deg images, *Mohamed Chaker Larabi, Université de Poitiers (France)*

4:50 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)*

IQSP

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 Zhang[1], Yi Yang[1], Eric Maggard[2], Yousun Bang[3], Minki Cho[3], and Jan Allebach[1]; [1]Purdue University (United States), [2]HP Inc. (United States), and [3]HP 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, Jinhyun 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-319
Prediction of performance of 2D DCT-based filter and adaptive selection of its parameter, *Oleksii Rubel[1], Sergiy Abramov[1], Vladimir Lukin[1], and Karen Egiazarian[2]; [1]National Aerospace University (Ukraine) and [2]Tampere 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 Zhang[1], Eric Maggard[2], Yousun Bang[3], Minki Cho[3], and Jan Allebach[1]; [1]Purdue University (United States), [2]HP Inc. (United States), and [3]HP Printing Korea Co. Ltd. (Republic of Korea)*

IQSP-322
Relation between image quality and resolution - Part I, *Zhenhua Hu[1], Litao Hu[1], Peter Bauer[2], Todd Harris[2], and Jan Allebach[1]; [1]Purdue University and [2]HP Inc. (United States)*

IQSP-323
Relation between image quality and resolution - Part II, *Litao Hu[1], Zhenhua Hu[1], Jan Allebach[1], Peter Bauer[2], and Todd Harris[2]; [1]Purdue University and [2]HP 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 Fry[1], Sophie Triantaphillidou[1], Robin Jenkin[1,2], Ralph Jacobson[1], and John Jarvis[1]; [1]University of Westminster (United Kingdom) and [2]NVIDIA 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 Koren[1] and Robin Jenkin[2]; [1]Imatest LLC and [2]NVIDIA Corporation (United States)*

9:50 IQSP-348
Scene-and-process-dependent spatial image quality metrics (JIST-first), *Edward Fry[1], Sophie Triantaphillidou[1], Robin Jenkin[2], and John Jarvis[1]; [1]University of Westminster (United Kingdom) and [2]NVIDIA 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 Zalczer[1], François-Xavier Thomas[1], Laurent Chanas[1], Gabriele Facciolo[2], and Frédéric Guichard[1]; [1]DXOMARK and [2]ENS Cachan (France)*

11:10 IQSP-371
Prediction of Lee filter performance for Sentinel-1 SAR images, *Oleksii Rubel[1], Vladimir Lukin[1], Andrii Rubel[1], and Karen Egiazarian[2]; [1]National Aerospace University (Ukraine) and [2]Tampere University (Finland)*

11:30 IQSP-372
Evaluating whole-slide imaging viewers used in digital pathology, *Wei-Chung Cheng[1], Samuel Lam[2], Qi Gong[1], and Paul Lemaillet[1]; [1]US Food and Drug Administration and [2]University of Maryland (United States)*

11:50 IQSP-373
Ink quality ruler experiments and print uniformity predictor, *Yi Yang[1], Utpal Sarkar[2], Isabel Borrell[2], and Jan Allebach[1]; [1]Purdue University (United States) and [2]HP Inc. (Spain)*

IQSP

Imaging and Multimedia Analytics in a Web and Mobile World 2020

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.

Award

Best Paper Award

Conference Sponsors

IMAGING AND MULTIMEDIA ANALYTICS IN A WEB AND MOBILE WORLD 2020

Tuesday, January 28, 2020

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

Drone Imaging I — Joint Session

Session Chairs: Andreas Savakis, Rochester Institute of Technology (United States) and Grigorios Tsagkatakis, Foundation for Research and Technology (FORTH) (Greece)

8:45 – 10:10 am
Cypress B
This session is jointly sponsored by: Food and Agricultural Imaging Systems 2020, and Imaging and Multimedia Analytics in a Web and Mobile World 2020.

8:45
Conference Welcome

8:50 IMAWM-084
A new training model for object detection in aerial images, *Geng Yang[1], Yu Geng[2], Qin Li[1], Jane You[3], and Mingpeng Cai[1]; [1]Shenzhen Institute of Information Technology (China), [2]Shenzhen Shangda Xinzhi Information Technology Co., Ltd. (China), and [3]The Hong Kong Polytechnic University (Hong Kong)*

9:10 IMAWM-085
Small object bird detection in infrared drone videos using mask R-CNN deep learning, *Yasmin Kassim[1], Michael Byrne[1], Cristy Burch[2], Kevin Mote[2], Jason Hardin[2], and Kannappan Palaniappan[1]; [1]University of Missouri and [2]Texas Parks and Wildlife (United States)*

9:30 IMAWM-086
High-quality multispectral image generation using conditional GANs, *Ayush Soni, Alexander Loui, Scott Brown, and Carl Salvaggio, Rochester Institute of Technology (United States)*

9:50 IMAWM-087
Deep Ram: Deep neural network architecture for oil/gas pipeline right-of-way automated monitoring, *Ruixu Liu, Theus Aspiras, and Vijayan Asari, University of Dayton (United States)*

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

10:10 – 10:30 am Coffee Break

Drone Imaging II — Joint Session

Session Chairs: Vijayan Asari, University of Dayton (United States) and Grigorios Tsagkatakis, Foundation for Research and Technology (FORTH) (Greece)

10:30 – 10:50 am
Cypress B
This session is jointly sponsored by: Food and Agricultural Imaging Systems 2020, and Imaging and Multimedia Analytics in a Web and Mobile World 2020.

IMAWM-114
LambdaNet: A fully convolutional architecture for directional change detection, *Bryan Blakeslee and Andreas Savakis, Rochester Institute of Technology (United States)*

KEYNOTE: Remote Sensing in Agriculture I — Joint Session

Session Chairs: Vijayan Asari, University of Dayton (United States) and Mohammed Yousefhussien, General Electric Global Research (United States)

10:50 – 11:40 am
Cypress B
This session is jointly sponsored by: Food and Agricultural Imaging Systems 2020, and Imaging and Multimedia Analytics in a Web and Mobile World 2020.

FAIS-127
Managing crops across spatial and temporal scales - The roles of UAS and satellite remote sensing, *Jan van Aardt, professor, Chester F. Carlson Center for Imaging Science, Rochester Institute of Technology (United States)*

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

KEYNOTE: Remote Sensing in Agriculture II — Joint Session

Session Chairs: Vijayan Asari, University of Dayton (United States) and Mohammed Yousefhussien, General Electric Global Research (United States)

11:40 am – 12:30 pm
Cypress B
This session is jointly sponsored by: Food and Agricultural Imaging Systems 2020, and Imaging and Multimedia Analytics in a Web and Mobile World 2020.

FAIS-151
Practical applications and trends for UAV remote sensing in agriculture, *Kevin Lang, general manager of agriculture, PrecisionHawk (United States)*

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

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

Deep Learning: Multi-Media Analysis

Session Chair: Zhigang Fan, Apple Inc. (United States)

3:30 – 5:40 pm
Cypress B

3:30 IMAWVM-183
Actual usage of AI to generate more interesting printed products (Invited), *Birte Stadtlander, Sven Wiegand, and Reiner Fageth, CEWE Stiftung & Co. KGAA (Germany)*

4:00 IMAWVM-184
Deep learning for printed mottle defect grading, *Jianhang Chen[1], Qian Lin[2], and Jan Allebach[1]; [1]Purdue University and [2]HP Labs, HP Inc. (United States)*

4:20 IMAWVM-185
A local-global aggregate network for facial landmark localization, *Ruiyi Mao[1,2], Qian Lin[3], and Jan Allebach[1]; [1]Purdue University, [2]Apple Inc., and [3]HP Labs, HP Inc. (United States)*

4:40 IMAWVM-186
The blessing and the curse of the noise behind facial landmark annotations, *Xiaoyu Xiang[1], Yang Cheng[1], Shaoyuan Xu[1], Qian Lin[2], and Jan Allebach[1]; [1]Purdue University and [2]HP Labs, HP Inc. (United States)*

5:00 IMAWVM-187
Gun source and muzzle head detection, *Zhong Zhou, Isak Czeresnia Etinger, Florian Metze, Alexander Hauptmann, and Alex Waibel, Carnegie Mellon University (United States)*

5:20 IMAWVM-188
Semi-supervised multi-task network for image aesthetic assessment, *Xiaoyu Xiang[1], Yang Cheng[1], Jianhang Chen[1], Qian Lin[2], and Jan Allebach[1]; [1]Purdue University and [2]HP Labs, HP Inc. (United States)*

5:30 – 7:30 pm Symposium Demonstration Session

Wednesday, January 29, 2020

KEYNOTE: Personal Health Data and Surveillance

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

9:10 – 10:10 am
Cypress B

IMAWVM-211
Health surveillance, *Ramesh Jain, Bren Professor in Information & Computer Sciences, Donald Bren School of Information and Computer Sciences, University of California, Irvine (United States)*

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

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

10:10 – 10:30 am Coffee Break

Augmented Reality in Built Environments — Joint Session

Session Chairs: Raja Bala, PARC (United States) and Matthew Shreve, Palo Alto Research Center (United States)

10:30 am – 12:40 pm
Cypress B

This session is jointly sponsored by: The Engineering Reality of Virtual Reality 2020, and Imaging and Multimedia Analytics in a Web and Mobile World 2020.

10:30 IMAWVM-220
Augmented reality assistants for enterprise, *Matthew Shreve and Shiwali Mohan, Palo Alto Research Center (United States)*

11:00 IMAWVM-221
Extra FAT: A photorealistic dataset for 6D object pose estimation, *Jianhang Chen[1], Daniel Mas Montserrat[1], Qian Lin[2], Edward Delp[1], and Jan Allebach[1]; [1]Purdue University and [2]HP Labs, HP Inc. (United States)*

11:20 IMAWVM-222
Space and media: Augmented reality in urban environments, *Luisa Caldas, University of California, Berkeley (United States)*

12:00 ERVR-223
Active shooter response training environment for a building evacuation in a collaborative virtual environment, *Sharad Sharma and Sri Teja Bodempudi, Bowie State University (United States)*

12:20 ERVR-224
Identifying anomalous behavior in a building using HoloLens for emergency response, *Sharad Sharma and Sri Teja Bodempudi, Bowie State University (United States)*

12:40 – 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

Deep Learning: Applications

Session Chair: Reiner Fageth, CEWE Stiftung & Co. KGAA (Germany)

3:30 – 4:30 pm
Cypress B

3:30 IMAWM-269
Identification of utility images with a mobile device, *Karthick Shankar[1], Qian Lin[2], and Jan Allebach[1]; [1]Purdue University and [2]HP Labs, HP Inc. (United States)*

3:50 IMAWM-270
PSO and genetic modeling of deep features for road passibility analysis during floods, *Naina Said[1], Aysha Nayab[1], Kashif Ahmad[2], Mohib Ullah[3], Touqir Gohar[1], and Ala Al-fuqaha[2]; [1]University of Engineering and Technology, Peshawar (Pakistan), [2]Hamad Bin Khallifa University (Qatar), and [3]Norwegian University of Science and Technology (Norway)*

4:10 IMAWM-271
A deep neural network-based indoor positioning algorithm by cascade of image and WiFi, *Jichao Jiao[1], Xing Wang[2], Yaxin Zhao[1], Xinping Chen[1], Meng Guan[1], and Wei Cui[1]; [1]Beijing University of Posts and Telecommunications and [2]XMotors (China)*

Food and Computer Vision

Session Chair: Qian Lin, HP Labs, HP Inc. (United States)

4:30 – 5:30 pm
Cypress B

4:30 IMAWM-300
Shazam for food: Learning diet with visual data (Invited), *Fengqing Zhu, Sri Kalyan Yarlagadda, Runyu Mao, Zeman Shao, and Jiangpeng He, Purdue University (United States)*

4:50 IMAWM-301
Visual processing of dietary data: A nutrition science perspective, *Heather Eicher-Miller, Marah Aqeel, and Luotao Lin, Purdue University (United States)*

5:10 IMAWM-302
Image analytics for food safety, *Min Zhao, Susana Diaz-Amaya, Amanda J. Deering, Lia Stanciu, George Chiu, and Jan Allebach, Purdue University (United States)*

Imaging and Multimedia Analytics in a Web and Mobile World 2020 Interactive Papers Session

5:30 – 7:00 pm
Sequoia

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

IMAWM-309
Real-time whiteboard coding on mobile devices, *Xunyu Pan, Frostburg State University (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

IMAWM

Imaging Sensors and Systems 2020

Conference overview

The Imaging Sensors and Systems Conference (ISS) begins with EI 2020, from the merger of the Image Sensors and Imaging Systems Conference and the Photography, Mobile, and Immersive Imaging Conference. Through these conferences, ISS traces its roots to the earlier Digital Photography Conference, which ran for thirteen years.

ISS focuses on image sensing for consumer, industrial, medical, and scientific applications, as well as embedded image processing, and pipeline tuning for these camera systems. This conference will serve to bring together researchers, scientists, and engineers working in these fields, and provides the opportunity for quick publication of their work. Topics can include, but are not limited to, research and applications in image sensors and detectors, camera/sensor characterization, ISP pipelines and tuning, image artifact correction and removal, image reconstruction, color calibration, image enhancement, HDR imaging, light-field imaging, multi-frame processing, computational photography, 3D imaging, 360/cinematic VR cameras, camera image quality evaluation and metrics, novel imaging applications, imaging system design, and deep learning applications in imaging.

Award

Arnaud Darmont Memorial Best Paper Award*

*The Arnaud Darmont Memorial Best Paper Award is given in recognition of IMSE Conference Chair Arnaud Darmont who passed away unexpectedly in September 2018.

Arnaud dedicated his professional life to the computer vision industry. After completing his degree in electronic engineering from the University of Liège in Belgium (2002) he launched his career in the field of CMOS image sensors and high dynamic range imaging, founding APHESA in 2008. He was fiercely dedicated to disseminating knowledge about sensors, computer vision, and custom electronics design of imaging devices as witnessed by his years of teaching courses at the Electronic Imaging Symposium and Photonics West Conference, as well as his authorship of several publications. At the time of his death, Arnaud was in the final stages of revising the second edition of "High Dynamic Range Imaging – Sensors and Architectures", first published in 2013. An active member of the EMVA 1288 standardization group, he was also the standards manager for the organization where he oversaw the development of EMVA standards and fostered cooperation with other imaging associations worldwide on the development and the dissemination of vision standards. His dedication, knowledge, and boundless energy will be missed by the IS&T and Electronic Imaging communities.

