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PROCEEDINGS

Autonomous Vehicles and Machines 2021

Editors: **Patrick Denny**, Valeo (Ireland),
Robin Jenkin, NVIDIA Corporation (United States), and
Peter van Beek, Intel Corporation (United States)

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Autonomous Vehicles and Machines 2021

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.

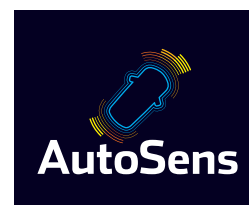
Successfully launched in 2017, Autonomous Vehicles and Machines (AVM) considers a broad range of topics as it relates to equipping vehicles and machines with the capacity to perceive dynamic environments, inform human participants, demonstrate situational awareness, and make unsupervised decisions on 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.

Paper authors listed as of 1 January 2021; refer to manuscript for final authors. Titles that are not listed with the proceedings files were presentation-only.

Conference Chairs: Peter van Beek, Intel Corporation (United States); Patrick Denny, Valeo Vision Systems (Ireland); and Robin Jenkin, NVIDIA Corporation (United States)

Program Committee: Umith Batur, Rivian Automotive (United States); Alexander Braun, University of Applied Sciences Düsseldorf (Germany); Zhigang Fan, Apple Inc. (United States); Ching Hung, NVIDIA Corporation (United States); Dave Jasinski, ON Semiconductor (United States); Darnell Moore, Texas Instruments (United States); Bo Mu, Quanergy, Inc. (United States); Binu Nair, United Technologies Research Center (United States); Dietrich Paulus, Universität Koblenz-Landau (Germany); Pavan Shastry, Continental (Germany); Weibao Wang, Xmotors.ai (United States); and Yi Zhang, Argo AI, LLC (United States)

Conference Sponsor



Autonomous Vehicles and Machines 2021

TUESDAY 19 JANUARY 2021

PLENARY: DEEP INTERNAL LEARNING—DEEP LEARNING WITH ZERO EXAMPLES

Session Chair: Charles Bouman, Purdue University (United States)

10:00 – 11:10

Deep internal learning—Deep learning with zero examples

Michal Irani, professor, Department of Computer Science and Applied Mathematics, Weizmann Institute of Science (Israel)

Michal Irani is a professor at the Weizmann Institute of Science. Her research interests include computer vision, AI, and deep learning. Irani's prizes and honors include the Maria Petrou Prize (2016), the Helmholtz "Test of Time Award" (2017), the Landau Prize in AI (2019), and the Rothschild Prize in Mathematics and Computer Science (2020). She also received the ECCV Best Paper Awards (2000 and 2002), and the Marr Prize Honorable Mention (2001 and 2005).

WEDNESDAY 20 JANUARY 2021

KEYNOTE: IMAGE SENSORS FOR AUTOMOTIVE APPLICATIONS

Session Chair: Robin Jenkin, NVIDIA Corporation (United States)

18:15 – 19:15

18:15

AVM-130

KEYNOTE: Global shutter image sensors for automotive applications, *Boyd Fowler, OmniVision Technologies (United States)*

Keynote speaker Boyd Fowler joined OmniVision in December 2015 as the vice president of marketing. Prior to joining OmniVision, he was co-founder and VP of engineering at Pixel Devices, where he focused on developing high-performance CMOS image sensors. After Pixel Devices was acquired by Agilent Technologies, Fowler was responsible for advanced development of commercial CMOS image sensor products. In 2003, he joined Fairchild Imaging as the CTO and VP of technology, where he developed SCMOS image sensors for high-performance scientific applications. After Fairchild Imaging was acquired by BAE Systems, Fowler was appointed technology director of the CCD/CMOS image sensor business. He has authored numerous technical papers, book chapters, and patents. Fowler received his MS and PhD in electrical engineering from Stanford University (1990 and 1995, respectively).

AUTONOMOUS AUTOMOTIVE DESIGN

Moderator: Peter van Beek, Intel Corporation (United States) / **Session Chair:** Robin Jenkin, NVIDIA Corporation (United States)

19:45 – 20:45

19:45

AVM-113

Single chip auto-valet parking system with TDA4VMID SoC, *Mihir Mody¹, Kedar Chitnis², Hemant Hariyani², Shyam Jagannathan¹, Jason Jones², Gregory Shurtz², Abhishek Shankar², Ankur Baranwai¹, Mayank Mangla², Sriramakrishnan Govindarajan¹, Aish Dubey², and Kai Chirca²; ¹Texas Instruments India Ltd and ²Texas Instruments (India)*

20:05 AVM-114
DRAM bandwidth optimal perspective transform engine, *Mihir Mody¹, Rajasekhar Allu², Gang Hua², Brijesh Jadav¹, Niraj Nandan², Ankur Baranwal¹, and Mayank Mangla²; ¹Texas Instruments India Ltd (India) and ²Texas Instruments Inc (United States)*

