

# **IS&T International Symposium on Electronic Imaging Science and Technology 2020**

**Autonomous Vehicles and Machines 2020**

**Burlingame, California, USA  
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**Editors:**

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# AUTONOMOUS VEHICLES AND MACHINES 2020

## Monday, January 27, 2020

<b>KEYNOTE: Automotive Camera Image Quality</b>	<b>JOINT SESSION</b>
Session Chair: Luke Cui, Amazon (United States)	
<b>8:45 – 9:30 am</b>	
Regency B	
This session is jointly sponsored by: Autonomous Vehicles and Machines 2020, and Image Quality and System Performance XVII.	
8:45	
<b>Conference Welcome</b>	
8:50	AVM-001
<b>LED flicker measurement: Challenges, considerations, and updates from IEEE P2020 working group</b> , Brian Deegan, senior expert, Valeo Vision Systems (Ireland)...1	

<b>Automotive Camera Image Quality</b>	<b>JOINT SESSION</b>
Session Chair: Luke Cui, Amazon (United States)	
<b>9:30 – 10:10 am</b>	
Regency B	
This session is jointly sponsored by: Autonomous Vehicles and Machines 2020, and Image Quality and System Performance XVII.	
9:30	IQSP-018
<b>A new dimension in geometric camera calibration</b> , Dietmar Wueller, Image Engineering GmbH & Co. KG (Germany)..N/A	
9:50	AVM-019
<b>Automotive image quality concepts for the next SAE levels: Color separation probability and contrast detection probability</b> , Marc Geese, Continental AG (Germany)...6	
10:10 – 10:50 am Coffee Break	

<b>Predicting Camera Detection Performance</b>	<b>JOINT SESSION</b>
Session Chair: Robin Jenkin, NVIDIA Corporation (United States)	
<b>10:50 am – 12:30 pm</b>	
Regency B	
This session is jointly sponsored by: Autonomous Vehicles and Machines 2020, Human Vision and Electronic Imaging 2020, and Image Quality and System Performance XVII.	
10:50	AVM-038
<b>Describing and sampling the LED flicker signal</b> , Robert Sumner, Imatest, LLC (United States)...15	
11:10	IQSP-039
<b>Demonstration of a virtual reality driving simulation platform</b> , Mingming Wang and Susan Farnand, Rochester Institute of Technology (United States)...N/A	

11:30	AVM-040
<b>Fast prediction of contrast detection probability</b> , Robin Jenkin, NVIDIA Corporation (United States)..21	

11:50	AVM-041
<b>Object detection using an ideal observer model</b> , Paul Kane and Orit Skorka, ON Semiconductor (United States)..27	

12:10	AVM-042
<b>Comparison of detectability index and contrast detection probability (JIST-first)</b> , Robin Jenkin, NVIDIA Corporation (United States)..133	

12:30 – 2:00 pm Lunch

<b>PLENARY: Frontiers in Computational Imaging</b>
Session Chairs: Radka Tezaur, Intel Corporation (United States) and Jonathan Phillips, Google Inc. (United States)
<b>2:00 – 3:10 pm</b>
Grand Peninsula Ballroom D
<b>Imaging the Unseen: Taking the First Picture of a Black Hole</b> , Katie Bouman, assistant professor, Computing and Mathematical Sciences Department, California Institute of Technology (United States)..N/A

3:10 – 3:30 pm Coffee Break

<b>KEYNOTE: Visibility</b>
Session Chair: Robin Jenkin, NVIDIA Corporation (United States)
<b>3:30 – 4:10 pm</b>
Regency B
AVM-057
<b>The automated drive west: Results</b> , Sara Sargent, engineering project manager, VSI Labs (United States)...N/A

<b>Visibility</b>	
Session Chair: Robin Jenkin, NVIDIA Corporation (United States)	
<b>4:10 – 5:10 pm</b>	
Regency B	
4:10	AVM-079
<b>VisibilityNet: Camera visibility detection and image restoration for autonomous driving</b> , Hazem Rashed, Senthil Yogamani, and Michal Uricar, Valeo Group (Egypt)..33	
4:30	AVM-080
<b>Sun-glare detection using late fusion of CNN and image processing operators</b> , Lucie Yahiaoui and Senthil Yogamani, Valeo Vision Systems (Ireland)...40	

4:50 AVM-081  
**Single image haze removal using multiple scattering model for road scenes**, Minsub Kim, Soonyoung Hong, and Moon Gi Kang, Yonsei University (Republic of Korea)...48

5:00 – 6:00 pm All-Conference Welcome Reception

## Tuesday, January 28, 2020

7:30 – 8:45 am Women in Electronic Imaging Breakfast; pre-registration required

### KEYNOTE: Human Interaction

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

**8:50 – 9:30 am**  
 Regency B

**Regaining sight of humanity on the roadway towards automation**, Mónica López-González, La Petite Noiseuse Productions (United States)...53 AVM-088

