PROGRAM AND PROCEEDINGS

Intelligent Robotics and Industrial Applications using Computer Vision 2022

Conference Chairs
Kurt Niel, Upper Austria University of Applied Sciences (Austria)
Juha Röning, University of Oulu (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.

Society for Imaging Science and Technology
7003 Kilworth Lane • Springfield, VA 22151 USA
703/642-9090; 703/642-9094 fax
info@imaging.org; www.imaging.org

ISSN 2470-1173

https://doi.org/10.2352/EI.2022.34.6.IRIACV-A06

electronic IMAGING 2022 ONLINE

Intelligent Robotics and Industrial Applications using Computer Vision 2022

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.

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.

Intelligent Robotics and Industrial Applications using Computer Vision 2022

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.

THURSDAY 20 JANUARY 2022

Materials Classification

Session Chair: Juha Röning, University of Oulu (Finland)
10:00 – 11:05

10:00
Conference Introduction

10:05 IRIACV-264
Deep learning based wheat ears count in robot images for wheat phenotyping, *Ehsan Ullah, Mohib Ullah, Muhammad Sajjad, and Faouzi Alaya Cheikh, Norwegian University of Science and Technology (Norway)*

10:25 IRIACV-265
Incremental two-network approach to develop a purity analyzer system for canola seeds, *Kuldeep Singh, Fernando Saccon, and Dileepan Joseph, University of Alberta (Canada)*

10:45 IRIACV-266
Instance segmentation for characterization of satellites on additive manufacturing feedstock powders [Presentation-Only], *Ryan Cohn and Elizabeth Holm, Carnegie Mellon University (United States)*

Active Learning -- Multi-target Tracking -- Model Learning Capabilities

Session Chair: Kurt Niel, University of Applied Sciences Upper Austria (Austria)
11:30 – 12:30

11:30 IRIACV-274
Quantitative analysis of deep learning based multi-target tracking algorithms, *Sanam Nisar Mangi, Mohib Ullah, and Faouzi Alaya Cheikh, Norwegian University of Science and Technology (Norway)*

11:50 IRIACV-275
Leveraging gradient weighted class activation mapping to improve classification effectiveness: Case study in transportation infrastructure characterization, *Thomas P. Karnowski, Deniz Aykac, Regina K. Ferrell, Christy Gambrell, Zach Langford, and Lauren Torkelson, Oak Ridge National Laboratory (United States)*

12:10 IRIACV-276
Deep learning-based multiple animal pose estimation, *Brage Arnkværn, Sigurd Schoeler, Mohib Ullah, and Faouzi Alaya Cheikh, Norwegian University of Science and Technology (Norway)*

Earth Imaging

Session Chair: Henry Ngan, ENPS Hong Kong (Hong Kong)
19:15 – 19:55

19:15 IRIACV-307
Efficient landslide detection by UAV-based multi-temporal visual analysis, *Yosuke Yamaguchi[1], Kai Matsui[1], Jun Ohya[1], Katsuya Hasegawa[2], and Hiroshi Nagahashi[3]; [1]Waseda University, [2]Japan Aerospace Exploration Agency, Institute of Space and Astronautical Science, and [3]Tokyo Institute of Technology (Japan)*

19:35 IRIACV-308
Detecting falling rocks by estimating excavation points using single color markers, *Rei Kobayashi[1], Yoshihiro Sato[1], Masaya Miura[2], Yuto Osada[1], and Yue Bao[1]; [1]Tokyo City University and [2]Tokyu Construction Co., Ltd. (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)