Conference Sponsors

ISS

IMAGING SENSORS AND SYSTEMS 2020

Tuesday, January 28, 2020

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

Depth Sensing I

Session Chairs: Jon McElvain, Dolby Laboratories (United States) and Arnaud Peizerat, CEA (France)

9:05 – 10:10 am
Regency A

9:05
Conference Welcome

9:10 ISS-103
A 4-tap global shutter pixel with enhanced IR sensitivity for VGA time-of-flight CMOS image sensors, *Taesub Jung, Yonghun Kwon, Sungyoung Seo, Min-Sun Keel, Changkeun Lee, Sung-Ho Choi, Sae-Young Kim, Sunghyuck Cho, Youngchan Kim, Young-Gu Jin, Moosup Lim, Hyunsurk Ryu, Yitae Kim, Joonseok Kim, and Chang-Rok Moon, Samsung Electronics (Republic of Korea)*

9:30 ISS-104
Indirect time-of-flight CMOS image sensor using 4-tap charge-modulation pixels and range-shifting multi-zone technique, *Kamel Mars[1,2], Keita Kondo[1], Michihiro Inoue[1], Shohei Daikoku[1], Masashi Hakamata[1], Keita Yasutomi[1], Keiichiro Kagawa[1], Sung-Wook Jun[3], Yoshiyuki Mineyama[3], Satoshi Aoyama[3], and Shoji Kawahito[1]; [1]Shizuoka University, [2]Tokyo Institute of Technology, and [3]Brookman Technology (Japan)*

9:50 ISS-105
Improving the disparity for depth extraction by decreasing the pixel height in monochrome CMOS image sensor with offset pixel apertures, *Jimin Lee[1], Sang-Hwan Kim[1], Hyeunwoo Kwen[1], Seunghyuk Chang[2], JongHo Park[2], Sang-Jin Lee[2], and Jang-Kyoo Shin[1]; [1]Kyungpook National University and [2]Center for Integrated Smart Sensors, Korea Advanced Institute of Science and Technology (Republic of Korea)*

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

10:10 – 10:30 am Coffee Break

KEYNOTE: Sensor Design Technology

Session Chairs: Jon McElvain, Dolby Laboratories (United States) and Arnaud Peizerat, CEA (France)

10:30 – 11:10 am
Regency A

ISS-115
3D-IC smart image sensors, *Laurent Millet[1] and Stephane Chevobbe[2]; [1]CEA/LETI and [2]CEA/LIST (France)*

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

Sensor Design Technology

Session Chairs: Jon McElvain, Dolby Laboratories (United States) and Arnaud Peizerat, CEA (France)

11:10 am – 12:10 pm
Regency A

11:10 ISS-143
An over 120dB dynamic range linear response single exposure CMOS image sensor with two-stage lateral overflow integration trench capacitors, *Yasuyuki Fujihara, Maasa Murata, Shota Nakayama, Rihito Kuroda, and Shigetoshi Sugawa, Tohoku University (Japan)*

11:30 ISS-144
Planar microlenses for near infrared CMOS image sensors, *Lucie Dilhan[1,2,3], Jérôme Vaillant[1,2], Alain Ostrovsky[3], Lilian Masarotto[1,2], Céline Pichard[1,2], and Romain Paquet[1,2]; [1]University Grenoble Alpes, [2]CEA, and [3]STMicroelectronics (France)*

11:50 ISS-145
Event threshold modulation in dynamic vision spiking imagers for data throughput reduction, *Luis Cubero[1,2], Arnaud Peizerat[1], Dominique Morche[1], and Gilles Sicard[1]; [1]CEA and [2]University Grenoble Alpes (France)*

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

PANEL: Sensors Technologies for Autonomous Vehicles — Joint Session

Panel Moderator: David Cardinal, Cardinal Photo & Extremetech.com (United States)

3:30 – 5:30 pm
Regency A

This session is jointly sponsored by: Autonomous Vehicles and Machines 2020, and Imaging Sensors and Systems 2020.

Imaging sensors are at the heart of any self-driving car project. However, selecting the right technologies isn't simple. Competitive products span a gamut of capabilities includi ng traditional visible-light cameras, thermal cameras, lidar, and radar. Our session includes experts in all of these areas, and in emerging technologies, who will help us understand the strengths, weaknesses, and future directions of each. Presentations by the speakers listed below will be followed by a panel discussion.

Biographies and/or abstracts are found on pages 15–21

Introduction, *David Cardinal, consultant and technology journalist (United States)*

LiDAR for Self-driving Cars, *Nikhil Naikal, VP of Software Engineering, Velodyne Lidar (United States)*

Challenges in Designing Cameras for Self-driving Cars, *Nicolas Touchard, VP of Marketing, DXOMARK (France)*

Using Thermal Imaging to Help Cars See Better, *Mike Walters, VP of product management for thermal cameras, FLIR Systems, Inc. (United States)*

Radar's Role, *Greg Stanley, field applications engineer, NXP Semiconductors (the Netherlands)*

Tales from the Automotive Sensor Trenches, *Sanjai Kohli, CEO, Visible Sensors, Inc. (United States)*

Auto Sensors for the Future, *Alberto Stochino, founder and CEO, Perceptive (United States)*

5:30 – 7:30 pm Symposium Demonstration Session

Wednesday, January 29, 2020

KEYNOTE: Imaging Systems and Processing — Joint Session

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

8:50 – 9:30 am
Regency A

This session is jointly sponsored by: The Engineering Reality of Virtual Reality 2020, Imaging Sensors and Systems 2020, and Stereoscopic Displays and Applications XXXI.

ISS-189
Mixed reality guided neuronavigation for non-invasive brain stimulation treatment, *Christoph Leuze, research scientist in the Incubator for Medical Mixed and Extended Reality, Stanford University (United States)*

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

Imaging Systems and Processing I

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

9:30 – 10:10 am
Regency A

9:30 ISS-212
Soft-prototyping imaging systems for oral cancer screening, *Joyce Farrell, Stanford University (United States)*

9:50 ISS-213
Calibration empowered minimalistic multi-exposure image processing technique for camera linear dynamic range extension, *Nabeel Riza and Nazim Ashraf, University College Cork (Ireland)*

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

10:10 – 10:30 am Coffee Break

Imaging Systems and Processing II

Session Chairs: Francisco Imai, Apple Inc. (United States) and Nitin Sampat, Edmund Optics, Inc (United States)

10:30 am – 12:50 pm
Regency A

10:30 ISS-225
Anisotropic subsurface scattering acquisition through a light field based apparatus, *Yurii Piadyk, Yitzchak Lockerman, and Claudio Silva, New York University (United States)*

10:50 ISS-226
CAOS smart camera-based robust low contrast image recovery over 90 dB scene linear dynamic range, *Nabeel Riza and Mohsin Mazhar, University College Cork (Ireland)*

11:10 ISS-227
TunnelCam - A HDR spherical camera array for structural integrity assessments of dam interiors, *Dominique Meyer[1], Eric Lo[1], Jonathan Klingspon[1], Anton Netchaev[2], Charles Ellison[2], and Falko Kuester[1]; [1]University of California, San Diego and [2]United States Army Corps of Engineers (United States)*

11:30 ISS-228
Characterization of camera shake, *Henry Dietz, William Davis, and Paul Eberhart, University of Kentucky (United States)*

11:50 ISS-229
Expanding dynamic range in a single-shot image through a sparse grid of low exposure pixels, *Leon Eisemann, Jan Fröhlich, Axel Hartz, and Johannes Maucher, Stuttgart Media University (Germany)*

12:10 ISS-230
Deep image demosaicing for submicron image sensors (JIST-first), *Irina Kim, Seongwook Song, SoonKeun Chang, SukHwan Lim, and Kai Guo, Samsung Electronics (Republic of Korea)*

12:30 ISS-231
Sun tracker sensor for attitude control of space navigation systems, *Antonio De la Calle-Martos[1], Rubén Gómez-Merchán[2], Juan A. Leñero-Bardallo[2], and Angel Rodríguez-Vázquez[1,2]; [1]Teledyne-Anafocus and [2]University of Seville (Spain)*

12:50 – 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

Depth Sensing II

Session Chairs: Sergio Goma, Qualcomm Technologies, Inc. (United States) and Radka Tezaur, Intel Corporation (United States)

3:30 – 4:30 pm
Regency A

3:30 ISS-272
A short-pulse based time-of-flight image sensor using 4-tap charge-modulation pixels with accelerated carrier response, *Michihiro Inoue, Shohei Daikoku, Keita Kondo, Akihito Komazawa, Keita Yasutomi, Keiichiro Kagawa, and Shoji Kawahito, Shizuoka University (Japan)*

3:50 ISS-273
Single-shot multi-frequency pulse-TOF depth imaging with sub-clock shifting for multi-path interference separation, *Tomoya Kokado[1], Yu Feng[1], Masaya Horio[1], Keita Yasutomi[1], Shoji Kawahito[1], Takashi Komuro[2], Hajime Ngahara[3], and Keiichiro Kagawa[1]; [1]Shizuoka University, [2]Saitama University, and [3]Institute for Datability Science, Osaka University (Japan)*

4:10 ISS-274
A high-linearity time-of-flight image sensor using a time-domain feedback technique, *Juyeong Kim, Keita Yasutomi, Keiichiro Kagawa, and Shoji Kawahito, Shizuoka University (Japan)*

Imaging Sensors and Systems 2020 Interactive Papers Session

5:30 – 7:00 pm
Sequoia

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

ISS-327
Camera support for use of unchipped manual lenses, *Henry Dietz, University of Kentucky (United States)*

ISS-328
CIS band noise prediction methodology using co-simulation of camera module, *Euncheol Lee, Hyunsu Jun, Wonho Choi, Kihyun Kwon, Jihyung Lim, Seung-hak Lee, and JoonSeo Yim, Samsung Electronics (Republic of Korea)*

ISS-329
From photons to digital values: A comprehensive simulator for image sensor design, *Alix de Gouvello, Laurent Soulier, and Antoine Dupret, CEA LIST (France)*

ISS-330
Non-uniform integration of TDCI captures, *Paul Eberhart, University of Kentucky (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

Intelligent Robotics and Industrial Applications using Computer Vision 2020

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.

Award

Best Student Paper

INTELLIGENT ROBOTICS AND INDUSTRIAL APPLICATIONS USING COMPUTER VISION 2020

Monday, January 27, 2020

Robotics

Session Chair: Juha Röning, University of Oulu (Finland)

8:45 – 10:10 am
Regency A

8:45
Conference Welcome

8:50 IRIACV-013
Passive infrared markers for indoor robotic positioning and navigation, *Jian Chen, AltVision, Inc. (United States)*

9:10 IRIACV-014
Improving multimodal localization through self-supervision, *Robert Relyea, Darshan Ramesh Bhanushali, Karan Manghi, Abhishek Vashist, Clark Hochgraf, Amlan Ganguly, Andres Kwasinski, Michael Kuhl, and Ray Ptucha, Rochester Institute of Technology (United States)*

9:30 IRIACV-015
Creation of a fusion image obtained in various electromagnetic ranges used in industrial robotic systems, *Evgeny Semenishchev[1] and Viacheslav Voronin[2]; [1]Moscow State Technical University (STANKIN) and [2]Don State Technical University (Russian Federation)*

9:50 IRIACV-016
Locating mechanical switches using RGB-D sensor mounted on a disaster response robot, *Takuya Kanda[1], Kazuya Miyakawa[1], Jeonghwang Hayashi[1], Jun Ohya[1], and Hiroyuki Ogata[2]; [1]Waseda University and [2]Seikei University (Japan)*

10:10 – 10:50 am Coffee Break

Machine Learning

Session Chairs: Kurt Niel, University of Applied Sciences Upper Austria (Austria) and Juha Röning, University of Oulu (Finland)

10:50 am – 12:30 pm
Regency A

10:50 IRIACV-048
A review and quantitative evaluation of small face detectors in deep learning, *Weihua Xionog, EagleSens Inc. (United States)*

11:10 IRIACV-049
Rare-class extraction using cascaded pretrained networks applied to crane classification, *Sander Klomp[1,2], Guido Brouwers[2], Rob Wijnhoven[2], and Peter de With[1]; [1]Eindhoven University of Technology and [2]ViNotion (the Netherlands)*

11:30 IRIACV-050
Detection and characterization of rumble strips in roadway video logs, *Deniz Aykac, Thomas Karnowski, Regina Ferrell, and James Goddard, Oak Ridge National Laboratory (United States)*

11:50 IRIACV-051
Real-time small-object change detection from ground vehicles using a Siamese convolutional neural network (JIST-first), *Sander Klomp, Dennis van de Wouw, and Peter de With, Eindhoven University of Technology (the Netherlands)*

12:10 IRIACV-052
Perceptual license plate super-resolution with CTC loss, *Zuzana Bilkova[1,2] and Michal Hradis[3]; [1]Charles University, [2]Institute of Information Theory and Automation, and [3]Brno University of Technology (Czechia)*

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

Computer Vision & Inspection

Session Chair: Kurt Niel, University of Applied Sciences Upper Austria (Austria)

3:30 – 4:50 pm
Regency A

3:30 IRIACV-070
Estimating vehicle fuel economy from overhead camera imagery and application for traffic control, *Thomas Karnowski[1], Ryan Tokola[1], Sean Oesch[1], Matthew Eicholtz[2], Jeff Price[3], and Tim Gee[3]; [1]Oak Ridge National Laboratory, [2]Florida Southern College, and [3]GRIDSMART (United States)*

3:50 IRIACV-071
Tailored photometric stereo: Optimization of light source positions for different materials, *Christian Kapeller[1,2], Doris Antensteiner[1], Thomas Pinez[1], Nicole Brosch[1], and Svorad Štolc[1]; [1]AIT Austrian Institute of Technology GmbH and [2]Vienna University of Technology (Austria)*

4:10 IRIACV-072
Crowd congestion detection in videos, *Sultan Daud Khan[1], Habib Ullah[1], Mohib Ullah[2], and Faouzi Alaya Cheikh[2]; [1]University of Ha'il (Saudi Arabia) and [2]Norwegian University of Science and Technology (Norway)*

4:30 IRIACV-074
Head-based tracking, *Mohib Ullah[1], Habib Ullah[2], Kashif Ahmad[3], Ali Shariq Imran[1], and Faouzi Alaya Cheikh[1]; [1]Norwegian University of Science and Technology (Norway), [2]University of Ha'il (Saudi Arabia), and [3]Hamad Bin Khalifa University (Qatar)*

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

Wednesday, January 29, 2020

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

10:10 – 11:00 am Coffee Break

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

Intelligent Robotics and Industrial Applications using Computer Vision 2020 Interactive Papers Session

5:30 – 7:00 pm
Sequoia
The following works will be presented at the EI 2020 Symposium Interactive Papers Session.

IRIACV-325
An evaluation of embedded GPU systems for visual SLam algorithms, *Tao Peng, Dingnan Zhang, Don Nirmal, and John Loomis, University of Dayton (United States)*

IRIACV-326
An evaluation of visual SLam methods on NVIDIA Jetson Systems, *Dingnan Zhang, Tao Peng, Don Nirmal, and John Loomis, University of Dayton (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

Material Appearance 2020

Conference overview

The rapid and continuous development of rendering simulators and devices such as displays and printers offers interesting challenges related to how the appearance of materials is understood. Over the years, researchers from different disciplines, including metrology, optical modeling, and digital simulation, 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 propose methods for characterizing the optical and visual properties of many materials, propose affordable measurement methods, predict optical properties or appearance attributes, and render 2.5D and 3D objects and scenes with high accuracy.

This conference offers the possibility to share research results and establish new collaborations between academic and industrial researchers from these related fields.

