PROGRAM AND PROCEEDINGS

Image Processing: Algorithms and Systems XX

Conference Chairs
Sos S. Agaian, The City University of New York (CUNY) College of Staten Island and CUNY Graduate Center (United States)
Karen O. Egiazarian, Tampere Univ. of Technology (Finland)
Atanas P. Gotchev, Tampere Univ. of Technology (Finland)

This document details the conference program, held as part of the 2022 IS&T International Symposium on Electronic Imaging, online 15–26 January 2022. Manuscripts of conference papers are reproduced from PDFs as submitted and approved by authors; no editorial changes were made.

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Image Processing: Algorithms and Systems XX

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 transform-, model-, and learning-based approaches for creating effective algorithms and building modern imaging systems for new and emerging applications.

Paper authors listed as of 1 January 2022; refer to manuscript for final authors. Titles that are not listed with the proceedings files were presentation-only.

Image Processing: Algorithms and Systems XX

MONDAY 17 JANUARY 2022

PLENARY: Quanta Image Sensors: Counting Photons Is the New Game in Town
10:00 – 11:10

Eric R. Fossum, Dartmouth College (United States)

The Quanta Image Sensor (QIS) was conceived as a different image sensor—one that counts photoelectrons one at a time using millions or billions of specialized pixels read out at high frame rate with computation imaging used to create gray scale images. QIS devices have been implemented in a CMOS image sensor (CIS) baseline room-temperature technology without using avalanche multiplication, and also with SPAD arrays. This plenary details the QIS concept, how it has been implemented in CIS and in SPADs, and what the major differences are. Applications that can be disrupted or enabled by this technology are also discussed, including smartphone, where CIS-QIS technology could even be employed in just a few years.

Eric R. Fossum is best known for the invention of the CMOS image sensor "camera-on-a-chip" used in billions of cameras. He is a solid-state image sensor device physicist and engineer, and his career has included academic and government research, and entrepreneurial leadership. At Dartmouth he is a professor of engineering and vice provost for entrepreneurship and technology transfer. Fossum received the 2017 Queen Elizabeth Prize from HRH Prince Charles, considered by many as the Nobel Prize of Engineering "for the creation of digital imaging sensors," along with three others. He was inducted into the National Inventors Hall of Fame, and elected to the National Academy of Engineering among other honors including a recent Emmy Award. He has published more than 300 technical papers and holds more than 175 US patents. He co-founded several startups and co-founded the International Image Sensor Society (IISS), serving as its first president. He is a Fellow of IEEE and OSA.

WEDNESDAY 19 JANUARY 2022

PLENARY: In situ Mobility for Planetary Exploration: Progress and Challenges
10:00 – 11:15

Larry Matthies, Jet Propulsion Laboratory (United States)

This year saw exciting milestones in planetary exploration with the successful landing of the Perseverance Mars rover, followed by its operation and the successful technology demonstration of the Ingenuity helicopter, the first heavier-than-air aircraft ever to fly on another planetary body. This plenary highlights new technologies used in this mission, including precision landing for Perseverance, a vision coprocessor, new algorithms for faster rover traverse, and the ingredients of the helicopter. It concludes with a survey of challenges for future planetary mobility systems, particularly for Mars, Earth's moon, and Saturn's moon, Titan.

Larry Matthies received his PhD in computer science from Carnegie Mellon University (1989), before joining JPL, where he has supervised the Computer Vision Group for 21 years, the past two coordinating internal technology investments in the Mars office. His research interests include 3-D perception, state estimation, terrain classification, and dynamic scene analysis for autonomous navigation of unmanned vehicles on Earth and in space. He has been a principal investigator in many programs involving robot vision and has initiated new technology developments that impacted every US Mars surface mission since 1997, including visual navigation algorithms for rovers, map matching algorithms for precision landers, and autonomous navigation hardware and software architectures for rotorcraft. He is a Fellow of the IEEE and was a joint winner in 2008 of the IEEE's Robotics and Automation Award for his contributions to robotic space exploration.

Image Processing: Algorithms and Systems XX Posters
11:20 – 12:20

Poster interactive session for all conferences authors and attendees.

IPAS-191

P-08: Class specific biased extrapolation of images in latent space for imbalanced image classification, *Suhyeon Jeong and Seungkyu Lee, Kyung Hee University (Republic of Korea)*

IPAS-192

P-09: Computer vision-based classification of schizophrenia patients from retinal imagery, *Diana Joseph, Adriann Lai, Steven Silverstein, Rajeev Ramchandran, and Edgar Bernal, University of Rochester (United States)*

IPAS-193

P-10: Optimal parameters selection of the Frost filter based on despeckling efficiency prediction for Sentinel SAR images, *Oleksii S. Rubel[1], Andrii S. Rubel[1], Vladimir Lukin[1], and Karen Egiazarian[2]; [1]National Aerospace University (Ukraine) and [2]Tampere University (Finland)*

IPAS-194

P-11: Simulation-based virtual reality training for firefighters, *Mohamed Saifeddine Hadj Sassi[1], Federica Battisti[2], and Marco Carli[1]; [1]Roma Tre University and [2]University of Padova (Italy)*