20:25 AVM-115
Data collection through translation network based on end-to-end deep learning for autonomous driving, *Zelin Zhang, Waseda Daigaku (Japan)*

THURSDAY 21 JANUARY 2021

PLENARY: THE DEVELOPMENT OF INTEGRAL COLOR IMAGE SENSORS AND CAMERAS

Session Chair: Jonathan B. Phillips, Google Inc. (United States)
10:00 – 11:10

The development of integral color image sensors and cameras
Kenneth A. Parulski, *expert consultant: mobile imaging (United States)*

Kenneth Parulski is an expert consultant to mobile imaging companies and leads the development of ISO standards for digital photography. He joined Kodak in 1980 after graduating from MIT and retired in 2012 as research fellow and chief scientist in Kodak's digital photography division. His work has been recognized with a Technical Emmy and other major awards. Parulski is a SMPTE fellow and an inventor on more than 225 US patents.

OBJECT DETECTION & VISION I

Moderator: Peter van Beek, Intel Corporation (United States) / **Session Chair:** Patrick Denny, Valeo Vision Systems (Ireland)
11:40 – 13:00

11:40 AVM-170
MODETR: Moving object detection with transformers, *Ahmad El Sallab and Eslam Bakr, Valeo (Egypt)*

12:00 AVM-171
GG-Net: Gaze guided network for self-driving cars, *Mohamed Hassan¹, Muhammad Abbas¹, Alaa Osama¹, Dalia Anwar¹, Mostafa Azzam¹, Mohammed Abdelalim Ali¹, Hassan Mostafa¹, Samah Shafiey¹, and Ibrahim Sobh²; ¹Cairo University and ²Valeo (Egypt)*

12:20 AVM-172
Quantitative study of vehicle-pedestrian interactions: Towards pedestrian-adapted lighting communication functions for autonomous vehicles, *Guoqin Zang^{1,2}, Shéhérazade Azouigui², Sébastien Saudrais³, Olivier Peyrico⁴, and Mathieu Heber¹; ¹Université Jean Monnet de Saint Etienne, ²Institut d'Optique Graduate School, ³ESTACA, and ⁴Cité du Design, Saini-Etienne (France)*

12:40 AVM-173
End-to-end imaging system optimization for computer vision in driving automation, *Korbinian Weiki^{1,2}, Damien Schroeder¹, Daniel Blau^{1,2}, Zhenyi Liu³, and Walter Stechele²; ¹BMW Group (Germany), ²Technische Universität München (Germany), and ³Jilin University (China)*

OBJECT DETECTION & VISION II

Session Chair: Robin Jenkin, NVIDIA Corporation (United States)

19:45 – 20:45

19:45

AVM-174

Boosting computer vision performance by enhancing camera ISP, *Peter van Beek, Chyuan-Tyng Wu, and Thomas Gardos, Intel Corporation (United States)*

20:05

AVM-175

Unify the view of camera mesh network to a common coordinate system, *Haney Williams and Steven Simske, Colorado State University (United States)*

20:25

AVM-176

Case study: Optimizing an automotive ISP to maximize object detection accuracy using a HDR sensor, *Doug Taylor and Max Leblond, Algalux (United States)*

MONDAY 25 JANUARY 2021

PLENARY: MAKING INVISIBLE VISIBLE

Session Chair: Jonathan B. Phillips, Google Inc. (United States)

10:00 – 11:10

Making invisible visible

Ramesh Raskar, *associate professor, MIT Media Lab (United States)*

Ramesh Raskar is an associate professor at MIT Media Lab and directs the Camera Culture research group. His focus is on AI and imaging for health and sustainability. They span research in physical (e.g., sensors, health-tech), digital (e.g., automated and privacy-aware machine learning), and global (e.g., geomaps, autonomous mobility) domains. He received the Lemelson Award (2016), ACM SIGGRAPH Achievement Award (2017), DARPA Young Faculty Award (2009), Alfred P. Sloan Research Fellowship (2009), TR100 Award from MIT Technology Review (2004), and Global Indus Technovator Award (2003). He has worked on special research projects at Google [X] and Facebook and co-founded/advised several companies.

AUTOMOTIVE IMAGE QUALITY I

Moderator: Peter van Beek, Intel Corporation (United States) / **Session Chair:** Patrick Denny, Valeo Vision Systems (Ireland)

11:40 – 13:00

11:40

AVM-180

Data driven degradation of automotive sensors and effect analysis, *Sven Fleck and Benjamin May, observer (Germany)*

12:00

AVM-181

FisheyeDistanceNet++: Self-supervised fisheye distance estimation with self-attention, robust loss function and camera view generalization, *Varun Ravi Kumar^{1,2}, Senthil Yogamani³, Stefan Milz², and Patrick Mäder²; ¹Valeo DAR Kronach, ²Technische Universität Ilmenau (Germany), and ³Valeo Vision Systems (Ireland)*

12:20 AVM-182
About the use of incremental SNR (iSNR) as criteria for the SOTIF of in-vehicle integrated camera sensor (Invited), *Christophe Lavergne, Technocentre Renault (France)*

Invited speaker Christophe Lavergne is an image sensor and processing expert with Technocentre Renault, France. Lavergne received his PhD (1991) from Paris-Sud University (Paris XI).

