
PROGRAM AND PROCEEDINGS

# Autonomous Vehicles and Machines 2023

Conference Chairs
Patrick Denny, University of Limerick (Ireland)
Peter van Beek, Intel Corporation (US)

This document details the conference program, held as part of the 2023 IS&T International Symposium on Electronic Imaging, 15-19 January 2023. 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.2023.35.16.AVM-A16

# Autonomous Vehicles and Machines 2023

## 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

Auto Sens | ACADEMY

*Paper authors listed as of 1 January 2023; refer to manuscript for final authors. Titles that are not listed with the proceedings files were presentation-only.*

# Autonomous Vehicles and Machines 2023

## MONDAY 16 JANUARY 2023

**Monday 16 January PLENARY: Neural Operators for Solving PDEs**
Session Chair: Robin Jenkin, NVIDIA Corporation (United States)
2:00 PM – 3:00 PM
Cyril Magnin I/II/III

*Deep learning surrogate models have shown promise in modeling complex physical phenomena such as fluid flows, molecular dynamics, and material properties. However, standard neural networks assume finite-dimensional inputs and outputs, and hence, cannot withstand a change in resolution or discretization between training and testing. We introduce Fourier neural operators that can learn operators, which are mappings between infinite dimensional spaces. They are independent of the resolution or grid of training data and allow for zero-shot generalization to higher resolution evaluations. When applied to weather forecasting, neural operators capture fine-scale phenomena and have similar skill as gold-standard numerical weather models for predictions up to a week or longer, while being 4-5 orders of magnitude faster.*

**Anima Anandkumar,** Bren professor, California Institute of Technology, and senior director of AI Research, NVIDIA Corporation (United States)

*Anima Anandkumar is a Bren Professor at Caltech and Senior Director of AI Research at NVIDIA. She is passionate about designing principled AI algorithms and applying them to interdisciplinary domains. She has received several honors such as the IEEE fellowship, Alfred. P. Sloan Fellowship, NSF Career Award, and Faculty Fellowships from Microsoft, Google, Facebook, and Adobe. She is part of the World Economic Forum's Expert Network. Anandkumar received her BTech from Indian Institute of Technology Madras, her PhD from Cornell University, and did her postdoctoral research at MIT and assistant professorship at University of California Irvine.*

**EI 2023 Highlights Session**
Session Chair: Robin Jenkin, NVIDIA Corporation (United States)
3:30 – 5:00 PM
Cyril Magnin II

*Join us for a session that celebrates the breadth of what EI has to offer with short papers selected from EI conferences.*

*NOTE: The EI-wide "EI 2023 Highlights" session is concurrent with Monday afternoon COIMG, COLOR, IMAGE, and IQSP conference sessions.*

IQSP-309
**Evaluation of image quality metrics designed for DRI tasks with automotive cameras,** *Valentine Klein, Yiqi LI, Claudio Greco, Laurent Chanas, and Frédéric Guichard, DXOMARK (France)*

SD&A-224

**Human performance using stereo 3D in a helmet mounted display and association with individual stereo acuity,** *Bonnie Posselt, RAF Centre of Aviation Medicine (United Kingdom)*

IMAGE-281

**Smartphone-enabled point-of-care blood hemoglobin testing with color accuracy-assisted spectral learning,** *Sang Mok Park[1], Yuhyun Ji[1], Semin Kwon[1], Andrew R. O'Brien[2], Ying Wang[2], and Young L. Kim[1]; [1]Purdue University and [2]Indiana University School of Medicine (United States)*

AVM-118

**Designing scenes to quantify the performance of automotive perception systems,** *Zhenyi Liu[1], Devesh Shah[2], Alireza Rahimpour[2], Joyce Farrell[1], and Brian Wandell[1]; [1]Stanford University and [2]Ford Motor Company (United States)*

VDA-403

**Visualizing and monitoring the process of injection molding,** *Christian A. Steinparz[1], Thomas Mitterlehner[2], Bernhard Praher[2], Klaus Straka[1,2], Holger Stitz[1,3], and Marc Streit[1,3]; [1]Johannes Kepler University, [2]Moldsonics GmbH, and [3]datavisyn GmbH (Austria)*

COIMG-155

**Commissioning the James Webb Space Telescope,** *Joseph M. Howard, NASA Goddard Space Flight Center (United States)*

HVEI-223

**Critical flicker frequency (CFF) at high luminance levels,** *Alexandre Chapiro[1], Nathan Matsuda[1], Maliha Ashraf[2], and Rafal Mantiuk[3]; [1]Meta (United States), [2]University of Liverpool (United Kingdom), and [3]University of Cambridge (United Kingdom)*

HPCI-228

**Physics guided machine learning for image-based material decomposition of tissues from simulated breast models with calcifications,** *Muralikrishnan Gopalakrishnan Meena[1], Amir K. Ziabari[1], Singanallur Venkatakrishnan[1], Isaac R. Lyngaas[1], Matthew R. Norman[1], Balint Joo[1], Thomas L. Beck[1], Charles A. Bouman[2], Anuj Kapadia[1], and Xiao Wang[1]; [1]Oak Ridge National Laboratory and [2]Purdue University (United States)*

