electronic IMAGING

JAN 2022

Stereoscopic Displays and Applications XXXIII

Conference Chairs
Andrew J. Woods, Curtin University (Australia)
Gregg E. Favalora, Draper (United States)
Nicolas S. Holliman, Newcastle University (United Kingdom)
Takashi Kawai, Waseda University (Japan)

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.

PROGRAM AND PROCEEDINGS

Stereoscopic Displays and Applications XXXIII

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. The long-running SD&A 3D Theater Session provides conference attendees with a wonderful opportunity to see how 3D content is being created and exhibited around the world. 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).

Event

3D Theatre Online

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); **Justus Ilgner,** University Hospital Aachen (Germany); **Eric Kurland,** 3-D SPACE Museum (United States); **Bjorn Sommer,** Royal College of Art, London (United Kingdom); **John D. Stern,** Intuitive Surgical, Inc. (Retired) (United States); **Chris Ward,** Lightspeed Design, Inc. (United States); and **Laurie Wilcox,** Lightspeed Design, Inc. (United States)

Founding Chair: **John O. Merritt,** The Merritt Group (United States), *in memoriam*

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.

Stereoscopic Displays and Applications XXXIII

SATURDAY 15 JANUARY 2022

SD&A 3D Theater Session - First Screening (Premiere)
19:30 – 20:30
via YouTube

The 3D Theater Session at each year's Stereoscopic Displays and Applications conference showcases the wide variety of 3D content that is being used, produced and exhibited around the world. There are three separately scheduled screenings to suit different time zones around the world. All three screenings are the same content. The three screenings will be streamed via YouTube in both red/cyan anaglyph and 3DTV compatible over-under format - be sure to choose the correct 3D stream. To get ready for the event, obtain a pair of red(left)-cyan(right) anaglyph glasses, or warm up your 3DTV with appropriate 3D glasses at the ready!

SUNDAY 16 JANUARY 2022

SD&A 3D Theater Session - Second Screening
05:30 – 06:30
via YouTube

SD&A 3D Theater Session - Final Screening
13:30 – 14:30
via YouTube

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.

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.

THURSDAY 20 JANUARY 2022

Making 3D Magic
Session Chairs: Bjorn Sommer, Royal College of Art (United Kingdom) and Andrew Woods, Curtin University (Australia)
10:00 – 11:05

10:00
Conference Introduction

10:05   SD&A-267
KEYNOTE: Tasks, traps, and tricks of a minion making 3D magic, *John R. Benson, Illumination Entertainment (France)*

"Um, this movie is going to be in stereo, like, 3D? Do we have to wear the glasses? How do we do that? How expensive is it going to be? And more importantly, if I buy that tool you wanted, can you finish the movie a week faster? No, ok, then figure it out for yourself. Go on, you can do it. We have faith…" And so it begins. From Coraline to Sing2, with Despicable Me, Minions, Pets, and a few Dr. Suess films, John Benson has designed the look and developed processes for making the stereo films of Illumination Entertainment both cost efficient and beneficial to the final film, whether as 2D or 3D presentations. He will discuss his workflow and design thoughts, as well as the philosophy of how he uses stereo visuals as a story telling device and definitely not a gimmick.

John R. Benson began his professional career in the camera department, shooting motion control and animation for "Pee-wee's Playhouse" in the mid 80's. He's been a visual effect supervisor for commercials in New York and San Francisco, managed the CG commercials division for Industrial Light and Magic, and was compositor for several films, including the Matrix sequels and Peter Jackson's "King Kong". After "Kong", he helped design the motion control systems and stereo pipeline for Laika's "Coraline". Since 2009, he has been working for Illumination Entertainment in Paris, France as the Stereographic Supervisor for the "Despicable Me" series, "Minions", several Dr. Seuss adaptations, the "Secret Life of Pets" series and both "Sing" films. Together, the Illumination projects have grossed over $6.7 billion worldwide.

10:45   SD&A-268
Multiple independent viewer stereoscopic projection (Invited), *Steve Chapman, Digital Projection Limited (United Kingdom)*

Applications I
Session Chairs: Gregg Favalora, The Charles Stark Draper Laboratory, Inc. (United States) and Nicolas Holliman, King's College London (United Kingdom)
13:00 – 14:20

13:00   SD&A-289
The relationship between vision and simulated remote vision system air refueling performance, *Eleanor O'Keefe[1], Matthew Ankrom[1], Charles Bullock[2], Eric Seemiller[1], Marc Winterbottom[2], Jonelle Knapp[2], and Steven Hadley[2]; [1]KBR and [2]US Air Force (United States)*

13:20   SD&A-290

Towards an immersive virtual studio for innovation design engineering, *Bjorn Sommer[1], Ayn Sayuti[2], Zidong Lin[1], Shefali Bohra[1], Emre Kayganaci[1], Caroline Yan Zheng[1], Chang Hee Lee[3], Ashley Hall[1], and Paul Anderson[1]; [1]Royal College of Art (United Kingdom), [2]Universiti Teknologi MARA (UiTM) (Malaysia), and [3]Korea Advanced Institute of Science and Technology (KAIST) (Republic of Korea)*

13:40   SD&A-291

Underwater 360 3D cameras: A summary of Hollywood and DoD applications (Invited), *Casey Sapp, Blue Ring Imaging (United States)*

14:00   SD&A-292

Why simulated reality will be the driver for the Metaverse and 3D immersive visualization in general (Invited), *Maarten Tobias, Dimenco B.V. (the Netherlands)*

Applications II

Session Chairs: Takashi Kawai, Waseda University (Japan) and Andrew Woods, Curtin University (Australia)
19:15 – 20:15

19:15   SD&A-309

Evaluation and estimation of discomfort during continuous work with mixed reality systems by deep learning, *Yoshihiro Banchi, Kento Tsuchiya, Masato Hirose, Ryu Takahashi, Riku Yamashita, and Takashi Kawai, Waseda University (Japan)*

19:35   SD&A-310

360° see-through full-parallax light-field display using Holographic Optical Elements, *Reiji Nakashima and Tomohiro Yendo, Nagaoka University of Technology (Japan)*

19:55   SD&A-311

An aerial floating naked-eye 3D display using crossed mirror arrays, *Yoshihiro Sato, 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)