Award
Best Paper Award

Conference Chairs: **Mathieu Hebert,** Université Jean Monnet de Saint Etienne (France); **Lionel Simonot,** Université de Poitiers (France); and **Ingeborg Tastl,** HP Inc. (United States)

Program Committee: **Simone Bianco,** University of Milan (Italy); **Marc Ellens**, Artomatix (United States); **Susan P. Farnand,** Rochester Institute of Technology (United States); **Roland Fleming,** Justus-Liebig-Universität Giessen (Germany); **Jon Yngve Hardeberg,** Norwegian University of Science and Technology (Norway); **Francisco H. Imai,** Apple Inc. (United States); **Susanne Klein,** University of the West of England (United Kingdom); **Gael Obein,** Conservatoire National des Arts et Metiers (France); **Carinna Parraman,** University of the West of England (United Kingdom); **Holly Rushmeier,** Yale University (United States); **Takuroh Sone,** Ricoh Japan (Japan); **Shoji Tominaga,** Chiba University (Japan); and **Philipp Urban,** Fraunhofer Institute for Computer Graphics Research IGD (Germany)

Conference Sponsors

MATERIAL APPEARANCE 2020

Monday, January 27, 2020

Material Appearance 2020 Conference Introduction

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

9:20 – 9:30 am
Regency C

KEYNOTE: 3D Digitization and Optical Material Interactions

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

9:30 – 10:10 am
Regency C

MAAP-020
Capturing and 3D rendering of optical behavior: The physical approach to realism, *Martin Ritz, deputy head, Competence Center Cultural Heritage Digitizatiion, Fraunhofer Institute for Computer Graphics Research (Germany)*

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

10:10 – 10:50 am Coffee Break

Sparkle, Gloss, Texture, and Translucency

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

10:50 am – 12:10 pm
Regency C

10:50 MAAP-030
One-shot multi-angle measurement device for evaluating the sparkle impression (JIST-first), *Shuhei Watanabe, Ricoh Company, Ltd. (Japan)*

11:10 MAAP-031
Appearance reproduction of material surface with strong specular reflection, *Shoji Tominaga[1,2], Giuseppe Guarnera[2], and Norihiro Tanaka[1]; [1]Nagano University (Japan) and [2]Norwegian University of Science and Technology (Norway)*

11:30 MAAP-032
BTF image recovery based on U-Net and texture interpolation, *Naoki Tada and Keita Hirai, Chiba University (Japan)*

11:50 MAAP-033
Caustics and translucency perception, *Davit Gigilashvili, Lucas Dubouchet, Jon Yngve Hardeberg, and Marius Pedersen, Norwegian University of Science and Technology (Norway)*

DISCUSSION; Material Appearance Morning Q&A

Session Chairs: Mathieu Hebert, Université Jean Monnet de Saint Etienne (France) and Ingeborg Tastl, HP Labs, HP Inc. (United States)

12:10 – 12:30 pm
Regency C

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

Aging and Renewing

Session Chair: Shoji Tominaga, Chiba University (Japan)

3:30 – 4:10 pm
Regency C

3:30 MAAP-060
Changes in the visual appearance of polychrome wood caused by (accelerated) aging, *Oleksii Sidorov[1], Jon Yngve Hardeberg[1], Sony George[1], Joshua Harvey[2], and Hannah Smithson[2]; [1]Norwegian University of Science and Technology (Norway) and [2]University of Oxford (United Kingdom)*

3:50 MAAP-061
Image processing method for renewing old objects using deep learning, *Runa Takahashi and Katsunori Okajima, Yokohama National University (Japan)*

DISCUSSION: Material Appearance Afternoon Q&A

Session Chairs: Mathieu Hebert, Université Jean Monnet de Saint Etienne (France) and Ingeborg Tastl, HP Labs, HP Inc. (United States)

4:10 – 4:30 pm
Regency C

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

Skin and Deep Learning — Joint Session

Session Chairs: Alessandro Rizzi, Università degli Studi di Milano (Italy) and Ingeborg Tastl, HP Labs, HP Inc. (United States)

8:45 – 9:30 am
Regency C
This session is jointly sponsored by: Color Imaging XXV: Displaying, Processing, Hardcopy, and Applications, and Material Appearance 2020.

8:45
Conference Welcome

8:50 MAAP-082
Beyond color correction: Skin color estimation in the wild through deep learning, *Robin Kips, Quoc Tran, Emmanuel Malherbe, and Matthieu Perrot, L'Oréal Research and Innovation (France)*

9:10 COLOR-083
SpectraNet: A deep model for skin oxygenation measurement from multi-spectral data, *Ahmed Mohammed, Mohib Ullah, and Jacob Bauer, Norwegian University of Science and Technology (Norway)*

Spectral Dataset — Joint Session

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

9:30 – 10:10 am
Regency C
This session is jointly sponsored by: Color Imaging XXV: Displaying, Processing, Hardcopy, and Applications, and Material Appearance 2020.

9:30 MAAP-106
Visible to near infrared reflectance hyperspectral images dataset for image sensors design, *Axel Clouet[1], Jérôme Vaillant[1], and Célia Viola[2]; [1]CEA-LETI and [2]CEA-LITEN (France)*

9:50 MAAP-107
A multispectral dataset of oil and watercolor paints, *Vahid Babaei[1], Azadeh Asadi Shahmirzadi[2], and Hans-Peter Seidel[1]; [1]Max-Planck-Institut für Informatik and [2]Consultant (Germany)*

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

10:10 – 10:40 am Coffee Break

Color and Appearance Reproduction — Joint Session

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

10:40 am – 12:30 pm
Regency C
This session is jointly sponsored by: Color Imaging XXV: Displaying, Processing, Hardcopy, and Applications, and Material Appearance 2020.

10:40 MAAP-396
From color and spectral reproduction to appearance, BRDF, and beyond, *Jon Yngve Hardeberg, Norwegian University of Science and Technology (NTNU) (Norway)*

11:10 MAAP-120
HP 3D color gamut – A reference system for HP's Jet Fusion 580 color 3D printers, *Ingeborg Tastl[1] and Alexandra Ju[2]; [1]HP Labs, HP Inc. and [2]HP Inc. (United States)*

11:30 COLOR-121
Spectral reproduction: Drivers, use cases, and workflow, *Tanzima Habib, Phil Green, and Peter Nussbaum, Norwegian University of Science and Technology (Norway)*

11:50 COLOR-122
Parameter estimation of PuRet algorithm for managing appearance of material objects on display devices (JIST-first), *Midori Tanaka, Ryusuke Arai, and Takahiko Horiuchi, Chiba University (Japan)*

12:10 COLOR-123
Colorimetrical performance estimation of a reference hyperspectral microscope for color tissue slides assessment, *Paul Lemaillet and Wei-Chung Cheng, US Food and Drug Administration (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

5:30 – 7:30 pm Symposium Demonstration Session

Media Watermarking, Security, and Forensics 2020

Conference overview

The ease of capturing, manipulating, distributing, and consuming digital media (e.g., images, audio, video, graphics, and text) has enabled new applications and brought a number of important security challenges to the forefront. These challenges have prompted significant research and development in the areas of digital watermarking, steganography, data hiding, forensics, media identification, biometrics, and encryption to protect owners' rights, establish provenance and veracity of content, and to preserve privacy. Research results in these areas has been translated into new paradigms and applications for monetizing media while maintaining ownership rights, and new biometric and forensic identification techniques for novel methods for ensuring privacy.

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 of the latest developments in watermarking, security, and forensics. Early results and fresh ideas are particularly encouraged and supported by the conference review format: only a structured abstract describing the work in progress and preliminary results is initially required and the full paper is requested just before the conference. A strong focus on how research results are applied by industry, in practice, also gives the conference its unique flavor.

Conference Sponsor

MEDIA WATERMARKING, SECURITY, AND FORENSICS 2020

Monday, January 27, 2020

KEYNOTE: Watermarking and Recycling

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

8:55 – 10:00 am
Cypress A

8:55
Conference Welcome

9:00 MWSF-017
Watermarking to turn plastic packaging from waste to asset through improved optical tagging,, *Larry Logan, chief evangelist, Digimarc Corporation (United States)*

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

10:10 – 10:30 am Coffee Break

Watermark

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

10:30 am – 12:10 pm
Cypress A

10:30 MWSF-021
Reducing invertible embedding distortion using graph matching model, *Hanzhou Wu and Xinpeng Zhang, Shanghai University (China)*

10:55 MWSF-022
Watermarking in deep neural networks via error back-propagation, *Jiangfeng Wang, Hanzhou Wu, Xinpeng Zhang, and Yuwei Yao, Shanghai University (China)*

11:20 MWSF-023
Signal rich art: Improvements and extensions, *Ajith Kamath, Digimarc Corporation (United States)*

11:45 MWSF-024
Estimating watermark synchronization signal using partial pixel least squares, *Robert Lyons and Brett Bradley, Digimarc 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 p m Coffee Break

Deep Learning Steganalysis

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

3:30 – 5:10 pm
Cypress A

3:30 MWSF-075
JPEG steganalysis detectors scalable with respect to compression quality, *Yassine Yousfi and Jessica Fridrich, Binghamton University (United States)*

3:55 MWSF-076
Detection of malicious spatial-domain steganography over noisy channels using convolutional neural networks, *Swaroop Shankar Prasad[1], Ofer Hadar[2], and Ilia Polian[1]; [1]University of Stuttgart (Germany) and [2]Ben-Gurion University of the Negev (Israel)*

4:20 MWSF-077
Semi-blind image resampling factor estimation for PRNU computation, *Miroslav Goljan and Morteza Darvish Morshedi Hosseini, Binghamton University (United States)*

4:45 MWSF-078
A CNN-based correlation predictor for PRNU-based image manipulation localization, *Sujoy Chakraborty; Binghamton University and Stockton University (United States)*

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

KEYNOTE: Technology in Context

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

9:00 – 10:00 am
Cypress A

MWSF-102
Technology in context: Solutions to foreign propaganda and disinformation, *Samaruddin Stewart, technology and media expert, Global Engagement Center, US State Department, and Justin Maddox, adjunct professor, Department of Information Sciences and Technology, George Mason University (United States)*

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

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

10:10 – 10:30 am Coffee Break

DeepFakes

Session Chair: Gaurav Sharma, University of Rochester (United States)

10:30 am – 12:10 pm
Cypress A

10:30 MWSF-116
Detecting "deepfakes" in H.264 video data using compression ghost artifacts, *Raphael Frick, Sascha Zmudzinski, and Martin Steinebach, Fraunhofer SIT (Germany)*

10:55 MWSF-117
A system for mitigating the problem of deepfake news videos using watermarking, *Adnan Alattar, Ravi Sharma, and John Scriven, Digimarc Corporation (United States)*

11:20 MWSF-118
Checking the integrity of images with signed thumbnail images, *Martin Steinebach, Huajian Liu, Sebastian Jörg, and Waldemar Berchtold, Fraunhofer SIT (Germany)*

11:45 MWSF-119
The effect of class definitions on the transferability of adversarial attacks against forensic CNNs, *Xinwei Zhao and Matthew Stamm, Drexel University (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

Identification

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

3:30 – 5:10 pm
Cypress A

3:30 MWSF-215
Score-based likelihood ratios in camera device identification, *Stephanie Reinders, Li Lin, Wenhao Chen, Yong Guan, and Jennifer Newman, Iowa State University (United States)*

3:55 MWSF-216
Camera unavoidable scene watermarks: A method for forcibly conveying information onto photographs, *Clark Demaree and Henry Dietz, University of Kentucky (United States)*

4:20 MWSF-217
A deep learning approach to MRI scanner manufacturer and model identification, *Shengbang Fang[1], Ronnie Sebro[2], and Matthew Stamm[1]; [1]Drexel University and [2]Hospital of the University of Pennsylvania (United States)*

4:45 MWSF-218
Motion vector based robust video hash, *Huajian Liu, Sebastian Fach, and Martin Steinebach, Fraunhofer SIT (Germany)*

5:30 – 7:30 pm Symposium Demonstration Session

Wednesday, January 29, 2020

KEYNOTE: Digital vs Physical Document Security

Session Chair: Gaurav Sharma, University of Rochester (United States)

9:00 – 10:00 am
Cypress A

MWSF-204
Digital vs physical: A watershed in document security, *Ian Lancaster, holography and authentication specialist, Lancaster Consulting (United Kingdom)*

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

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

10:10 – 10:30 am Coffee Break

Physical Object Security

Session Chair: Gaurav Sharma, University of Rochester (United States)

10:30 am – 12:10 pm
Cypress A

10:30 MWSF-398
Smartphone systems for secure documents, *Alan Hodgson, Alan Hodgson Consulting Ltd. (United Kingdom)*

10:55 MWSF-397
Embedding data in the blue channel*, *Robert Ulichney, HP Labs, HP Inc. (United States)*

*Proceedings Note: A proceedings paper related to the Robert Ulichney talk will be found in the proceedings issue for the Color Imaging XXV: Displaying, Processing, Hardcopy, and Applications Conference.

11:20 MWSF-399
Physical object security (TBA), *Gaurav Sharma, University of Rochester (United States)*

11:45 MWSF-219
High-entropy optically variable device characterization – Facilitating multimodal authentication and capture of deep learning data, *Mikael Lindstrand, gonioLabs AB (Sweden)*

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

Steganography

Session Chair: Jessica Fridrich, Binghamton University (United States)

3:30 – 5:10 pm
Cypress A

3:30 MWSF-289
Minimum perturbation cost modulation for side-informed steganography, *Jan Butora and Jessica Fridrich, Binghamton University (United States)*

3:55 MWSF-290
Synchronizing embedding changes in side-informed steganography, *Mehdi Boroumand and Jessica Fridrich, Binghamton University (United States)*

4:20 MWSF-291
Generative text steganography based on adaptive arithmetic coding and LSTM network, *Huixian Kang, Hanzhou Wu, and Xinpeng Zhang, Shanghai University (China)*

4:45 MWSF-292
Analyzing the decoding rate of circular coding in a noisy transmission channel, *Yufang Sun and Jan Allebach, Purdue University (United States)*

DISCUSSION: Concluding Remarks

Session Chairs: Adnan Alattar, Digimarc Corporation (United States) and Gaurav Sharma, University of Rochester (United States)

5:10 – 5:20 pm
Cypress A

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

Mobile Devices and Multimedia: Enabling Technologies, Algorithms, and Applications 2020

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

Best Student Paper

MOBILE DEVICES AND MULTIMEDIA: ENABLING TECHNOLOGIES, ALGORITHMS, AND APPLICATIONS 2020

Wednesday, January 29, 2020

Imaging Technologies

Session Chair: Reiner Creutzburg, Technische Hochschule Brandenburg (Germany)

9:05 – 10:10 am
Sandpebble A/B

9:05
Conference Welcome

9:10 MOBMU-205
Strategies of using ACES look modification transforms (LMTs) in a VFX environment, *Eberhard Hasche, Oliver Karaschewski, and Reiner Creutzburg, Technische Hochschule Brandenburg (Germany)*

9:30 MOBMU-206
Creating high resolution 360° 15:1-content for a conference room using film compositing technologies, *Eberhard Hasche, Dominik Benning, Oliver Karaschewski, and Reiner Creutzburg, Technische Hochschule Brandenburg (Germany)*

9:50 MOBMU-207
JAB code - A versatile polychrome 2D barcode, *Waldemar Berchtold and Huajian Liu, Fraunhofer SIT (Germany)*