12:40 AVM-183
An analytic-numerical image flicker study to test novel flicker metrics (Invited), *Christian Wittpahl¹, Brian Deegan², Bob Black³, and Alexander Braun¹; ¹Hochschule Dusseldorf (Germany), ²Valeo Vision Systems (Ireland), and ³Independent (United States)*

Invited speaker Christian Wittpahl is a graduate student at the Hochschule (University of Applied Sciences) Düsseldorf, Germany.

ROBOTIC VISION SYSTEMS I

Session Chair: Patrick Denny, Valeo Vision Systems (Ireland)

13:30 – 14:50

13:30 AVM-208
Replacing LiDAR sensors with low-cost computational sensors, *Felix Heide^{1,2} and Max Leblona¹; ¹Algolux (Canada) and ²Princeton University (United States)*

13:50 AVM-209
High precision 3D video streaming for remote autonomous vehicle control, *Yi-Hong Liac¹, Tyler Bell², Brian Acosta¹, Andrew Bowman¹, and Song Zhang¹; ¹Purdue University and ²University of Iowa (United States)*

14:10 AVM-210
RoadEdgeNet: Road edge detection system using surround view camera images, *Ashok Dahi¹, Eric Golab², Rajender Garlapati¹, Varun Ravi Kumar³, and Senthil Yogamani⁴; ¹Valeo DVS Troy, ²University of Michigan (United States), ³Valeo DAR Kronach (Germany), and ⁴Valeo Vision Systems (Ireland)*

14:30 AVM-211
Radiometry and photometry for autonomous vehicles and machines - Fundamental performance limits, *Robin Jenkin and Cheng Zhao, NVIDIA Corporation (United States)*

AUTOMOTIVE IMAGE QUALITY II

Moderator: Peter van Beek, Intel Corporation (United States) / **Session Chair:** Patrick Denny, Valeo Vision Systems (Ireland)

18:15 – 19:15

18:15

AVM-184

Update on progress of IEEE P2020 automotive image quality working group (Invited), Margaret Belska, IEEE Standards Association - P2020 Automotive Image Quality Working Group (United States)

Invited speaker Margaret Belska is the chair of the IEEE Standards Association - P2020 Automotive Image Quality Working Group. Belska previously managed the Customer Camera team at NVIDIA, with an objective of ensuring image quality across all segments employing Tegra Mobile Processors, including mobile, automotive, and embedded. Belska has 20 years' experience in imaging, ranging from space-based scientific cameras to DSLRs and mobile cameras.

18:35

AVM-186

Contrast signal to noise ratio, Robin Jenkin, NVIDIA Corporation (United States)

ROBOTIC VISION SYSTEMS II

Moderator: Peter van Beek, Intel Corporation (United States) / **Session Chair:** Robin Jenkin, NVIDIA Corporation (United States)

20:05 – 20:45

20:05

AVM-213

Evaluation of semi-frozen semi-fixed neural network for efficient computer vision inference, Chyuan-Tyng Wu, Peter van Beek, Phillip Schmidt, Joao Peralta Moreira, and Thomas Gardos, Intel Corporation (United States)

20:25

AVM-214

Design, implementation, and evaluation of a semi-autonomous, vision-based, modular unmanned ground vehicle prototype, Doncey Albin and Steven Simske, Colorado State University (United States)

WEDNESDAY 27 JANUARY 2021

PLENARY: REVEALING THE INVISIBLE TO MACHINES WITH NEUROMORPHIC VISION SYSTEMS: TECHNOLOGY AND APPLICATIONS OVERVIEW

Session Chair: Radka Tezaur, Intel Corporation (United States)

10:00 – 11:10

Revealing the invisible to machines with neuromorphic vision systems: Technology and applications overview
Luca Verre, CEO and co-founder, Prophesee (France)

Luca Verre is co-founder and CEO of Prophesee, the inventor of the world's most advanced neuromorphic vision systems. Verre is a World Economic Forum technology pioneer. His experience includes project and product management, marketing, and business development roles at Schneider Electric. Prior to Schneider Electric, Verre worked as a research assistant in photonics at the Imperial College of London. Verre holds a MSc in physics, electronic and industrial engineering from Politecnico di Milano and Ecole Centrale and an MBA from Institut Européen d'Administration des Affaires, INSEAD.