3DIA-104

**Layered view synthesis for general images,** *Loïc Dehan, Wiebe Van Ranst, and Patrick Vandewalle, Katholieke University Leuven (Belgium)*

ISS-329

**A self-powered asynchronous image sensor with independent in-pixel harvesting and sensing operations,** *Ruben Gomez-Merchan, Juan Antonio Leñero-Bardallo, and Ángel Rodríguez-Vázquez, University of Seville (Spain)*

COLOR-184

**Color blindness and modern board games,** *Alessandro Rizzi[1] and Matteo Sassi[2]; [1]Università degli Studi di Milano and [2]consultant (Italy)*

## TUESDAY 17 JANUARY 2023

**Sensors (T1)**
**Session Chair:** Brian Deegan, National University of Ireland, Galway (Ireland)
9:05 – 9:50 AM
Cyril Magnin I

9:05
**Conference Welcome**

9:30 AVM-122
**How much depth information can radar contribute to a depth estimation model?,** *Chen-Chou Lo and Patrick Vandewalle, Katholieke University Leuven (Belgium)*

**Camera Performance Evaluation (T2)**
**Session Chair:** Patrick Denny, University of Limerick (Ireland)
10:40 AM – 12:40 PM
Cyril Magnin I

10:40 AVM-123
**Update on progress of IEEE P2020 Automotive Image Quality Working Group,** *The IEEE P2020 Working Group[1], Uwe Artmann[2], and Darryl Perks[3]; [1]IEEE Standards Association - P2020 Automotive Image Quality Working Group (United States), [2]presenter (Image Engineering GmbH & Co KG) (Germany), and [3]presenter (onsemi) (United Kingdom)*

11:00 AVM-124
**An investigation into the impact of image compression on image quality prior to image signal processing,** *Jordan Cahill[1], Brian Deegan[2], Patrick Denny[3], Enda Ward[4], Martin Glavin[1], and Edward Jones[1]; [1]University of Galway, [2]National University of Ireland, Galway, [3]University of Limerick, and [4]Valeo Vision Systems (Ireland)*

11:20 AVM-125
**Modulation-transfer function as performance indicator for AI algorithms?,** *Patrick Müller[1] and Alexander Braun[2]; [1]Hochschule Düsseldorf, University of Applied Sciences Düsseldorf and [2]Düsseldorf University of Applied Sciences (Germany)*

11:40 AVM-126
**The influence of image capture and processing on MTF for end of line test and validation,** *Brian Deegan, Martin Glavin, and Edward Jones, University of Galway (Ireland)*

12:00 AVM-127
**Comprehensive stray light (flare) testing: Lessons learned,** *Jackson S. Knappen, Imatest LLC (United States)*

12:20 AVM-128
**Optical flow for autonomous driving: applications, challenges and improvements,** *Shihao Shen[1], Louis Kerofsky[2], and Senthil Yogamani[3]; [1]Carnegie Mellon University (United States), [2]Qualcomm Technologies Inc. (United States), and [3]QT Technologies Ireland Limited (Ireland)*

**Tuesday 17 January PLENARY: Embedded Gain Maps for Adaptive Display of High Dynamic Range Images**
Session Chair: Robin Jenkin, NVIDIA Corporation (United States)
2:00 PM – 3:00 PM
Cyril Magnin I/II/III

*Images optimized for High Dynamic Range (HDR) displays have brighter highlights and more detailed shadows, resulting in an increased sense of realism and greater impact. However, a major issue with HDR content is the lack of consistency in appearance across different devices and viewing environments. There are several reasons, including varying capabilities of HDR displays and the different tone mapping methods implemented across software and platforms. Consequently, HDR content authors can neither control nor predict how their images will appear in other apps.*

*We present a flexible system that provides consistent and adaptive display of HDR images. Conceptually, the method combines both SDR and HDR renditions within a single image and interpolates between the two dynamically at display time. We compute a Gain Map that represents the difference between the two renditions. In the file, we store a Base rendition (either SDR or HDR), the Gain Map, and some associated metadata. At display time, we combine the Base image with a scaled version of the Gain Map, where the scale factor depends on the image metadata, the HDR capacity of the display, and the viewing environment.*

**Eric Chan,** Fellow, Adobe Inc. (United States)

*Eric Chan is a Fellow at Adobe, where he develops software for editing photographs. Current projects include Photoshop, Lightroom, Camera Raw, and Digital Negative (DNG). When not writing software, Chan enjoys spending time at his other keyboard, the piano. He is an enthusiastic nature photographer and often combines his photo activities with travel and hiking.*

**Paul M. Hubel,** director of Image Quality in Software Engineering, Apple Inc. (United States)

*Paul M. Hubel is director of Image Quality in Software Engineering at Apple. He has worked on computational photography and image quality of photographic systems for many years on all aspects of the imaging chain, particularly for iPhone. He trained in optical engineering at University of Rochester, Oxford University, and MIT, and has more than 50 patents on color imaging and camera technology. Hubel is active on the ISO-TC42 committee Digital Photography, where this work is under discussion, and is currently a VP on the IS&T Board. Outside work he enjoys photography, travel, cycling, coffee roasting, and plays trumpet in several bay area ensembles.*