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

10:10 – 10:50 am Coffee Break

Emerging Technologies

Session Chair: Eberhard Hasche, TH Brandenburg (Germany)

10:50 – 11:10 am
Sandpebble A/B

MOBMU-232
The human factor and social engineering - Personality traits and personality types as a basis for security awareness, *Nicole Malletzky, Michael Pilgermann, and Reiner Creutzburg, Technische Hochschule Brandenburg (Germany)*

Infrastructure Security

Session Chair: Eberhard Hasche, TH Brandenburg (Germany)

11:10 am – 12:10 pm
Sandpebble A/B

11:10 MOBMU-252
Measuring IT security, compliance, and digital sovereignty within small and medium-sized IT enterprises, *Andreas Johannsen, Daniel Kant, and Reiner Creutzburg, Technische Hochschule Brandenburg (Germany)*

11:30 MOBMU-253
Investigation of risks for critical infrastructures due to the exposure of SCADA systems and industrial controls on the Internet based on the search engine Shodan, *Daniel Kant, Reiner Creutzburg, and Andreas Johannsen, Technische Hochschule Brandenburg (Germany)*

11:50 MOBMU-254
Towards sector-specific security operation, *Michael Pilgermann[1], Sören Werth[2], and Reiner Creutzburg[1]; [1] Technische Hochschule Brandenburg and [2]Technische Hochschule Lübeck (Germany)*

12:10 MOBMU-402
Situational Strategic Awareness Monitoring Surveillance System (SSAMSS) - Microcomputer and microcomputer clustering used for intelligent, economical, scalable, and deployable approach for materials (JIST-first), *Kenly Maldonado and Steven Simske, Colorado State University (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

IoT, Security

Session Chair: Eberhard Hasche, TH Brandenburg (Germany)

3:30 – 4:50 pm
Sandpebble A/B

3:30 MOBMU-275
Security and privacy investigation of Wi-Fi connected and app-controlled IoT-based consumer market smart light bulbs, *Franziska Schwarz[1], Klaus Schwarz[1], Reiner Creutzburg[1], and David Akopian[2]; [1]Technische Hochschule Brandenburg (Germany) and [2]The University of Texas at San Antonio (United States)*

3:50 MOBMU-276
New methodology and checklist of Wi-Fi connected and app-controlled IoT-based consumer market smart home devices, *Franziska Schwarz[1], Klaus Schwarz[1], Reiner Creutzburg[1], and David Akopian[2]; [1]Technische Hochschule Brandenburg (Germany) and [2]The University of Texas at San Antonio (United States)*

4:10 MOBMU-277
Conception and implementation of a course for professional training and education in the field of IoT and smart home security, *Michael Pilgermann, Thomas Bocklisch, and Reiner Creutzburg, Technische Hochschule Brandenburg (Germany)*

4:30 MOBMU-278
Conception and implementation of professional laboratory exercises in the field of open source intelligence (OSINT), *Klaus Schwarz, Franziska Schwarz, and Reiner Creutzburg, Technische Hochschule Brandenburg (Germany)*

Healthcare Technologies & Security

Session Chair: Eberhard Hasche, TH Brandenburg (Germany)

4:50 – 5:30 pm
Sandpebble A/B

4:50 MOBMU-303
Mobile head tracking for eCommerce and beyond, *Muratcan Cicek[1], Jinrong Xie[2], Qiaosong Wang[2], and Robinson Piramuthu[2]; [1]University of California, Santa Cruz and [2]eBay Inc. (United States)*

5:10 MOBMU-304
International biobanking interface service - Health sciences in the digital age, *Christian Linke[1], Rene Mantke[1], and Reiner Creutzburg[2]; [1]Brandenburg Medical School Theodor Fontane and [2] Technische Hochschule Brandenburg (Germany)*

Mobile Devices and Multimedia: Enabling Technologies, Algorithms, and Applications 2020 Interactive Papers Session

5:30 – 7:00 pm
Sequoia

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

MOBMU-331
AI-based anomaly detection for cyberattacks on Windows systems - Creation of a prototype for automated monitoring of the process environment, *Benjamin Yüksel, Klaus Schwarz, and Reiner Creutzburg, Technische Hochschule Brandenburg (Germany)*

MOBMU-332
An implementation of drone-projector: Stabilization of projected images, *Eunbin Choi, Younghyeon Park, and Byeungwoo Jeon, Sungkyunkwan University (Republic of Korea)*

MOBMU-333
Cybersecurity and forensic challenges - A bibliographic review 2020, *Reiner Creutzburg, Technische Hochschule Brandenburg (Germany)*

MOBMU-334
MessageSpace. Messaging systems for health research, *Thinh Vo[1], Sahak Kaghyan[1], Rodrigo Escobar[1], David Akopian[1], Deborah Parra-Medina[2], and Laura Esparza[2]; [1]The University of Texas at San Antonio and [2]University of Texas Health Science Center at San Antonio (United States)*

MOBMU-335
Performance analysis of mobile cloud architectures for mHealth app, *Devasena Inupakutika and David Akopian, The University of Texas at San Antonio (United States)*

MOBMU-336
Secure remote service box, *Klaus Schwarz and Reiner Creutzburg, Technische Hochschule Brandenburg (Germany)*

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

Stereoscopic Displays and Applications XXXI

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. The 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)

Best film (live action)

Event

3D Theatre Session

Conference Chairs: **Gregg E. Favalora,** Draper (United States); **Nicolas S. Holliman,** Newcastle University (United Kingdom); **Takashi Kawai,** Waseda University (Japan); and **Andrew J. Woods,** Curtin University (Australia))

Program Committee: **Neil A. Dodgson,** Victoria University of Wellington (New Zealand); **Davide Gadia,** University degli Studi di Milano (Italy); **Hideki Kakeya,** University of Tsukuba (Japan); **Stephan R. Keith,** SRK Graphics Research (United States); **Björn Sommer,** Royal College of Art, London (United Kingdom); **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)

Conference Sponsors:

PROJECTION SYSTEM

CHRISTIE

DepthQ

3D THEATRE PARTNERS

3-D FILM ARCHIVE

LA 3D movie festival

SD&A

STEREOSCOPIC DISPLAYS AND APPLICATIONS XXXI

Monday, January 27, 2020

Human Factors in Stereoscopic Displays — Joint Session

Session Chairs: Nicolas Holliman, University of Newcastle (United Kingdom) and Jeffrey Mulligan, NASA Ames Research Center (United States)

8:4 5 – 10:10 am
Grand Peninsula D

This session is jointly sponsored by: Human Vision and Electronic Imaging 2020, and Stereoscopic Displays and Applications XXXI.

8:45
Conference Welcome

8:50 HVEI-009
Stereoscopic 3D optic flow distortions caused by mismatches between image acquisition and display parameters (JIST-first), *Alex Hwang and Eli Peli, Harvard Medical School (United States)*

9:10 HVEI-010
The impact of radial distortions in VR headsets on perceived surface slant (JIST-first), *Jonathan Tong, Robert Allison, and Laurie Wilcox, York University (Canada)*

9:30 SD&A-011
Visual fatigue assessment based on multitask learning (JIST-first), *Danli Wang, Chinese Academy of Sciences (China)*

9:50 SD&A-012
Depth sensitivity investigation on multi-view glasses-free 3D display, *Di Zhang[1], Xinzhu Sang[2], and Peng Wang[2]; [1]Communication University of China and [2]Beijing University of Posts and Telecommunications (China)*

10:10 – 10:50 am Coffee Break

SD&A 2020: Welcome & Introduction

Session Chair: Andrew Woods, Curtin University (Australia)

10:50 – 11:10 am
Grand Peninsula D

Autostereoscopy I

Session Chair: Bjorn Sommer, Royal College of Art (United Kingdom)

11:10 am – 12:30 pm
Grand Peninsula D

11:10 SD&A-053
Morpholo: A hologram generator algorithm, *Enrique Canessa, ICTP (Italy)*

11:30 SD&A-054
HoloExtension - AI-based 2D backwards compatible super-multiview display technology, *Rolf-Dieter Naske, psHolix AG (Germany)*

11:50 SD&A-055
Application of a high resolution autostereoscopic display for medical purposes, *Kokoro Higuchi, Ayuki Hayashishita, and Hideki Kakeya, University of Tsukuba (Japan)*

12:10 SD&A-403
Monolithic surface-emitting electroholographic optical modulator, *Gregg Favalora, Michael Moebius, Joy Perkinson, Elizabeth Brundage, William Teynor, Steven Byrnes, James Hsiao, William Sawyer, Dennis Callahan, Ian Frank, and John LeBlanc, The Charles Stark Draper Laboratory, Inc. (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

KEYNOTE: Immersive 3D Display Systems

Session Chair: Takashi Kawai, Waseda University (Japan)

3:30 – 4:30 pm
Grand Peninsula D

SD&A-065
High frame rate 3D-challenges, issues, and techniques for success, *Larry Paul, executive director, Technology and Custom Solutions Enterprise and Entertainment, Christie Digital Systems (United States)*

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

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

SD&A Conference 3D Theatre

Producers: Dan Lawrence, Lightspeed Design Group (United States); John Stern, retired (United States); Chris Ward, Lightspeed Design, Inc. (United States); and Andrew Woods, Curtin University (Australia)

6:00 – 7:30 pm
Grand Peninsula 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 Theatre 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.

SD&A Annual Conference Dinner

7:50 – 10:00 pm
Offsite Restaurant
The annual informal dinner for SD&A attendees. An opportunity to meet with colleagues and discuss the latest advances. There is no host for the dinner. Information on venue and cost will be provided during the first day of the conference.

Tuesday, January 28, 2020

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

Autostereoscopy II

Session Chair: Gregg Favalora, Draper Laboratory (United States)

8:50 – 10:10 am
Grand Peninsula D

8:50 SD&A-098
Dynamic zero-parallax-setting techniques for multi-view autostereoscopic display, *Yuzhong Jiao, Mark Mok, Kayton Cheung, Man Chi Chan, and Tak Wai Shen, United Microelectronics Centre (Hong Kong)*

9:10 SD&A-099
Projection type 3D display using spinning screen, *Hiroki Hayakawa and Tomohiro Yendo, Nagaoka University of Technology (Japan)*

9:30 SD&A-100
Full-parallax 3D display using time-multiplexing projection technology, *Takuya Omura, Hayato Watanabe, Naoto Okaichi, Hisayuki Sasaki, and Masahiro Kawakita, NHK (Japan Broadcasting Corporation) (Japan)*

9:50 SD&A-101
Light field display using wavelength division multiplexing, *Masaki Yamauchi and Tomohiro Yendo, Nagaoka University of Technology (Japan)*

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

10:10 – 10:50 am Coffee Break

Stereoscopic Image Processing

Session Chair: Nicolas Holliman, University of Newcastle (United Kingdom)

10:50 am – 12:30 pm
Grand Peninsula D

10:50 SD&A-138
Objective and subjective evaluation of a multi-stereo 3D reconstruction system, *Christian Kapeller[1,2], Braulio Sespede[2], Matej Nezveda[3], Matthias Labschütz[4], Simon Flöry[4], Florian Seitner[3], and Margrit Gelautz[2]; [1]Austrian Institute of Technology, [2]Vienna University of Technology, [3]emotion3D GmbH, and [4]Rechenraum e.U. (Austria)*

11:10 SD&A-139
Flow map guided correction to stereoscopic panorama, *Haoyu Wang, Daniel Sandin, and Dan Schonfeld, University of Illinois at Chicago (United States)*

11:30 SD&A-140
Spatial distance-based interpolation algorithm for computer generated 2D+Z images, *Yuzhong Jiao, Kayton Cheung, and Mark Mok, United Microelectronics Centre (Hong Kong)*

11:50 SD&A-141
Processing legacy underwater stereophotography for new applications, *Patrick Baker[1], Trevor Winton[2], Daniel Adams[3], and Andrew Woods[3]; [1]Western Australian Museum, [2]Flinders University of South Australia, and [3]Curtin University (Australia)*

12:10 SD&A-142
Multifunctional stereoscopic machine vision system with multiple 3D outputs, *Vasily Ezhov, Natalia Vasilieva, Peter Ivashkin, and Alexander Galstian, GPI RAS (Russian Federation)*

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

3D Developments

Session Chair: John Stern, retired (United States)

3:30 – 4:10 pm
Grand Peninsula D

3:30 SD&A-154
CubicSpace: A reliable model for proportional, comfortable and universal capture and display of stereoscopic content, *Nicholas Routhier, Mindtrick Innovations Inc. (Canada)*

3:50 SD&A-155
A camera array system based on DSLR cameras for autostereoscopic prints, *Tzung-Han Lin, Yu-Lun Liu, Chi-Cheng Lee, and Hsuan-Kai Huang, National Taiwan University of Science and Technology (Taiwan)*

KEYNOTE: Multiple Viewer Stereoscopic Displays

Session Chair: Gregg Favalora, The Charles Stark Draper Laboratory, Inc. (United States)

4:10 – 5:10 pm
Grand Peninsula D

SD&A-400
Challenges and solutions for multiple viewer stereoscopic displays, *Kurt Hoffmeister, Mechdyne Corp. (United States)*

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

5:30 – 7:30 pm Symposium Demonstration Session

Wednesday, January 29, 2020

KEYNOTE: Imaging Systems and Processing — Joint Session

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

8:50 – 9:30 am
Regency A

This session is jointly sponsored by: The Engineering Reality of Virtual Reality 2020, Imaging Sensors and Systems 2020, and Stereoscopic

ISS-189

Mixed reality guided neuronavigation for non-invasive brain stimulation treatment, *Christoph Leuze, research scientist in the Incubator for Medical Mixed and Extended Reality, Stanford University (United States)*

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

SD&A 3D Theatre – Spotlight

Session Chair: John Stern, retired (United States)

9:40 – 10:10 am
Grand Peninsula D

This session is an opportunity to take an extended look at highlights from the Monday evening 3D Theatre session.

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

10:10 – 10:50 am Coffee Break

Stereoscopic Perception and VR

Session Chair: Takashi Kawai, Waseda University (Japan)

10:50 am – 12:10 pm
Grand Peninsula D

10:50 SD&A-243
Evaluating the stereoscopic display of visual entropy glyphs in complex environments, *Nicolas Holliman, University of Newcastle (United Kingdom)*

11:10 SD&A-244
Evaluating user experience of 180 and 360 degree images, *Yoshihiro Banchi, Keisuke Yoshikawa, and Takashi Kawai, Waseda University (Japan)*

11:30 SD&A-245
Visual quality in VR head mounted device: Lessons learned making professional headsets, *Bernard Mendiburu, Varjo (Finland)*

11:50 SD&A-246
The single image stereoscopic auto-pseudogram – Classification and theory, *Ilicia Benoit, National 3-D Day (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

Visualization Facilities — Joint Session

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

3:30 – 4:10 pm
Grand Peninsula D

This session is jointly sponsored by: The Engineering Reality of Virtual Reality 2020, and Stereoscopic Displays and Applications XXXI.