TUESDAY 25 JANUARY 2022

PLENARY: Physics-based Image Systems Simulation

10:00 – 11:00

Joyce Farrell, Stanford Center for Image Systems Engineering, Stanford University, CEO and Co-founder, ImagEval Consulting (United States)

Three quarters of a century ago, visionaries in academia and industry saw the need for a new field called photographic engineering and formed what would become the Society for Imaging Science and Technology (IS&T). Thirty-five years ago, IS&T recognized the massive transition from analog to digital imaging and created the Symposium on Electronic Imaging (EI). IS&T and EI continue to evolve by cross-pollinating electronic imaging in the fields of computer graphics, computer vision, machine learning, and visual perception, among others. This talk describes open-source software and applications that build on this vision. The software combines quantitative computer graphics with models of optics and image sensors to generate physically accurate synthetic image data for devices that are being prototyped. These simulations can be a powerful tool in the design and evaluation of novel imaging systems, as well as for the production of synthetic data for machine learning applications.

Joyce Farrell is a senior research associate and lecturer in the Stanford School of Engineering and the executive director of the Stanford Center for Image Systems Engineering (SCIEN). Joyce received her BS from the University of California at San Diego and her PhD from Stanford University. She was a postdoctoral fellow at NASA Ames Research Center, New York University, and Xerox PARC, before joining the research staff at Hewlett Packard in 1985. In 2000 Joyce joined Shutterfly, a startup company specializing in online digital photofinishing, and in 2001 she formed ImagEval Consulting, LLC, a company specializing in the development of software and design tools for image systems simulation. In 2003, Joyce returned to Stanford University to develop the SCIEN Industry Affiliates Program.

PANEL: The Brave New World of Virtual Reality

11:00 – 12:00

Advances in electronic imaging, computer graphics, and machine learning have made it possible to create photorealistic images and videos. In the future, one can imagine that it will be possible to create a virtual reality that is indistinguishable from real-world experiences. This panel discusses the benefits of this brave new world of virtual reality and how we can mitigate the risks that it poses. The goal of the panel discussion is to showcase state-of-the art synthetic imagery, learn how this progress benefits society, and discuss how we can mitigate the risks that the technology also poses. After brief demos of the state-of-their-art, the panelists will discuss: creating photorealistic avatars, Project Shoah, and digital forensics.

Panel Moderator: Joyce Farrell, Stanford Center for Image Systems Engineering, Stanford University, CEO and Co-founder, ImagEval Consulting (United States)
Panelist: Matthias Neissner, Technical University of Munich (Germany)
Panelist: Paul Debevec, Netflix, Inc. (United States)
Panelist: Hany Farid, University of California, Berkeley (United States)

Image Filtering, Enhancement, and Object Detection

Session Chair: Karen Egiazarian, Tampere University (Finland)

12:15 – 13:20

12:15

Conference Introduction

12:20 IPAS-344

Contrast enhancement: Cross-modal learning approach for medical images, *Rabia Naseem[1], Akib J. Islam[1,2], Faouzi Alaya Cheikh[1], and Azeddine Beghdadi[3]; [1]Norwegian University of Science and Technology (Norway), [2]University Jean Monnet Saint-Etienne (France), and [3]University Sorbonne Paris Nord (France)*

12:40 IPAS-345

Rapid circle detection through fusion of summative statistics of edge components, *Scott A. Craver and Pheona Anjoy, Binghamton University (United States)*

13:00 IPAS-346

Training decision trees to guide feature selection for infrared image pre-screening algorithms, *Dawne Deaver[1] and Nader Namazi[2]; [1]US Army DEVCOM C5ISR and [2]The Catholic University of America (United States)*

Multi-dimensional and Multimodal Image Processing Algorithms I

Session Chair: Karen Egiazarian, Tampere University (Finland)

13:45 – 14:45

13:45 IPAS-354

On properties of visual quality metrics in remote sensing applications, *Oleg Ieremeiev[1], Vladimir Lukin[1], Krzysztof Okarma[2], Karen Egiazarian[3], and Benoit Vozel[4]; [1]National Aerospace University (Ukraine), [2]West Pomeranian University of Technology (Poland), [3]Tampere University (Finland), and [4]University of Rennes 1 (France)*

14:05 IPAS-355

Face detection and recognition in organic video: A comparative study for sport celebrities database, *Yigit O. AKBAY and Mihai Mitrea, Institut Mines-Telecom (France)*

14:25 IPAS-356

Volumetric segmentation for integral microscopy with Fourier plane recording, *Sergio Moreschini, Robert Bregovic, and Atanas Gotchev, University of Tampere (Finland)*

Multi-dimensional and Multimodal Image Processing Algorithms II

Session Chair: Sos Agaian, College of Staten Island and the Graduate Center, CUNY (United States)

18:00 – 19:00

18:00 IPAS-365

A frame level rate allocation algorithm based on temporal dependency model for AV1, *Cheng Chen, Jingning Han, Paul Wilkins, and Yaowu Xu, Google Inc. (United States)*

