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Signal Processing for Smart Vehicle Technologies

The invention of the automobile has transformed how people live, work, and interact in society. Today, with an ever-increasing number of in-vehicle options/activities, as well as the increasing demands being placed on the driver, vehicle platform, and transportation infrastructure, more is being asked of engineers, designers, scientists, and transportation specialists. Signal processing is playing an increasingly substantial role in this domain, including such general topics as monitoring driver distraction, vehicle lane/control detection/tracking, driver assistance through autonomous platforms, and vehicle infrastructure support and planning/monitoring. The diversity of these problems requires a more collaborative effort from engineers and scientists in a diverse set of specialties. The impact to society is massive, including such broad aspects as 1) safety, 2) commerce (i.e., sales and support/maintenance of vehicles), 3) energy costs (i.e., fossil fuel consumption, etc.), and 4) population mobility for effective traffic management. How will signal processing advance today's vehicles into "smart" cars that are able to think and contribute to the task of operating a vehicle? What safety concerns are there in moving from a 100% driver-controlled vehicle, to driver assistive technologies (e.g., cruise control, assistive braking, lane-departure monitoring, etc.), to full autonomous driving? Many new and emerging challenges arise and need to be addressed in collaborative ways.

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This special issue provides a venue for summarizing, educating, and sharing the state of the art in signal processing applied to the domain of automotive systems. Due to the significance of this topic from both an engineering/technology as well as a global society perspective, this special issue of *IEEE Signal Processing Magazine* will appear in two parts (part 1 is the current issue, and part 2 is scheduled to be published in the spring of 2017). Highlighted below is the scope of topics addressed in varying degrees by the articles that are explored in both parts:

- digital signal processing technologies in adaptive automobiles, diagnosis, and maintenance
- speech, hands-free, and in-car communication algorithms and evaluation
- in-vehicle dialog systems and human-machine interfaces
- driver-status monitoring and distraction/stress detection
- computer vision methods for vehicle recognition and assisted driving
- multisensor fusion for driver identification and robust driver monitoring
- signal processing for position and velocity estimation and control
- signal processing for green vehicle-related energy management
- vehicle-to-vehicle and vehicle-to-infrastructure communications and networking
- autonomous, semiautonomous, and networked vehicular control
- human factors and cognitive science in enhancing vehicle and driver safety
- machine learning and data analytics associated with automotive systems
- issues regarding security and privacy aspects for smart vehicle systems.

In planning this special issue, we worked extensively to ensure a wide representation of the field. A large number of white papers were received, and the authors of a select set of white papers were invited to submit full papers that were then peer reviewed.

Six articles appearing in the current issue span a broad range of signal processing for vehicle systems. The first group contains three articles that address driver behavior and monitoring: "Driver-Behavior Modeling Using On-Road Driving Data," by Miyajima and Takeda, "Driver Status Monitoring Systems for Smart Vehicles Using Physiological Sensors" by Choi et al., and "Smart Driver Monitoring: When Signal Processing Meets Human Factors" by Aghaei at al. Next, Weng et al.'s article, "Conversational In-Vehicle Dialog

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Systems," explores past, present, and future trends. Since speech interaction and audio are underutilized modalities for driver interaction, this represents an important emerging trend in the field. Samarasinghe et al. focus on advancements in active noise control within car environments in their article "Recent Advances in Active Noise Control Inside Automobile Cabins." Finally, Hult et al.'s article, "Coordination of Cooperative Autonomous Vehicles," focuses on the ability to effectively coordinate autonomous vehicles within the transportation system.

We would like to encourage readers to explore these articles, as well as the field of signal processing for vehicle technologies, since the prospects for growth and impact on safety, legal, and social aspects are enormous Finally, from a purely cognitive standpoint, we ask that all drivers be aware of the impact of cognitive load in employing any technologies during their driving tasks (e.g., please, no texting while driving). We look forward to bringing you the next installment of this special issue in the spring of 2017. Happy reading (and driving)!

Guest Editors

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Gerhard U. Schmidt (gus@tf.uni-kiel.de) received the Dipl.-Ing. degree in 1996 and the Dr.-Ing. degree in 2001, both from the Darmstadt University of Technology, Germany. He has worked with the research groups of the Acoustic Signal Processing Department, Harman/Becker Automotive Systems, and at SVOX, Ulm, Germany. Parallel to his time at SVOX, he was a part-time professor with the Darmstadt University of Technology. Since 2010, he has been a full professor with Kiel University, Germany. His main research interests include adaptive methods for audio and medical signal processing.

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