3D Imaging and Applications 2022

Conference Chairs
Tyler Bell, University of Iowa (United States)
William Puech, Laboratory d'Informatique de Robotique et de Microelectronique de Montpellier (France)
Robert Sitnik, Warsaw University of Technology (Poland)

PROGRAM AND PROCEEDINGS

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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3D Imaging and Applications 2022

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.

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.

3D Imaging and Applications 2022 (3DIA)

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.

Acquisition and Processing

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

12:30 – 13:35

12:30

Conference Introduction

12:35 3DIA-211

Investigation of demosaicing effect on digital image correlation method: A case study on paintings with natural texture [Presentation-Only], *Athanasia Papanikolaou, Malgorzata Kujawinska, and Piotr Garbat, Politechnika Warszawska (Poland)*

12:55 3DIA-212

Pose estimation of teeth in pathological dental models, *Maxime Chapuis[1,2], Mathieu Lafourcade[1], William Puech[1], Noura Faraj[1], and Gérard Guillerm[2]; [1]Université de Montpellier and [2]Groupe Orqual (France)*

13:15 3DIA-213

Segmentation in application to deformation analysis of cultural heritage surfaces, *Sunita Saha and Robert Sitnik, Warsaw University of Technology (Poland)*

Analysis and Compression

Session Chair: William Puech, Laboratory d'Informatique de Robotique et de Microelectronique de Montpellier (France)

13:50 – 14:50

13:50 3DIA-223

Scale-adaptive local intentional surface feature detection, *Yujian Xu[1], Matthew Gaubatz[2], Stephen Pollard[2], Robert Ulichney[1], and Jan P. Allebach[1]; [1]Purdue University and [2]HP Labs (United States)*

14:10 3DIA-224

Feature-driven 3D range geometry compression via spatially-aware depth encoding, *Broderick S. Schwartz, Matthew G. Finley, and Tyler Bell, University of Iowa (United States)*

14:30 3DIA-225

Quality analysis of point cloud coding solutions, *Joao Prazeres[1,2], Manuela Pereira[1,2], and Antonio Pinheiro[1,2]; [1]Universidade da Beira Interior (U.B.I.) and [2]Instituto de Telecomunicacoes (Portugal)*

Processing and Applications

Session Chair: Robert Sitnik, Warsaw University of Technology (Poland)

18:00 – 19:00

18:00 3DIA-235

Hand authentication from RGB-D video based on deep neural network, *Ryogo Miyazaki[1], Kazuya Sasaki[2], Norimichi Tsumura[1], and Keita Hirai[1]; [1]Chiba University and [2]MagikEye (Japan)*

18:20 3DIA-236

A 3D subtractive brush system for an immersive, multilayered archaeological map, *Mike Yeates, Maxime Cordeil, and Tom Chandler, Monash University (Australia)*

18:40 3DIA-237

Design of ghost-free aerial display by using prism and dihedral corner reflector array, *Yuto Osada and Yue Bao, Tokyo City University (Japan)*

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)