3:30 SD&A-265
Immersive design engineering, *Bjorn Sommer, Chang Lee, and Savina Toirrisi, Royal College of Art (United Kingdom)*

3:50 SD&A-266
Using a random dot stereogram as a test image for 3D demonstrations, *Andrew Woods, Wesley Lamont, and Joshua Hollick, Curtin University (Australia)*

KEYNOTE: Visualization Facilities — Joint Session

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

4:10 – 5:10 pm
Grand Peninsula D

This session is jointly sponsored by: The Engineering Reality of Virtual Reality 2020, and Stereoscopic Displays and Applications XXXI.

ERVR-295

Social holographics: Addressing the forgotten human factor, *Derek Van Tonder, business development manager, and Andy McCutcheon, global sales manager for Aerospace & Defence, Euclideon Holographics (Australia)*

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

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

SD&A

Visualization and Data Analysis 2020

Conference overview

The Conference on Visualization and Data Analysis (VDA) 2020 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 served as 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

VISUALIZATION AND DATA ANALYSIS 2020

Wednesday, January 29, 2020

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

10:10 – 11:00 am Coffee Break

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

Visualization and Data Analysis 2020 Interactive Papers Session

5:30 – 7:00 pm
Sequoia

The Visualization and Data Analysis 2020 Conference work to be presented at the EI 2020 Symposium Interactive Posters Session is listed in the Visualization and Data Analysis 2020 "Information Visualization" session on Thursday afternoon.

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

10:10 – 11:00 am Coffee Break

Scientific Visualization

Session Chair: Yi-Jen Chiang, New York University (United States)

11:05 am – 12:10 pm
Regency C

11:05
Conference Welcome

11:10 VDA-374
A gaze-contingent system for foveated multiresolution visualization of vector and volumetric data, *Thanawut Ananpiriyakul[1], Josh Anghel[2], Kristi Potter[3], and Alark Joshi[1]; [1]University of San Francisco, [2]Boise State University, and [3]National Renewal Energy Laboratory (United States)*

11:30 VDA-375
A visualization system for performance analysis of image classification models, *Chanhee Park[1], Hyojin Kim[2], and Kyungwon Lee[1]; [1]Ajou University (Republic of Korea) and [2]Lawrence Livermore National Laboratory (United States)*

11:50 VDA-376
HashFight: A platform-portable hash table for multi-core and many-core architectures, *Brenton Lessley[1], Shaomeng Li[2], and Hank Childs[1]; [1]University of Oregon and [2]National Center for Atmospheric Research (United States)*

12:30 – 2:00 pm Lunch

KEYNOTE: Visualization and Cognition

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

2:00 – 3:00 pm
Regency C

VDA-386
Augmenting cognition through data visualization, *Alark Joshi, data visualization researcher and associate professor, University of San Francisco (United States)*

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

3:00 – 3:30 pm Coffee Break

Information Visualization

Session Chair: David Kao, NASA Ames Research Center (United States)

3:30 – 4:20 pm
Regency C

3:30 VDA-387
A visualization tool for analyzing the suitability of software libraries via their code repositories, *Casey Haber[1] and Robert Gove[2]; [1]Chartio and [2]Two Six Labs (United States)*

3:50 VDA-388
Visualization of search results of large document sets, *James Anderson and Thomas Wischgoll, Wright State University (United States)*

The title below is presented as an overview of the interactive presentation at the EI 2020 Interactive Poster session on Wednesday evening.

4:10 VDA-389
Human-computer interface based on tongue and lips movements and its application for speech therapy system, *Barbara Zitova, Zuzana Bilkova, Adam Novozamsky, and Michal Bartos, Institute of Information Theory and Automation, Czech Academy of Sciences (Czechia)*

EI 2020 SHORT COURSES AND DESCRIPTIONS

Sunday, January 26, 2020

SC01: Stereoscopic Imaging Fundamentals

Sunday 26 January • 8:00 am – 12:15 pm
Course Length: 4 hours
Course Level: Introductory
Instructors: Andrew Woods, Curtin University, and John Merritt, The Merritt Group
Fee: Member: $355 / **Non-member:** $380 / **Student:** $120

Learning Outcomes
This course enables the attendee to:
- Understand how the human visual system interprets depth.
- Understand how camera focal length, lens and eye separation, display size, and viewing distance affect stereoscopic image geometry.
- Understand the human factors of using stereoscopic displays.
- Understand concepts of orthostereoscopy, focus/fixation mismatch, comfort limits for on-screen parallax values.

Evaluate the operating principles of currently available stereoscopic display technologies and consider suitability 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. When correctly implemented, stereoscopic 3D imaging systems can provide significant benefits in many application areas, including medical imaging, teleoperation, molecular modeling, and 3D visualization. This course provides an understanding of the fundamentals of correctly implementing, using, and optimizing stereoscopic 3D displays. Topics covered include: stereoscopic image capture and stereoscopic content generation; stereoscopic image and video transmission, compression, processing, and storage; stereoscopic display system technologies; and human factors.

Intended Audience
Engineers, scientists, and project managers involved with imaging and video display systems for applications such as: medical imaging and endoscopic surgery, simulation & training systems, teleoperation systems, animation and computer graphics, data visualization, and virtual & augmented reality.

Dr. Andrew Woods is manager of the Curtin HIVE visualization facility and a senior research fellow with the Centre for Marine Science and Technology at Curtin University. He has expertise in imaging and visualization with applications in oil and gas and maritime archaeology. He has bachelors, masters and PhD degrees in electronic engineering and stereoscopic imaging. In 2017, he was recognized as one of Australia's Most Innovative Engineers by Engineers Australia.

John O. Merritt is a display systems consultant at The Merritt Group, Williamsburg, MA, with more than 25 years of experience in the design and human-factors evaluation of stereoscopic video displays for telepresence & telerobotics, scientific visualization, and medical imaging.

SC02: Advanced Image Enhancement and Deblurring

Sunday 26 January • 8:00 am – 12:15 pm
Course Length: 4 hours
Course Level: Advanced
Instructor: Majid Rabbani, Rochester Institute of Technology
Fee: Member: $355 / **Non-member:** $380 / **Student:** $120

Learning Outcomes
This course will enable the attendee to:
- 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 variations of nonlinear unsharp masking.
- Understand advanced techniques used in image noise removal such as bilateral filtering.
- Understand how motion information can be utilized in image sequences to improve the performance of various enhancement techniques such as sharpening, noise removal, and artifact removal.
- Understand Wiener filtering and its variations for image deblurring (restoration).

This course discusses some of the advanced algorithms used in contrast enhancement, noise reduction, sharpening, and deblurring of still images and video. Applications include consumer and professional imaging, medical imaging, forensic imaging, surveillance, and astronomical imaging. Image examples complement the technical descriptions.

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, will benefit from this course. Some knowledge of digital filtering (convolution) and frequency decomposition is necessary for understanding the deblurring concepts.

Majid Rabbani has 37 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 the EE department of Rochester Institute of Technology (RIT). He is a twice co-recipient of the Kodak C. E. K. Mees Research Award and the co-recipient of two Engineering Emmy Awards. He is a Fellow of IEEE (1997), a Fellow of SPIE (1993), a Kodak Distinguished Inventor with 44 issued patents and the 2015 recipient of the Electronic Imaging Scientist of the Year Award. He has been an active educator in the digital imaging community for the past 32 years.

SC03: Optics and Hardware Calibration of Compact Camera Modules for AR/VR, Automotive, and Machine Vision Applications

Sunday 26 January • 8:00 am – 12:15 pm
Course Length: 4 hours
Course Level: Intermediate
Instructors: Uwe Artmann, Image Engineering GmbH & Co. KG, and Kevin J. Matherson, Microsoft Corporation
Fee: Member: $355 / **Non-member:** $380 / **Student:** $120

Learning Outcomes

This course enables the attendee to:

- Describe illumination, photons, sensor, and camera radiometry.
- Select optics and sensor for a given application.
- Understand the optics of compact camera modules based on application.
- Understand the difficulties in minimizing size of sensor and volume of camera modules.
- Assess the need for per unit camera calibrations in compact camera modules.
- Learn how distortion, flare, and relative illumination calibrations are performed.
- Review autofocus actuators and why per unit calibrations are required.
- Review 3D imaging systems (stereo, time of flight, structured light, etc.).
- Understand the calibrations associated with 3D imaging systems.
- Understand how to perform the various calibrations typically done in compact camera modules (relative illumination, distortion, gain, actuator variability, etc.).
- Understand equipment required for performing calibrations.
- Compare hardware tradeoffs such as temperature variation, its impact on calibration, and overall influence on final quality.

The emphasis of this course is camera hardware calibration with minimal content on camera calibration of color. Electronic camera and system performance are 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, AR/VR, automotive, and machine vision applications as well as providing techniques for mitigating those issues. The course covers optics, sensors, actuators, camera modules, and the camera calibrations typically performed to mitigate issues associated with production variation of lenses, sensors, and autofocus actuators. For those interested in more depth on color camera calibration, see SC12: Color and Calibration in Compact Camera Modules for AR, Machine Vision, Automotive, and Mobile Applications.

Intended Audience

People involved in the design and image quality of digital cameras, mobile cameras, and scanners. Technical staff of manufacturers, managers of digital imaging projects, as well as journalists and students studying image technology.

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.

Kevin Matherson is a director of optical engineering at Microsoft Corporation working on advanced optical technologies for AR/VR, machine vision, and 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.

SC04: 3D Point Cloud Processing

Sunday 26 January • 8:00 am – 12:15 pm
Course Length: 4 hours
Course Level: Introductory
Instructor: Gady Agam, Illinois Institute of Technology
Fee: Member: $355 / **Non-member:** $380 / **Student:** $120

Learning Outcomes

This course enables the attendee to:

- Describe fundamental concepts for point cloud processing.
- Develop algorithms for point cloud processing.
- Incorporate point cloud processing in your applications.
- Understand the limitations of point cloud processing.
- Use industry standard tools for developing point cloud processing applications.

Point clouds are an increasingly important modality for imaging with applications ranging from user interfaces to street modeling for GIS. Range sensors such as the Intel RealSense camera or Microsoft Azure Kinect camera are becoming increasingly small and cost effective thus opening a wide range of applications. The purpose of this course is to review the necessary steps in point cloud processing and introduce fundamental algorithms in this area.

Point cloud processing is similar to traditional image processing in some sense yet different due to the 3D and unstructured nature of the data. In contrast to a traditional camera sensor which produces a 2D array of samples representing an image, a range sensor produces 3D point samples representing a 3D surface. The points are generally unorganized and so are termed "cloud". Once the points are acquired there is a need to store them in a data structure that facilitates finding neighbors of a given point in an efficient way. The point cloud often contains noise and holes which can be treated using noise filtering and hole filling algorithms. For computational efficiency purposes the point cloud may be downsampled. In an attempt to further organize the points and obtain a higher level representation of the points, planar or quadratic surface patches can be extracted and segmentation can be performed. For higher level analysis key points can be extracted and features can be computed at their locations. These can then be used to facilitate registration and recognition algorithms. Finally, for visualization and analysis purposes the point cloud may be triangulated. The course discusses and explains the steps described above and introduces the increasingly popular PCL (Point Cloud Library) and other open source frameworks for processing point clouds.

Intended Audience

Engineers, researchers, and software developers, who develop imaging applications and/or use camera sensors for inspection, control, and analysis.

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 (1999).

SC05: Digital Camera Image Quality Tuning

Sunday 26 January • 8:00 am – 12:15 pm
Course Length: 4 hours
Course Level: Intermediate
Instructor: Luke Cui, Amazon
Fee: Member: $355 / **Non-member:** $380 / **Student:** $120

Learning Outcomes
This course enables the attendee to understand:
- The goals of image quality tuning.
- Hardware capabilities based on specification.
- Capabilities of the image processing pipelines.
- Objective image quality metrics and standards applicable to tuning.
- Overview of the image quality tuning process.
- Tunings tools and their development.
- Deep dive into the tuning process.
- Camera per module factory calibration.
- 3A tuning processes and steps.
- Scene classification, analysis, and measurement.
- Camera geometric and radiometric defect and distortion corrections.
- De-mosaicking, color transformation and correction.
- Tone curves, LUTS and their significance.
- Denoising, noise masking and substitution.
- Tone and color preference tuning.
- Subjective image quality and competitive benchmarking for tuning.
- Tuning for autonomous robots.
- Application of deep neural networks to tuning.
- Tracking the performance of best performance smartphone cameras.

Digital camera image quality tuning is critical in the camera development process. It is an interdisciplinary field that is as much art as science. It is also a treacherous engineering process that is full of pseudoscience pitfalls and prone to engineering blunders. This course intends to prepare perspective professionals for that process starting from fundamental science and techniques to the evaluation of current competitive smartphone cameras.

Intended Audience
Camera and imaging engineers, scientists, students, and program managers.

Luke Cui has been hands-on working on imaging systems for more than thirty years with a BS in optics, MS in color science and PhD in human vision. He has been involved with the delivery of numerous market proven digital imaging systems, working from photons, lenses, sensors, cameras, color science, imaging processing, image quality evaluation systems, to psychophysics and human vision. He has more than sixty patents and patent applications. He has worked for Macbeth Co. on standard lighting, color formulation, spectrophotometry, and colorimetry; led high speed document scanner optical imaging system development at Lexmark International, working from lens design to final image pipeline tuning; and led camera tuning of most Surface products on the market at Microsoft, covering from system specification, ISP evaluation, selection, and all phases of camera tuning. Currently, he is a principal imaging scientist at Amazon Prime Air, working on sensing systems for autonomous drones. Disclaimer: Opinions and content covered by the course are solely his own and do not express the views or opinions of his employer, past and present.

SC06: Computer Vision and Image Analysis of Art

Sunday 26 January • 8:00 am – 12:15 pm
Course Length: 4 hours
Course Length: Intermediate
Instructor: David G. Stork
Fee: Member: $355 / **Non-member:** $380 / **Student:** $120

Learning Outcomes
This course will enable the attendee to:
Identifying problems in the history and interpretation of fine art that are amenable to computer methods
- Perspective analysis
- Brush stroke analysis
- Color analysis
- Lighting analysis
- Stylometry (quantification of artistic style) and artistic influence
- Basics of art authentication

This course presents the application of rigorous image processing, computer vision, machine learning, computer graphics, and artificial intelligence techniques to problems in the history and interpretation of fine art paintings, drawings, murals, and other two-dimensional works, including abstract art. The course focuses on the aspects of these problems that are unlike those addressed widely elsewhere in computer image analysis applied to physics-constrained images in photographs, videos, and medical images, such as the analysis of brushstrokes and marks, medium, inferring artists' working methods, compositional principles, stylometry (quantification of style), the tracing of artistic influence, and art attribution and authentication. The course revisits classic problems, such as image-based object recognition, but in highly non-realistic, stylized artworks.

Intended Audience
Students and scholars in imaging, image science, computer vision, and art and art history.

David G. Stork is widely considered a pioneer in the application of rigorous computer vision and image analysis to the study of fine art. He is a graduate from MIT and the University of Maryland in physics, and has held faculty positions in physics, mathematics, electrical engineering, computer science, statistics, neuroscience, psychology, and art and art history variously at Wellesley and Swarthmore Colleges, and Clark, Boston and Stanford Universities. He is a fellow of six international societies, and founding co-chair of "Electronic Imaging" Computer vision and image analysis of art symposium. His 56 patents, more than 200 scholarly works, including eight books, have garnered more than 75,000 citations. He is completing "Pixels and paintings: Foundations of computer-assisted connoisseurship" for Wiley Publishers.