### Human Interaction

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

**9:30 – 10:30 am**  
 Regency B

9:30 AVM-109  
**VRUNet: Multitask learning model for intent prediction of vulnerable road users**, Adithya Pravarun Reddy Ranga<sup>1</sup>, Filippo Giruzzi<sup>2</sup>, Jagdish Bhanushali<sup>3</sup>, Emilie Wirbel<sup>3</sup>, Patrick Pérez<sup>4</sup>, Tuan-Hung Vu<sup>5</sup>, and Xavier Perrotton<sup>3</sup>; <sup>1</sup>Valeo NA Inc. (United States), <sup>2</sup>MINES Paristech (France), <sup>3</sup>Valeo France (France), and <sup>4</sup>Valeo.ai (France)...61

9:50 AVM-108  
**Multiple pedestrian tracking using Siamese random forests and shallow convolutional neural networks**, Jimi Lee, Jaeyeal Nam, and ByoungChul Ko, Keimyung University (Republic of Korea)..57

10:10 AVM-110  
**End-to-end multitask learning for driver gaze and head pose estimation**, Marwa El Shawarby<sup>1</sup>, Mahmoud Ewaisha<sup>1</sup>, Hazem Abbas<sup>1</sup>, and Ibrahim Sobh<sup>2</sup>; <sup>1</sup>Ain Shams University and <sup>2</sup>Valeo Group (Egypt)...70

10:00 am – 7:30 pm Industry Exhibition - Tuesday

10:10 – 10:50 am Coffee Break

### KEYNOTE: Quality Metrics

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

**10:50 – 11:30 am**  
 Regency B

**Automated optimization of ISP hyperparameters to improve computer vision accuracy**, Doug Taylor, Avinash Sharma, Karl St. Arnaud, and Dave Tokic, Algolux (Canada)...N/A AVM-124

### Quality Metrics

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

**11:30 am – 12:30 pm**  
 Regency B

11:30 AVM-148  
**Using the dead leaves pattern for more than spatial frequency response measurements**, Uwe Artmann, Image Engineering GmbH & Co. KG (Germany)...75

11:50 AVM-149  
**Simulating tests to test simulation**, Patrick Müller, Matthias Lehmann, and Alexander Braun, Düsseldorf University of Applied Sciences (Germany)...80

12:10 AVM-150  
**Validation methods for geometric camera calibration**, Paul Romanczyk, Imatest, LLC (United States)...87

12:30 – 2:00 pm Lunch

### PLENARY: Automotive Imaging

Session Chairs: Radka Tezaur, Intel Corporation (United States) and Jonathan Phillips, Google Inc. (United States)

**2:00 – 3:10 pm**

Grand Peninsula Ballroom D

**Imaging in the Autonomous Vehicle Revolution**, Gary Hicok, senior vice president, hardware development, NVIDIA Corporation (United States)...N/A

3:10 – 3:30 pm Coffee Break

**PANEL: Sensors Technologies for Autonomous Vehicles** JOINT SESSION

Panel Moderator: David Cardinal, Cardinal Photo & Extremetech.com (United States)

Panelists: Sanjai Kohli, Visible Sensors, Inc. (United States); Nikhil Naikal, Velodyne Lidar (United States); Greg Stanley, NXP Semiconductors (United States); Alberto Stochino, Perceptive Machines (United States); Nicolas Touchard, DXOMARK (France); and Mike Walters, FLIR Systems (United States)

**3:30 – 5:30 pm**

Regency A

This session is jointly sponsored by: Autonomous Vehicles and Machines 2020, and Imaging Sensors and Systems 2020.

Imaging sensors are at the heart of any self-driving car project. However, selecting the right technologies isn't simple. Competitive products span a gamut of capabilities including traditional visible-light cameras, thermal cameras, lidar, and radar. This session includes experts in all of these areas, and in emerging technologies, who will help attendees understand the strengths, weaknesses, and future directions of each. Presentations are followed by a panel discussion. Introduction, David Cardinal, consultant and technology journalist (United States); LiDAR for Self-driving Cars, Nikhil Naikal, VP of software engineering, Velodyne Lidar (United States); Challenges in Designing Cameras for Self-driving Cars, Nicolas Touchard, VP of marketing, DXOMARK (France); Using Thermal Imaging to Help Cars See Better, Mike Walters, VP of product management for thermal cameras, FLIR Systems, Inc. (United States); Radar's Role, Greg Stanley, field applications engineer, NXP Semiconductors (the Netherlands); Tales from the Automotive Sensor Trenches, Sanjai Kohli, CEO, Visible Sensors, Inc. (United States); Auto Sensors for the Future, Alberto Stochino, founder and CEO, Perceptive (United States)