# WEDNESDAY 18 JANUARY 2023

**End-to-end Systems (W2)**
**Session Chair:** Patrick Denny, University of Limerick (Ireland)
11:10 AM – 12:30 PM
Cyril Magnin I

11:10 AVM-110
**tRANSAC: Dynamic feature accumulation across time for stable online RANSAC model estimation in automotive applications,** *Shimiao Li[1], Yang Song[2], Ruijiang Luo[1], Zhongyang Huang[1], and Chengming Liu[1]; [1]OmniVision Technologies (Singapore) and [2]OmniVision Technologies Inc. (United States)*

11:30 AVM-111
**End-to-end evaluation of practical video analytics systems for face detection and recognition,** *Praneet Singh, Edward J. Delp, and Amy R. Reibman, Purdue University (United States)*

11:50 AVM-112
**Orchestration of co-operative and adaptive multi-core deep learning engines,** *Mihir Mody[1], Kumar Desappan[1], Pramod Swami[1], David Smith[1], Shyam Jagannathan[1], Kevin Lavery[1], Gregory Shultz[1], Jason Jones[1], and Jesse Villarreal[2]; [1]Texas Instruments India Ltd (India) and [2]Texas Instruments (United States)*

12:10 AVM-113
**opTIFlow – An optimized end-to-end dataflow for accelerating deep learning workloads on heterogeneous SoCs,** *Shyam Jagannathan[1], Vijay Pothukuchi[2], Jesse Villarreal[2], Kumar Desappan[1], Manu Mathew[1], Rahul Ravikumar[1], Aniket Limaye[1], Mihir Mody[1], Pramod Swami[1], Piyali Goswami[1,3], Carlos Rodriguez[3], Emmanuel Madrigal[3], and Marco Herrera[3]; [1]Texas Instruments India Ltd (India), [2]Texas Instruments (United States), and [3]RidgeRun (United States)*

**Wednesday 18 January PLENARY: Bringing Vision Science to Electronic Imaging: The Pyramid of Visibility**
Session Chair: Andreas Savakis, Rochester Institute of Technology (United States)
2:00 PM – 3:00 PM
Cyril Magnin I/II/III

*Electronic imaging depends fundamentally on the capabilities and limitations of human vision. The challenge for the vision scientist is to describe these limitations to the engineer in a comprehensive, computable, and elegant formulation. Primary among these limitations are visibility of variations in light intensity over space and time, of variations in color over space and time, and of all of these patterns with position in the visual field. Lastly, we must describe how all these sensitivities vary with adapting light level. We have recently developed a structural description of human visual sensitivity that we call the Pyramid of Visibility, that accomplishes this synthesis. This talk shows how this structure accommodates all the dimensions described above, and how it can be used to solve a wide variety of problems in display engineering.*

**Andrew B. Watson,** chief vision scientist, Apple Inc. (United States)

*Andrew Watson is Chief Vision Scientist at Apple, where he leads the application of vision science to technologies, applications, and displays. His research focuses on computational models of early vision. He is the author of more than 100 scientific papers and 8 patents. He has 21,180 citations and an h-index of 63. Watson founded the Journal of Vision, and served as editor-in-chief 2001-2013 and 2018-2022. Watson has received numerous awards including the Presidential Rank Award from the President of the United States.*

## Simulation Methods (W3)

**Session Chair:** Alexander Braun, Düsseldorf University of Applied Sciences (Germany)
3:30 – 5:10 PM
Cyril Magnin I

3:30 AVM-114
**Simulation standards and their impact on the quantification of simulation quality,** *Marius Dupuis, ASAM e.V. (Germany)*

3:50 AVM-116
**Design and validation of a rain model for a realistic automotive simulation environment,** *Tim Brophy[1], Brian Deegan[1], Martin Glavin[1], Javier Salado[2], Ángel Tena[2], Patrick Denny[3], Enda Ward[4], Jonathan Horgan[4], and Edward Jones[1]; [1]University of Galway (Ireland), [2]Anyverse (Spain), [3]University of Limerick (Ireland), and [4]Valeo (Ireland)*

4:10 AVM-117
**Simulating motion blur and exposure time and evaluating its effect on image quality and object detection performance.,** *Hao Lin, University of Galway (Ireland)*

4:30 AVM-118
**Designing scenes to quantify the performance of automotive perception systems,** *Zhenyi Liu[1], Devesh Shah[2], Alireza Rahimpour[2], Joyce Farrell[1], and Brian Wandell[1]; [1]Stanford University and [2]Ford Motor Company (United States)*

4:50 AVM-119
**Design of an automotive platform for computer vision research,** *Dominik Schörkhuber[1], Roman Popp[2], Oleksandr Chistov[3], Fabian Windbacher[4], Michael Hödlmoser[4], and Margrit Gelautz[1]; [1]Vienna University of Technology, [2]ZKW Lichtsysteme, [3]ZKW Group GmbH, and [4]emotion3d (Austria)* [view abstract]