SC07: Perceptual Metrics for Image and Video Quality

Sunday 26 January • 1:30 - 5:45 pm
Course Length: 4 hours
Course Level: Intermediate
Instructors: Thrasyvoulos N. Pappas, Northwestern University, and Sheila Hemami, Draper Lab
Fee: Member: $355 / **Non-member:** $380 / **Student:** $120

Learning Outcomes
This course enables the attendee to:
- 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.

We examine objective criteria for the evaluation of image quality that are based on models of visual perception. Our primary emphasis is on image fidelity, i.e., how close an image is to a given original or reference image, but we broaden the scope of image fidelity to include structural equivalence. We also discuss no-reference and limited-reference metrics. We examine a variety of applications with special emphasis on image and video compression. 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. We also consider 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. We also take 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.

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 a SB, SM, and PhD in electrical engineering and computer science from MIT (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 Vice-President Publications, IEEE Signal Processing Society (2015-1017), 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 IVMSP) Technical Committee (2002-03), technical program co-chair of ICIP-01 and ICIP-09, and co-chair of the 2011 IEEE IVMSP Workshop on Perception and Visual Analysis. He has also served as co-chair of the 2005 SPIE/IS&T Electronic Imaging Symposium and co-chair of the SPIE/IS&T Conference on Human Vision and Electronic Imaging (1997-2018). He is currently co-editor-in-chief of the IS&T* Journal of Perceptual Imaging. *Pappas is a Fellow of IEEE, SPIE, and IS&T.*

Sheila S. Hemami received a BSEE from the University of Michigan (1990), and a MSEE and PhD from Stanford University (1992 and 1994). She was with Hewlett-Packard Laboratories in Palo Alto, California in 1994 and was with the School of Electrical Engineering at Cornell University from 1995-2013. From 2013 to 2016 she was professor and chair of the department of electrical and computer engineering at Northeastern University in Boston, MA. She is currently Director of Strategic Technical Opportunities at Draper Lab. Hemami's 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 her 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 Federale de Lausanne, Switzerland. She has received numerous university and national teaching awards, including Eta Kappa Nu's C. Holmes MacDonald Award. She served as Vice-President Publications Products and Services, IEEE (2015-2016). She was a Distinguished Lecturer for the IEEE Signal Processing Society in 2010-11, was editor-in-chief for the IEEE Transactions on Multimedia *from 2008-10. She has held various technical leadership positions in the IEEE.*

SC08: Fundamentals BioInspired Image Processing

Sunday 26 January • 1:30 - 5:45 pm
Course Length: 4 hours
Course Level: Intermediate
Instructor: Sos Agaian, The Graduate Center and CSI, City University of New York (CUNY)
Prerequisites: Basic understanding of image processing algorithms and statistics.
Fee: Member: $355 / **Non-member:** $380 / **Student:** $120

Learning Outcomes
The main purpose of this course is to provide the most fundamental knowledge to the students so that they can understand what the human visual system is and how to use it in image processing applications. The course enables the attendee to:

- Become familiar with:
  - Fundamentals bioinspired image processing concepts and applications.
  - The behavior of the human visual system (HVS).
  - A new HSV based image arithmetic.
- Provide some examples of the utilization of models of vision in the context of digital image quality assessment, enhancement, and representation.
- Understand the capabilities and limitations of full-reference, reduced reference, and no-reference metrics for image quality assessment, and why each might be used in a particular application.
- Gain hands-on experience in building developed biological mechanisms to optimize image processing algorithms.
- Discuss various research solutions for improving current image processing algorithms.

The rapid proliferation of hand-held mobile computing devices, coupled with the acceleration of the 'Internet-of-Things' connectivity, and visual data producing systems (embedded sensors, mobile phones, and surveillance cameras) have certainly contributed to these advances. In our modern digital information connected society, we are producing, storing, and using ever-increasing volumes of a digital image and video content. How can

we possibly make sense of all this visual-centric data? Studies in biological vision have always been an excessive source of inspiration for the design of image processing procedures. The objective of this course is to highlight the fundamentals and latest advances in this research area for image processing and to provide novel insights into bio-inspired intelligence. We also present a synopsis of the existing state-of-the-art results in the field of image processing, and discuss the current trends in these technologies as well as the associated commercial impact and opportunities.

Intended Audience
Engineers, scientists, students, and managers interested in acquiring a broad understanding of image processing. Prior familiarity with the basics of image processing is helpful.

Prerequisites
Students are expected to have a solid background in the analysis of algorithms, proofs in propositional and first-order logic, discrete mathematics, and elementary probability.

Sos Agaian is currently a distinguished professor of computer science at the City University of New York (CUNY). Prior to this, Agaian was the Peter T. Flawn Professor of electrical and computer engineering at the University of Texas, San Antonio (UTSA). He has been a visiting faculty member at Tufts University in Medford, MA. Currently, at CUNY, Agaian is the recipient of numerous awards including UTSA's Innovator of the Year Award; and, the San Antonio Business Journal's "The Tech Flash Titans-Top Researcher" Award. Moreover, Agaian established two university research centers: the NSF Center for Simulation Visualization & Real-Time Prediction and the DHS National Center of Academic Excellence in Information Assurance Research. Other honors include IS&T Fellow, IEEE Fellow, SPIE Fellow, and AAAS Fellow. Agaian is an Editorial Board Member for the Journal of Pattern Recognition and Image Analysis*, and he is an associate editor for nine journals, including the* Journal of Electronic Imaging *(SPIE, IS&T);* IEEE Transaction on Image Processing*;* IEEE Transaction on Systems, Man, and Cybernetics*; and* Journal of Electrical and Computer Engineering *(Hindawi Publishing Corporation). Agaian received his MS in mathematics and mechanics (summa cum laude) from the Yerevan State University, Armenia; his PhD in mathematics and physics from the Steklov Institute of Mathematics, Russian Academy of Sciences (RAS); and his doctor of engineering sciences degree from the Institute of Control Systems, RAS.*

SC09: Resolution in Mobile Imaging Devices: Concepts & Measurement

Sunday 26 January • 1:30 - 3:30 pm
Course Length: 2 hours
Course Level: Intermediate
Instructors: Uwe Artmann, Image Engineering GmbH & Co. KG, and Kevin J. Matherson, Microsoft Corporation
Fee: Member: $245 / **Non-member:** $270 / **Student:** $95

Learning Outcomes
This course enables the attendee to:
- 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.
- Learn contrast transfer function.
- Understand human visual system resolution and perceptual resolution limits.
- Understand the difference between and uses 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 for visible and near-infrared resolution measurements.
- 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.
- Specifying center versus corner resolution.
- Understand the impact of large distortion on slanted edge and Siemens star SFR.
- Learn about SFR measurement of wide angle lenses.
- Learn about impact of field curvature.
- Understand through-focus MTF.

This class is an update of our 2019 course and adds measurement of resolution in wide angles lenses as well as measurement of resolution in the near-infrared/infrared spectral regions. The course is of interest to those wanting to characterize cameras in AR/VR, automotive, machine vision, consumer, and mobile applications.

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. 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.

Intended Audience
Managers, engineers, and technicians involved in the design and evaluation of image quality of electronic cameras (regardless of application), video cameras, and scanners. Technical staff of manufacturers, managers of digital imaging projects, as well as journalists and students studying image technology.

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.

Kevin Matherson is a director of optical engineering at Microsoft Corporation working on advanced optical technologies for AR/VR, machine vision, and 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.

SC10: Image Quality: Industry Standards for Mobile, Automotive, and Machine Vision Applications

Sunday 26 January • 1:30 - 5:45 pm
Course Length: 4 hours
Course Level: Introductory/Intermediate
Instructors: Don Williams, Image Science Associates, and Peter Burns, Burns Digital Imaging
Fee: Member: $355 / **Non-member:** $380 / **Student:** $120

Learning Outcomes

This course enables the attendee to:

- Understand current methods for objective image quality evaluation.
- Explain the difference between imaging performance and image quality.
- Describe why standard performance methods might differ with markets.
- Identify challenges, and approaches for evaluating wide Field-of-View (FOV) cameras.
- Quantify and mitigate sources of system variability, e.g., in multi-camera systems.

We start by discussing objective image quality methods, as developed for image capture systems. Several of these methods have been adapted in emerging standards for, e.g., automotive (ADAS) and machine-vision applications. We describe how and why imaging performance methods are being adopted. Most efforts rely on several ISO-defined methods, e.g., for color-encoding, image resolution, distortion, and noise. While several measurement protocols are similar, the image quality needs are different. For example, the EMVA 12288 standard for machine vision emphasizes detector signal and noise characteristics. However, the CPIQ and IEEE P2020 automotive imaging initiatives include attributes due to optical and video performance (e.g., distortion and motion artifacts).

Intended Audience

Image scientists, quality engineers, and others evaluating digital camera and scanner performance. The previous introduction to methods for imaging performance testing (optical distortion, color-error, MTF, etc.) will be useful.

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).

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 for clients and universities for many years.

SC11: Color Optimization for Displays

Sunday 26 January • 1:30 - 3:30pm
Course Length: 2 hours
Course Level: Intermediate
Instructor: Gabriel Marcu, Apple, Inc
Fee: Member: $245 / **Non-member:** $270 / **Student:** $95

Benefits

This course enables the attendee to:

- Identify the critical parameters and their impact on display color quality for smartphones, tablets, notebooks, desktops, LCD TVs, and projectors.
- Compare color performance and limitations for various LCD modes like IPS, MVA, FFS.
- Understand the critical factors for HDR displays and wide gamut displays.
- Understand the advantages of the LED backlight modulation and the principles of quantum dot gamut enhancement for QLED technology.
- Select the optimal color model for a display and highlight its dependency on display technology.
- Understand the use of the color model for the display ICC profile and the implication for the color management.
- Follow a live calibration and characterization of an LCD screen and projector used in the class, using tools varying from visual calibrator to instrument based ones.
- Apply the knowledge from the course to practical problems of color optimization for displays.

This course introduces color optimization techniques for various display types (LCDs, plasma, OLED, QLED, and projection: DLP, LCD, LcoS), and ranging from mobile devices to large LCD TV screens. Factors such as technology, luminance level (including HDR), dynamic/static contrast ratio (including local dimming), linearization and gamma correction, gray tracking, color gamut (including wide gamut), white point, response time, viewing angle, uniformity, color model, calibration, and characterization are discussed and color optimization methods for displays are presented.

Learning Outcomes

Apply the knowledge from the course to practical problems of color optimization for displays.

Intended Audience

Engineers, scientists, managers, pre-press professionals, and those confronting display related color issues.

Gabriel Marcu is senior scientist at Apple, Inc. His achievements are in color reproduction on displays and desktop printing (characterization/calibration, halftoning, gamut mapping, ICC profiling, HDR imaging, RAW color conversion). He holds more than 80 issued patents in these areas. Marcu is responsible for color calibration and characterization of Apple desktop display products. He has taught seminars and courses on color topics at various IS&T, SPIE, and SID conferences and IMI Europe. He was co-chair of the 2006 SPIE/IS&T Electronic Imaging Symposium and CIC11; he is co-chair of the Electronic Imaging Symposium's Color Imaging: Displaying, Hardcopy, Processing, and Applications conference. Marcu is an IS&T and SPIE Fellow.

SC12: Color and Calibration in Compact Camera Modules for AR, Machine Vision, Automotive, and Mobile Applications

Sunday 26 January • 3:45 - 5:45 pm
Course Length: 2 hours
Course Level: Introductory
Instructors: Uwe Artmann, Image Engineering GmbH & Co. KG, and Kevin J. Matherson, Microsoft Corporation
Fee: Member: $245 / **Non-member:** $270 / **Student:** $95

Learning Outcomes

This course enables the attendee to:

- 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 color cameras based on application.
- Understand calibration methods used for camera modules.
- Describe the differences between class calibration and individual module calibration.
- Understand how spectral sensitivities and color matrices are calculated.
- Understand how the calibration light source impacts calibration.
- Describe required calibration methods based on the hardware chosen and the image processing used.
- Understand artifacts associated with color shading and incorrect calibrations.
- Understand how chromatic aberrations impact color and how to remove its unwanted effects.
- Learn about the impacts of pixel saturation and the importance of controlling it for color.
- Learn about the impact of tone reproduction on perceived color (skin tone, memory colors, etc.).
- Learn how flare compensation is done in electronic cameras.

Color cameras produce several different images in a single acquisition, often one red, one green, and one blue. The most common configuration is the Bayer filter, a designation to the arrangement of the color filters. Following capture, the image needs to be rendered. For most AR/VR, consumer, mobile, and automotive applications, image 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 has a significant influence on the color and overall image quality. There are many implementation challenges, the largest being part-to-part variation. 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 capture, calibration, and processing of a color camera image for applications in AR/VR, machine vision, automotive, and consumer cameras. 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 for a particular application.

Intended Audience

People involved in the design and image quality of electronic cameras (regardless of application) and scanners. Technical staff of manufacturers, managers of digital imaging projects, as well as journalists, and students studying image technology.

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.

Kevin Matherson is a director of optical engineering at Microsoft Corporation working on advanced optical technologies for AR/VR, machine vision, and 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.

SC13: Normal and Defective Colour Vision across the Lifespan

Sunday 26 January • 3:45 - 5:45 pm
Course Length: 2 hours
Course Level: Intermediate
Instructor: Caterina Ripamonti, Cambridge Research Systems
Fee: Member: $245 / **Non-member:** $270 / **Student:** $95

Learning Objectives

The course enables the attendee to:

- Understand how normal colour vision operates.
- Learn about the causes underlying individual differences in perceiving colour.
- Appreciate the difference between normal and affected colour vision.
- Simulate how vision changes during the lifespan.

The course aims to provide a general introduction to normal and defective colour vision and to describe the principles of some existing software and tools that can be used to simulate how images may be perceived by observers with normal or defective colour vision across the lifespan.
The first part of the course provides the physiological fundamentals to understanding how colour vision operates and focuses on the causes underlying individual differences in the perception of colour across the lifespan. In particular, we examine the changes in colour vision that take place as a consequence of the early development or aging of the visual system.

This is followed by an analysis of the differences between colour vision in normal trichromats and observers affected by inherited or acquired colour deficiencies. The differences between normal trichromats and affected observers is considered in terms of spatial, temporal, and colour resolution as well as their light and dark adaptation processes.

The second part concentrates on simulating how vision changes during the lifespan.

This is followed by the presentation of some image processing techniques used to simulate the differences between normal and affected observers in perceiving coloured images.

Intended Audience

Colour engineers, scientists and designers. Those who wish to understand colour vision of normal trichromats as well as observers with defective colour vision. Those interested in understanding the principles of how to correct and improve the visual discrimination of images by affected observers or normal trichromats of different ages.

