# Special Section Guest Editorial: Autonomous Vehicles

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The Special Section on Autonomous Vehicles (AVs) includes works that will contribute to the advancement and adoption of AVs and Advanced Driver Assistance Systems (ADAS). Sensors and data processing architectures to convert sensor data into information are critical for developing automated systems to assist human drivers or to take over the task of driving. These technologies will save many lives. According to the Association for Safe International Vehicle Travel, more than 46,000 people die in car crashes each year in the U.S. alone. The U.S. traffic fatality rate is 12.4 deaths per 100,000 inhabitants, and globally, 1.35 million people are killed on roadways each year, according to World Health Organization statistics. In the U.S. over 5 million vehicle accidents also lead to injury, property damage, and lost productivity. AV and ADAS technologies are also applicable to other technology areas such as agriculture, industrial robotics, healthcare, and security for increasing efficiency, and automating routine tasks while reducing human exposure to hazards. Similarly, AV technologies are also expected to improve our quality of life by providing assistance through autonomous personal robots, especially for the disabled and elderly.

The human brain is a wonderful processor and has done a great job of keeping people relatively safe while driving for over 100 years. However, as we all know humans can be bored or distracted, and our senses are also imperfect. Meanwhile, ADAS and autonomous vehicles make use of an array of precision sensors: visible cameras, radar, and lidar, as well as potentially ultrasonic sensors and thermal imaging sensors. These sensors, dominated by optical technologies, together with advances in perception and behavior prediction algorithms stand poised to drastically improve safety and improve our lives.

This special section has significant importance to the community, owing to SPIE's long commitment to supporting the dissemination of research in the area of autonomous vehicles and systems. What may be the society's first talk on the topic, specifically on robotic stereo vision for planetary rovers, was given in 1977. Conferences specifically dedicated to these systems have been a staple of SPIE Defense and Security, Defense and Commercial Sensing, and other SPIE conferences for over 40 years. It is this long history and SPIE's role that inspired this special section in the society's flagship journal.

The effects of weather on AV and ADAS systems continue to be an active area of research, a fact reinforced by three papers in this section. The first paper uses open winter driving datasets to train a neural net to detect the drivable path when the road surface is occluded by ice and snow. The second describes a 36 Terabyte, multimodal, winter driving data set featuring severe winter weather, likely the first of its kind. A third describes a technique for estimating depth from a single camera in fog. This section also includes papers on new sensing technologies, including change detection sensors and techniques for improving lidars by modeling or the use of new materials. Lidar is also the subject of two more introspective papers, the first, by Holzhüter et al., reviews aspects of lidar design in automotive applications. The second, by Jeffries et al., details the results of an SPIE-sponsored AV lidar data collection aimed at the development of standards for these devices. Improvements to AV/ADAS perception tasks like pedestrian detection using camera arrays and thermal imagers are the subject of the last two papers in the section.

Altogether, this successful special section contains twelve papers, and we hope it will encourage other researchers to publish their work in future issues of *Optical Engineering*.