18:20 IPAS-366

Alignment and fusion of visible and infrared images based on gradient-domain processing, *Ayaka Tanihata, Masayuki Tanaka, and Masatoshi Okutomi, Tokyo Institute of Technology (Japan)*

18:40 IPAS-367

Deep reinforcement learning approach to predict head movement in 360° videos, *Tanmay Ambadkar and Pramit Mazumdar, IIIT Vadodara (India)*

WEDNESDAY 26 JANUARY 2022

Signal and Image Classification I

Session Chair: Atanas Gotchev, Tampere University (Finland)
10:00 – 11:00

10:00 IPAS-381
Machine learning with blind imbalanced domains, *Hiroshi Kuwajima[1], Masayuki Tanaka[2], and Masatoshi Okutomi[2]; [1]DENSO Corporation and [2]Tokyo Institute of Technology (Japan)*

10:20 IPAS-382
Real-time defect detection and classification on wood surfaces using deep learning, *Mazhar Mohsin, Oluwafemi Samson Balogun, Keijo Haataja, and Pekka Toivanen, University of Eastern Finland (Finland)*

10:40 IPAS-383
Hair color digitization through imaging and deep inverse graphics, *Robin Kips[1,2], Panagiotis-Alexandros Bokaris[1], Matthieu Perrot[1], Pietro Gori[2], and Isabelle Bloch[3]; [1]L'Oréal Research and Innovation, [2]LTCI, Telecom Paris, Institut Polytechnique de Paris, and [3]Sorbonne Universite CNRS (France)*

Signal and Image Classification II

Session Chair: Atanas Gotchev, Tampere University (Finland)
11:30 – 12:30

11:30 IPAS-390
Deep learning based udder classification for cattle traits analysis, *Hina Afridi[1,2], Mohib Ullah[1], Øyvind Nordbø[2], and Faouzi Alaya Cheikh[1]; [1]Norwegian University of Science and Technology and [2]GENO SA (Norway)*

11:50 IPAS-392
Expert training: Enhancing AI resilience to image coding artifacts, *Alban Marie, Karol Desnos, Luce Morin, and Lu Zhang, Institut National des Sciences Appliquées de Rennes (France)*

12:10 IPAS-419
Accuracy evaluation of methods for pose estimation from fiducial markers, *Ugurcan Budak[1], Olli Suominen[1], Emilio Ruiz Morales[2], and Atanas Gotchev[1]; [1]Tampere University (Finland) and [2]Fusion for Energy (F4E) (Spain)*

Perception and Image Quality

Session Chair: Atanas Gotchev, Tampere University (Finland)
13:00 – 14:00

IPAS-399
KEYNOTE: Perception-guided image quality measurements: Principles and future trends [Presentation-Only], *Sos S. Agaian, College of Staten Island and the Graduate Center, CUNY (United States)*

Bio-inspired image processing is about learning image algorithms from computational neuroscience, cognitive science, and biology and applying them to the design of real-world image processing-based systems. More specifically, this field is giving computers the ability to "see" just as humans do. Recently, many useful image processing algorithms developed with varying degrees of correspondence with biological vision studies. This is natural since a biological system can provide a source of inspiration for new computational efficient/robust vision models and measurements. Simultaneously, the image processing tools may give new insights for understanding biological visual systems. Digital images are subject to various distortions during acquisition, processing, transmission, compression, storage, and reproduction. How can we automatically predict quantitatively or perceived image quality? In this talk, we present originating in visual perception studies: Visual perception-driven image quality measurements: principles, future trends, applications. We will also give our recent research works and a synopsis of the current state-of-the-art results in image quality measurements and discuss future trends in these technologies and the associated commercial impact and opportunities.

Sos S. Agaian is a distinguished professor of computer science at CSI and the Graduate Center, CUNY. Dr. Agaian was a Peter T. Flawn Professor of the University of Texas at San Antonio. His research sponsors include DARPA, NSF, US Department of Transportation, US Department of Energy, NIJ, and private industry. Dr. Agaian's research interests are in big and small data analytics, computational vision and sensing, machine learning and urban computing, multimodal biometric and digital forensics, information processing and fusion, and fast algorithms. He has special interests in finding meaning in visual content-examine images for faces, text, objects, action, sciences, and other contents; and in the development of scientific systems and architectures in the theory and practice of engineering and computer sciences (emphasizing complex digital data processing, information sciences and systems technologies in the military, as well as medical and industrial information processing centers). Dr. Agaian has developed applications in

healthcare, biomedical data mining, object recognition, signal processing, computer-aided food quality inspection, 3D imaging visible and thermal sensors, computational photography, multimedia security, needs-driven medical and biomedical technology, finance, and other related areas. He has published 750 articles, 10 books, 19 book chapters, and holds more than 56 American and foreign issued or pending patents/ disclosures. Several of Agaian's IP are commercially licensed. He is an Associate Editor for several journals, including the Image processing Transaction (IEEE) and IEEE Transaction of Cybernetics. He is a fellow of IS&T, SPIE, AAAS, IEEE, and AAI. Dr. Agaian gave more than 15 plenary/keynote speeches and 50+ Invited talks.