Caterina Ripamonti is a senior vision scientist at Cambridge Research Systems Ltd. and an Honorary Senior Research Fellow at UCL Institute of Ophthalmology and Moorfields Eye Hospital (UK). She is the author of numerous papers on human colour vision, spatial and temporal properties of normal and defective vision, and applied aspects of colour science related to human factors. She is also the co-author of the book Computational Colour Science using MATLAB.

SC14: High-Dynamic-Range (HDR) Theory and Technology

Sunday 26 January • 3:45 - 5:45 pm
Course Length: 2 hours
Course Level: Intermediate
Instructors: John J. McCann, McCann Imaging, and Alessandro Rizzi, University of Milano
Fee: Member: $245 / **Non-member:** $270 / **Student:** $95

Learning Outcomes
This course enables the attendee to:
- Measure the optical limits in acquisition and display; in particular measure the scene dependent effects of optical glare.
- Compare the accuracy of scene capture using single and multiple-exposures in normal and RAW formats.
- Engage in a discussion of human spatial vision that responds to the retinal image altered by glare.
- Engage in a discussion of current HDR TV systems and standards: tone-rendering vs. spatial HDR methods.
- Explore the history of HDR imaging.

Leonardo da Vinci made HDR paintings. Artists, photographers, and image processors continue to capture/reproduce HDR scenes. Today's HDR TVs use developing technologies (LCD, LED, OLED, QLED); and standards (HDR10, DolbyAtmos, TechnicolorHDR, HybridLogGamma). The key to HDR is understanding the specific goal of the image. Is it the display's physical accuracy (radiances), or the reproduction's appearance? Since 1500, painters have reproduced HDR scenes ignoring accurate radiances.

This course emphasizes measurements of physics (accurate reproduction) and psychophysics (visual appearance). Physics shows limits caused by optical glare; HDR does not reproduce scene radiances. Psychophysics shows that human vision's spatial-image-processing renders scene appearance.

The course reviews successful HDR reproductions; limits of radiance reproduction; HDR TV's technology and standards; appearance and display luminance; and appearance models. HDR technology is a complex problem controlled by optics, signal-processing, and visual limits. The solution depends on its goal: physical information or preferred appearance.

Intended Audience
Anyone interested in using HDR imaging: science, technology of displays, and applications. This includes students, color scientists, imaging researchers, medical imagers, software and hardware engineers, photographers, cinematographers, and production specialists.

John McCann worked in, and managed, Polaroid's Vision Research Laboratory (1961-1996). He studied Retinex theory, color constancy, color from rod/cone interactions at low light levels, image reproduction, appearance with scattered light, cataracts, and HDR imaging. He is a Fellow of IS&T and the Optical Society of America (OSA); a past president of IS&T and the Artists Foundation, Boston; IS&T/OSA 2002 Edwin Land Medalist and IS&T 2005 Honorary Member.

Alessandro Rizzi is full professor and head of MIPSLab, department of computer science, University of Milan. He researches color, HDR, and related perceptual issues. He is one of the founders of the Italian Color Group, Secretary of CIE Division 8, and IS&T Fellow and vice president, topical editor of the Journal of the Optical Society of America, *associate editor of the* Journal of Electronic Imaging. *In 2015 Rizzi received the Davies Medal from the Royal Photographic Society.*

Monday, January 27, 2020

SC15: 3D Imaging

Monday 27 January • 8:30 am – 12:45 pm
Course Length: 4 hours
Course Level: Introductory
Instructor: Gady Agam, Illinois Institute of Technology
Fee: Member: $355 / **Non-member:** $380 / **Student:** $120

Learning Outcomes
This course enables the attendee to:
- 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.

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 discusses 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. We discuss algorithms for determining camera parameters (camera calibration) and for obtaining correspondence using epipolar constraints between views. The course also introduces relevant 3D imaging software components available through the industry standard OpenCV library.

Intended Audience
Engineers, researchers, and software developers, who develop imaging applications and/or use camera sensors for inspection, control, and analysis. The course assumes a 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 (1999).

SC16: Classical and Deep Learning-based Computer Vision

Monday 27 January • 8:30 am – 12:45 pm
Course Length: 4 hours
Course Level: Intermediate
Instructor: Richard Xu, University of Technology Sydney
Fee: Member: $355 / **Non-member:** $380 / **Student:** $120

Learning Outcomes
This course enables the attendee to:
- Understand several important aspects and tasks in computer vision.
- Explain why computer vision is challenging
- Explain the role deep learning plays in computer vision.
- Be able to apply OpenCV and TensorFlow 2.0 to build CV models, including object classification, object detection, face recognition, generating synthetic images, and image-to-text.

Computer Vision (CV) is an important application of Artificial Intelligence and Machine Learning models. CV concerns techniques to help computers to "see" and "understand" the content of still images (photos) and sequences of images (videos) and often in the modern context, to combine visual info with other media: e.g., text-to-image and/or image-to-text. In this course, our aim is to teach participants both the classical and modern treatments in computer vision: from camera anatomy (e.g., camera calibration) to manually designed filters (for example, scale-invariant-feature-transform) to powerful modern-day deep learning approach to computer vision.

Intended Audience
Professionals and academics with some background in computer science or programming who are interested in entering the field of computer vision.

Richard Xu is an associate professor in machine learning and a leading researcher in the fields of machine learning, deep learning, data analytics, and computer vision. He is the founder and director of the UTS DataLounge, which provides customised short courses for organisations seeking expertise in the field of machine learning. Xu is also a core member of the Innovation in IT Services and Applications research centre and the Global Big Data Technologies research centre, both at UTS.

SC17: Camera Noise Sources and its Characterization using International Standards

Monday 27 January • 8:30 – 10:30 am
Course Length: 2 hours
Course Level: Intermediate
Instructors: Uwe Artmann, Image Engineering GmbH & Co. KG, and Kevin J. Matherson, Microsoft Corporation
Fee: Member: $245 / **Non-member:** $270 / **Student:** $95

Learning Outcomes
This course enables the attendee to:
- Become familiar with basic noise sources in electronic imaging devices.
- Learn how image processing impacts noise sources in electronic imaging devices.
- Make noise measurements based on international standards: EMVA 1288, ISO 14524, ISO 15739, IEEE P2020, and visual noise measurements.
- Learn how to make dynamic range measurements based on international standards.
- Describe the 3D noise method used for measuring near-IR and infrared sensors.
- Make noise measurements using the 3D noise method.
- Describe simple test setups for measuring noise based on international standards.
- Predict system level camera performance using international standards.
- Learn how to compare image sensor performance using the photon transfer curve.

This short course provides an overview of noise sources associated with "light in to byte out" in compact camera modules used in automotive (ADAS), AR/VR, consumer, and machine vision applications. 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.

Intended Audience
People involved in the design and image quality of digital cameras, mobile cameras, and scanners. Technical staff of manufacturers, managers of digital imaging projects, as well as journalists and students studying image technology.

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.

Kevin Matherson is a director of optical engineering at Microsoft Corporation working on advanced optical technologies for AR/VR, machine vision, and 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.

SC18: Perception and Cognition for Imaging

Monday 27 January • 8:30 am – 12:45 pm
Course Length: 4 hours
Course Level: Introductory/Intermediate
Instructor: Bernice Rogowitz, Visual Perspectives and Columbia University
Fee: Member: $355 / **Non-member:** $380 / **Student:** $120

Learning Outcomes
- 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 real-world imaging and visual analytics applications.

Imaging is a very broad field. We produce a wide range of visual representations that support many different tasks in every industry. These representations are created for human consumption, so it is critical for us to understand how the human sees, interprets, and makes decisions based on this visual information.

The human observer actively processes 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 engineering decisions about how to represent data visually. This course will provide a fundamental perceptual foundation for approaching important topics in imaging, such as image quality, visual feature analysis, and data visualization. The course will begin with understanding early vision mechanisms, such as contrast and color perception, cover important topics in attention and memory, and provide insights into individual differences, aesthetics, and emotion.

Intended Audience
Imaging scientists, engineers, application developers. Domain experts are also welcome, since imaging plays a pivotal role in today's application areas, including finance, medicine, science, environment, telecommunications, sensor integration, augmented and virtual reality, art and design, and others. Students interested in understanding imaging systems from the perspective of the human user are also encouraged to attend, as well as anyone interested in how the visual world is processed by our eye-brain system.

Bernice Rogowitz is the Chief Scientist at Visual Perspectives, a consulting and research practice that works with companies and universities to improve visual imaging and visualization systems through a better understanding of human vision and cognition. She created the Data Visualization and Design curriculum at Columbia University, where she is an instructor in the Applied Analytics Program, and is one of the founding Editors-in-Chief (with Thrasyvoulos Pappas) of the new IS&T Journal of Perceptual Imaging, *which publishes research at the intersection of human perception/cognition and imaging. Dr. Rogowitz 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. 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. She is the founder, and past chair of the IS&T Conference on Human Vision and Electronic Imaging, which has been a vital part of the imaging community for more than 30 years. Rogowitz is a Fellow of IS&T and SPIE, and a Senior Member of the IEEE. In 2015, she was named the IS&T Honorary Member, and was cited as a "leader in defining the research agenda for human-computer interaction in imaging, driving technology innovation through research in human perception, cognition, and aesthetics."*

SC19: Camera Image Quality Benchmarking

Monday 27 January • 10:45 am – 12:45 pm
Course Length: 2 hours
Course Level: Intermediate
Instructor: Henrik Eliasson, Eclipse Optics
Fee: Member: $245 / **Non-member:** $270 / **Student:** $95

Learning Outcomes
This course will enable the attendee to:
- Identify defects that degrade image quality in natural images and what component of the camera may be improved for better image quality.
- Be aware of existing image quality standards and metrics.
- Understand how to judge the overall image quality of a camera.
- Evaluate the impact various output use cases can have on overall image quality.
- Describe an image quality lab and measurement protocols.
- Understand how to compare the image quality of a set of cameras.

The purpose of this short course is to show that it is possible to compare the image quality of consumer imaging systems in a perceptually relevant manner. Because image quality is multi-faceted, generating a concise and relevant evaluative summary of photographic systems can be challenging. Indeed, benchmarking the image quality of still and video imaging systems requires that the assessor understands not only the capture device itself, but also the imaging applications for the system. This course explains how objective metrics and subjective methodologies are used to benchmark image quality of photographic still image and video capture devices. The course reviews key image quality attributes and the flaws that may degrade those attributes. Content touches on various subjective evaluation methodologies as well as objective measurement methodologies relying on existing standards from sources such as ISO, IEEE/CPIQ, and ITU. The course focus is on consumer imaging systems, so the emphasis is on the value of using objective metrics that are perceptually correlated and how to generate benchmark data from the combination of objective and subjective metrics.

Intended Audience
Image scientists, engineers, or managers who wish to learn more about image quality and how to evaluate still and video cameras for various applications. A good understanding of imaging and how a camera works is assumed.

Henrik Eliasson is a camera systems specialist working at Eclipse Optics in Sweden. He has extensive experience in image quality assessment, previously working as a camera systems engineer at Sony Ericsson/Sony Mobile Communications and Axis Communications. He has previously been a key contributor in the CPIQ initiative, now run by IEEE, and a Swedish delegate to the ISO TC42 committee on photography standards. He has published work in a broad range of camera related areas, from optical simulations to camera color characterization and image sensor crosstalk investigations. Eliasson is a senior member of SPIE.

Tuesday, January 28, 2020

SC20: Fundamentals of Deep Learning

Tuesday 28 January • 8:30 am – 12:45 pm
Length: 4 hours
Level: Intermediate
Instructor: Raymond Ptucha, Rochester Institute of Technology
Fee: Member: $355 / **Non-member:** $380 / **Student:** $120

Learning Outcomes
This course enables the attendee to:
- Become familiar with deep learning concepts and applications.
- Understand how deep learning methods work, specifically convolutional neural networks and recurrent neural networks.
- Gain hands-on experience in building, testing, and improving the performance of deep networks using popular open-source utilities.

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 many cases, results surpass 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 classifiers simultaneously in a supervised fashion, giving a 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, is 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 such as autonomous driving.

There is 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 are discussed. The session concludes with tips and techniques for creating and training deep neural networks to perform classification on imagery, assessing the performance of a trained network, and modifications for improved performance.

Intended Audience
Engineers, scientists, students, and managers interested in acquiring a broad understanding of deep learning. Prior familiarity with the basics of machine learning and a scripting language is helpful.

Raymond Ptucha is an associate professor in computer engineering and director of the Machine Intelligence Laboratory at Rochester Institute of Technology. His research includes machine learning, computer vision, and robotics, with a specialization in deep learning. Ptucha was a research scientist with Eastman Kodak Company where he worked on computational imaging algorithms and was awarded 32 U.S. patents. He graduated from SUNY/Buffalo with a BS in computer science and a BS in electrical engineering. He earned a MS in image science from RIT. He earned a PhD in computer science from RIT (2013). Ray was awarded an NSF Graduate Research Fellowship (2010) and his PhD research earned the 2014 Best RIT Doctoral Dissertation Award. Ptucha is a passionate supporter of STEM education, an NVIDIA certified Deep Learning Institute instructor, Chair of the Rochester area IEEE Signal Processing Society, and an active member of his local IEEE chapter and FIRST robotics organizations.

SC21: Production Line Camera Color Calibration

Tuesday 28 January • 8:30 am – 12:45 pm
Course Length: 4 hours
Course Level: Intermediate
Instructors: Eric Walowit, consultant, and Dietmar Wueller, Image Engineering, GmbH & Co. KG
Fee: Member: $355 / **Non-member:** $380 / **Student:** $120

Learning Outcomes
This course enables the attendee to:
- Understand the need for camera colorimetric characterization and the impact of color calibration on image quality and manufacturing yield.
- Perform target-based and spectral-based camera characterization.
- Solve for colorimetric camera transforms and build profiles using linear and nonlinear techniques.
- Evaluate current colorimetric camera characterization hardware and software technology and products.
- Participate in hands-on spectral camera characterization, camera transform generation, and matching from capture to display.

This course covers the process of colorimetric camera characterization in theory and practice. The need for camera characterization and calibration and the impact on general image quality are first reviewed. Known issues in traditional approaches are discussed. Methodology for building camera colorimetric transforms and profiles are detailed step-by-step. State-of-the-art solutions using current technology are presented including monochromators, multispectral LED light sources, in situ measurements of spectral radiances of natural objects, and modern color transform methods including multidimensional color lookup tables. A live demonstration is performed of the end-to-end process of spectral camera characterization, camera transform generation, and matching from capture to display. This course provides the basis needed to implement advanced color correction in cameras and software.

Intended Audience
Engineers, project leaders, and managers involved in-camera image processing pipeline development, image quality engineering, and production-line quality assurance.

Eric Walowit's interests are in color management, appearance estimation, and image processing pipelines for digital photographic applications. He is the founder (retired) of Color Savvy Systems, a color management hardware and software company. He graduated from RIT's Image Science program (1985), concentrating in color science. Walowit is a member of ICC, ISOTC42, IS&T, and CIEJTC10.

Dietmar Wueller studied photographic sciences from 1987 to 1992 in Cologne. He is the founder of Image Engineering, one of the leading suppliers for test equipment for digital image capture devices. Wueller is a member of IS&T, DGPH, and ECI and he is the German representative for ISO/TC42/WG18 and also participates in several other standardization activities.