Biographies and/or abstracts are found on pages 15–21

5:30 – 7:30 pm Symposium Demonstration Session

**Wednesday, January 29, 2020**

**Data Collection and Generation**

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

**8:50 – 10:10 am**

Regency B

8:50

AVM-200

**A tool for semi-automatic ground truth annotation of traffic videos,** Florian Groh, Margrit Gelautz, and Dominik Schörkhuber, TU Wien (Austria)...92

9:10

WITHDRAWN AVM-201

**A low-cost approach to data collection and processing for autonomous vehicles with a realistic virtual environment,** Victor Fernandes<sup>1</sup>, Verônica Silva<sup>2</sup>, and Thais Rêgo<sup>1</sup>; <sup>1</sup>Federal University of Paraíba and <sup>2</sup>Ufersa (Brazil)...N/A

9:30

AVM-202

**Metrology impact of advanced driver assistance systems,** Paola Iacomussi, INRIM (Italy)...98

9:50

AVM-203

**A study on training data selection for object detection in nighttime traffic scenes,** Astrid Unger<sup>1,2</sup>, Margrit Gelautz<sup>1</sup>, Florian Seitner<sup>2</sup>, and Michael Hödlmoser<sup>2</sup>; <sup>1</sup>TU Wien and <sup>2</sup>Emotion3D (Austria)...103

10:00 am – 3:30 pm Industry Exhibition - Wednesday

10:10 – 10:50 am Coffee Break

**Psychophysics and LED Flicker Artifacts** JOINT SESSION

Session Chair: Jeffrey Mulligan, NASA Ames Research Center (United States)

**10:50 – 11:30 am**

Regency B

This session is jointly sponsored by: Autonomous Vehicles and Machines 2020, and Human Vision and Electronic Imaging 2020.

10:50

HVEI-233

**Predicting visible flicker in temporally changing images,** Gyorgy Denes and Rafal Mantiuk, University of Cambridge (United Kingdom)...N/A

11:10

HVEI-234

**Psychophysics study on LED flicker artefacts for automotive digital mirror replacement systems,** Nicolai Behmann and Holger Blume, Leibniz University Hannover (Germany)...N/A

**Multi-Sensor**

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

**11:30 am – 12:30 pm**

Regency B

11:30

AVM-255

**Multi-sensor fusion in dynamic environments using evidential grid mapping,** Dilshan Godaliyadda, Vijay Pothukuchi, and JuneChul Roh, Texas Instruments (United States)...108

11:50

AVM-257

**LiDAR-camera fusion for 3D object detection,** Darshan Ramesh Bhanushali, Robert Relyea, Karan Manghi, Abhishek Vashist, Clark Hochgraf, Amlan Ganguly, Michael Kuhl, Andres Kwasinski, and Ray Ptucha, Rochester Institute of Technology (United States)...114

12:10

AVM-258

**Active stereo vision for precise autonomous vehicle control,** Song Zhang and Michael Feller, Purdue University (United States)...122

12:30 – 2:00 pm Lunch

**PLENARY: VR/AR Future Technology**

Session Chairs: Radka Tezaur, Intel Corporation (United States) and Jonathan Phillips, Google Inc. (United States)

**2:00 – 3:10 pm**

Grand Peninsula Ballroom D

**Quality Screen Time: Leveraging Computational Displays for Spatial Computing**, Douglas Lanman, director, Display Systems Research, Facebook Reality Labs (United States)...N/A

3:10 – 3:30 pm Coffee Break

**KEYNOTE: Image Processing**

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

**3:30 – 4:10 pm**

Regency B

AVM-262

**Deep image processing**, Vladlen Koltun, chief scientist for Intelligent Systems, Intel Labs (United States)...N/A

**Image Processing**

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

**4:10 – 5:30 pm**

Regency B

4:10 AVM-296

**End-to-end deep path planning and automatic emergency braking camera cocoon-based solution**, Mohammed Abdou and Eslam Bakr, Valeo Group (Egypt)...N/A

4:30 AVM-297

**Federated semantic mapping and localization for autonomous driving**, Ravi Kiran<sup>1</sup> and Senthil Yogamani<sup>2</sup>; <sup>1</sup>Navya (France) and <sup>2</sup>Valeo Vision Systems (Ireland)...N/A

4:50 AVM-298

**Progress on the AUTOSAR adaptive platform for intelligent vehicles**, Keith Derrick, AUTOSAR (Germany)...N/A

5:10 AVM-299

**Object tracking continuity through track and trace method**, Haney Williams and Steven Simske, Colorado State University (United States)...127

5:30 – 7:00 pm EI 2020 Symposium Interactive Posters Session

5:30 – 7:00 pm Meet the Future: A Showcase of Student and Young Professionals Research