SC22: An Introduction to Blockchain

Tuesday 28 January • 3:15 - 5:15 pm
Course Length: 2 hours
Course Level: Introductory
Instructor: Gaurav Sharma, University of Rochester
Fee: Member: $245 / **Non-member:** $270 / **Student:** $95

Learning Outcomes
This course enables the attendee to:
- Explain how the blockchain construction provides resistance against tampering.
- Distinguish between centralized and distributed ledgers and highlight their pros and cons.
- Describe the concepts of proof-of-work and proof-of-stake.
- Explain the utility and applicability of blockchains in diverse applications.
- Cite example applications of blockchains.

This course introduces attendees to blockchains, which have recently emerged as a revolutionary technology that has the potential to disrupt a range of diverse business processes and applications. Using a concrete application setting, the course illustrates the construction of blockchains as a distributed, secure, and tamper-resistant framework for the management of transaction ledgers. Necessary background in the technologies underlying blockchains, including basic cryptographic concepts, are introduced as required.

Intended Audience
Engineers, scientists, students, and managers interested in understanding how blockchains are constructed and how they can be useful in a variety of business processes. The course includes an overview of necessary background information, such as cryptographic tools utilized in the blockchain; prior familiarity with these concepts is not required.

Gaurav Sharma is a professor of electrical and computer engineering and of computer science at the University of Rochester where his research span data analytics, machine learning, 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 computer vision and image processing algorithms. He holds 51 issued patents and has authored more than 190 peer-reviewed publications. He is the editor of the "Digital Color Imaging Handbook" published by CRC Press. He currently serves as the Editor-in-Chief for the IEEE Transactions on Image Processing *and previously served as the Editor-in-Chief for the SPIE/IS&T* Journal of Electronic Imaging *(2011-2015). Sharma is a fellow of IS&T, IEEE, and SPIE.*

SC23: Using Cognitive and Behavioral Sciences and the Arts in Artificial Intelligence Research and Design

Tuesday 28 January • 3:15 - 5:15 pm
Course Length: 2 hours
Course Level: Introductory/Intermediate
Instructor: Mónica López-González, La Petite Noiseuse Productions
Fee: Member: $245 / **Non-member:** $270 / **Student:** $95

Learning Outcomes
This course enables the attendee to:
- Identify the major, yet pressing, failures of contemporary autonomous intelligent systems.
- Understand the challenges of implementation of and necessary mindset needed for integrative, multidisciplinary research.
- Review the latest findings in the cognitive and behavioral sciences, particularly learning, attention, problem solving, decision-making, emotion perception, and spontaneous creative artistic thinking.
- Explain how relevant findings in the cognitive and behavioral sciences apply to the advancement of efficient and autonomous intelligent systems.
- Discuss various research solutions for improving current computational frameworks.

An increasing demand of machine learning and autonomous systems research is to create human-like intelligent machines. Despite the current surge of sophisticated computational systems available, from natural language processors and pattern recognizers to surveillance drones and self-driving cars, machines are not human-like, most fundamentally, in regards to our capacity to integrate past with incoming multi-sensory information and creatively adapt to the ever-changing environment. To create an accurate human-like machine entails thoroughly understanding human perceptual-cognitive processes and behavior. The complexity of the mind/brain and its cognitive processes necessitates that multidisciplinary expertise and lines of research must be brought together and combined. This introductory to intermediate course presents a multidisciplinary perspective about method, data, and theory from the cognitive and behavioral sciences and the arts evermore imperative in artificial intelligence research and design. The goal of this course is to provide a theoretical framework from which to build highly efficient and integrated cognitive-behavioral-computational models to advance the field of artificial intelligence.

Intended Audience
Computer and imaging scientists, mathematicians, statisticians, engineers, program managers, system and software developers, and students in those fields interested in exploring the importance of using multidisciplinary concepts, questions, and methods within cognitive science, a fundamental and necessary field to build novel mathematical algorithms for computational systems.

Mónica López-González, a polymath and visionary, is a multilingual cognitive scientist, educator, entrepreneur, multidisciplinary artist, public speaker, and writer. Using her original cross-disciplinary research work in the science of creativity, imagination, learning, and human intelligence, López-González uniquely merges the cognitive, brain, behavioral, social, and health sciences with business strategy and artistic acumen to integrate human-centered factors, like cognition and behavioral insights, into artificial intelligence development and competitive business solutions. She's the chief executive & science-art officer of La Petite Noiseuse Productions, a unique consulting firm at the forefront of innovative science-art integration. She is also faculty at Johns Hopkins University. López-González holds BAs in psychology and French, and a MA and PhD in cognitive science, all from Johns Hopkins University, and a Certificate of Art in photography from Maryland Institute College of Art. She held a postdoctoral fellowship in the Johns Hopkins School of Medicine. She is a committee member of HVEI.

Wednesday, January 29, 2020

SC24: Imaging Applications of Artificial Intelligence

Wednesday 29 January • 8:30 am – 12:45 pm
Course Length: 4 hours
Course Level: Introductory/Intermediate
Instructor: Sos Agaian, The Graduate Center and CSI, City University of New York (CUNY)
Fee: Member: $355 / **Non-member:** $380 / **Student:** $120

Learning Outcomes
The main purpose of this course is to provide the most fundamental knowledge to the attendees so that they can understand what artificial intelligence (AI) is and how to use it in image processing applications. This course enables attendees to:
- Become familiar with AI concepts and applications.
- Understand machine learning and describe the specifics of several prominent machine-learning methods (e.g., SVMs, decision trees, Bayes nets, and artificial neural networks).
- Gain hands-on experience in building, and improving, the performance of AI methods tailoring robotics and vision application.
- Discuss various research solutions for improving current AI algorithms.

Artificial intelligence is a research field that studies how to realize intelligent human behaviors on a computer. The fundamental goal of AI is to make a computer that can learn, plan, and solve problems independently. This course aims to give an overview of some basic AI algorithms and an understanding of the possibilities and limitations of AI. This is an introductory course on artificial intelligence. It emphasizes fast and smart search heuristics, thoughtful ways to represent knowledge, and incisive techniques that support rational decision-making. Application areas will include image processing and robotics.

Intended Audience
Engineers, scientists, students, and managers interested in acquiring a broad understanding of artificial intelligence. Prior familiarity with the basics of image processing is helpful.

Students are expected to have a solid background in the analysis of algorithms, proofs in propositional and first-order logic, discrete mathematics, and elementary probability.

Sos Agaian is currently a distinguished professor of computer science at the City University of New York (CUNY). Prior to this, Agaian was the Peter T. Flawn Professor of electrical and computer engineering at the University of Texas, San Antonio (UTSA). He has been a visiting faculty member at Tufts University in Medford, MA. Currently, at CUNY, Agaian leads the Computational Vision and Learning Laboratory. His research group's multidisciplinary approach, combining computer science, electrical engineering, behavioral science, neuroscience, and studies in human perception, enables computational devices to see, learn, and understand the physical world as artificially intelligent devices with human-like data processing abilities. Agaian is the recipient of numerous awards including UTSA's Innovator of the Year Award; and the San Antonio Business Journal's "The Tech Flash Titans-Top Researcher" Award. Moreover, Agaian established two university research centers: the NSF Center for Simulation Visualization & Real-Time Prediction and the DHS National Center of Academic Excellence in Information Assurance Research. Other honors include IS&T Fellow, IEEE Fellow, SPIE Fellow, and AAAS Fellow. Agaian is an Editorial Board Member for the Journal of Pattern Recognition and Image Analysis, *and he is an associate editor for nine journals, including the* Journal of Electronic Imaging *(SPIE, IS&T),* IEEE Transaction on Image Processing*;* IEEE Transaction on Systems, Man, and Cybernetics*; and* Journal of Electrical and Computer Engineering *(Hindawi Publishing Corporation). Agaian received his MS in mathematics and mechanics (summa cum laude) from the Yerevan State University, Armenia; his PhD in mathematics and physics from the Steklov Institute of Mathematics, Russian Academy of Sciences (RAS); and his doctor of engineering sciences degree from the Institute of Control Systems, RAS.*

SC25: Smartphone Imaging for Secure Applications

Wednesday 29 January • 3:15 - 5:15 pm
Course Length: 2 hours
Course Level: Introductory
Instructor: Alan Hodgson, Alan Hodgson Consulting Ltd.
Fee: Member: $245 / **Non-member:** $270 / **Student:** $95

Learning Outcomes
This course enables the attendee to:
- Evaluate the current and potential applications of smartphone imaging in inspection and authentication.
- Have an overview of current secure print vision tools and where smartphones are now making a difference.
- Comprehend the risks and benefits associated with smartphone implementations in secure applications.
- Be able to identify the power and vulnerabilities of smartphone solutions in this space.
- Understand the opportunities that future developments in smartphone technology could bring to inspection and authentication.

The smartphone has the potential to have a profound effect on secure applications, ranging from product inspection through to finance and identity. These are all enabled by the machine vision capabilities of the smartphone, from camera systems to biometric authentication. The aim of this course is to take a fresh look at smartphone technology, from the perspective of the secure applications industry in areas such as document inspection, e-commerce, and mobile identity.

It starts by reviewing the technical, social, economic, and political landscape then moves into the early implementations in product inspection, finance, and identity. We discuss the implications of some market studies and the relevance of associated technologies such as Internet of Things and wearable electronics. This leads to an appraisal of the risks and benefits of the smartphone platform from the perspective of both the "tech giants" and the authentication industries such as currency and identity.

These concepts are illustrated through a number of case studies.

Intended Audience
The course is primarily intended for those interested in the use of smartphone technology in the broad area of security applications, from the following perspectives:
- Biometric imaging applications in identity and commerce
- Smartphones as a carrier for e-commerce and electronic ID
- Camera systems for machine vision in document inspection

This is an introductory level course in that it assumes no knowledge of secure applications industry. All that is required is an interest in the application of smartphones to this application. It aims to inform an audience ranging from students and engineers to market innovators and academics.

Alan Hodgson has 35 years' experience across the print and imaging industry as an image physicist. He has been involved in security documents for the past 15 years, both within the industry and as an external consultant, teaching courses at security and imaging conferences. Over the last 5 years he has been investigating the applicability of smartphone technology to this industry. Hodgson is a past president of IS&T and a fellow of both the Institute of Physics and The Royal Photographic Society.

Thursday, January 30, 2020

SC26: Introduction to Probabilistic Models for Machine Learning

Thursday 30 January • 8:30 am – 12:45 pm
Course Length: 4 hours
Course Level: Introductory
Instructor: Gaurav Sharma, University of Rochester
Fee: Member: $355 / **Non-member:** $380 / **Student:** $120

Learning Outcomes
This course enables the attendee to:
- Describe and intuitively explain fundamental probabilistic concepts such as independence, Bayes' rule, and stationarity.
- Explain the basis of Maximum Aposteriori Probability (MAP) and Maximum Likelihood (ML) detection and estimation rules.
- Describe how latent variables and sequential dependence underlie expectation maximization and hidden Markov Models.
- Develop simple applications of probabilistic models for computer vision and image processing problems.
- Cite and explain application examples involving the use of probabilistic models in computer vision, machine learning, and image processing.

The course aims at providing attendees a foundation in inference and estimation for machine learning using probabilistic models. Starting from the broad base of probabilistic inference and estimation, the course develops

the treatment of specific techniques that underlie many current day machine learning and inference algorithms. Topics covered include a review of concepts from probability and stochastic processes, IID and Markov processes, basics of inference and estimation, Maximum Aposteriori Probability (MAP) and Maximum Likelihood (ML), expectation maximization for ML estimation, hidden Markov models, and Markov and conditional random fields. The pedagogical approach is to illustrate the use of models via concrete examples: each model is introduced via a detailed toy example and then illustrated via one or two actual application examples.

Intended Audience

Engineers, scientists, students, and managers interested in understanding how probabilistic models are used in inference and parameter estimation problems in today's machine learning and computer vision applications and in applying such models to their own problems. Prior familiarity with basics of probability and with matrix vector operations are necessary for a thorough understanding, although attendees lacking this background can still develop an intuitive high-level understanding.

Gaurav Sharma is a professor of electrical and computer engineering and of computer science at the University of Rochester where his research span data analytics, machine learning, 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 computer vision and image processing algorithms. He holds 51 issued patents and has authored more than 190 peer-reviewed publications. He is the editor of the "Digital Color Imaging Handbook" published by CRC Press. He currently serves as the Editor-in-Chief for the IEEE Transactions on Image Processing *and previously served as the Editor-in-Chief for the SPIE/IS&T* Journal of Electronic Imaging *(2011-2015). Sharma is a fellow of IS&T, IEEE, and SPIE.*

GENERAL INFORMATION

Registration

Symposium Registration
Symposium Registration Includes: Admission to all technical sessions; coffee breaks; the Symposium Reception, exhibition, poster and demonstration sessions; 3D theatre; 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 are priced separately. Course-only registration includes your selected course(s), course notes, coffee breaks, and admittance to the exhibition. Courses 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.

Author/Presenter Information

Speaker AV Prep Room: Conference Office
Open limited hours during Registration Desk Hours. Visit Registration Desk for more information.

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 requested special equipment prior to the request deadline are asked to confirm that their requested equipment is available.

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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, image preservation, and hybrid imaging systems.

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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.

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AUTHOR INDEX

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Y

Z

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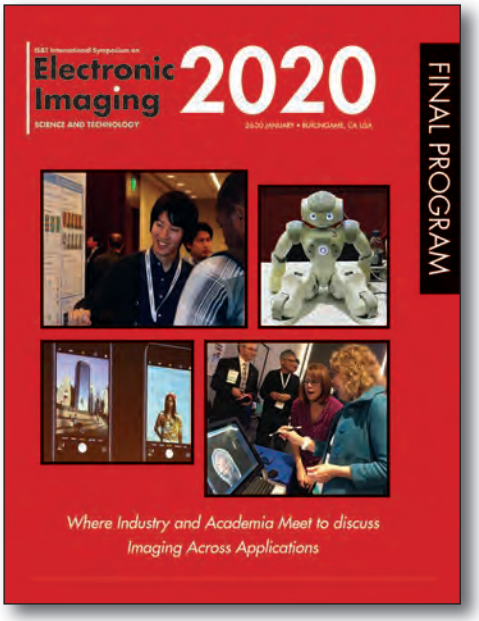

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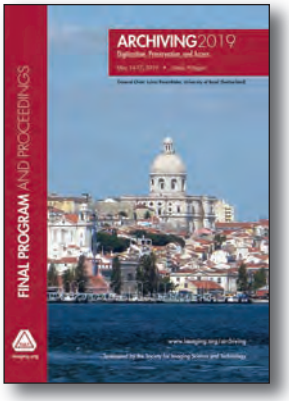

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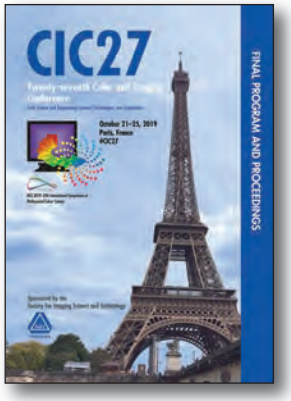

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