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Special Issue on the 2013 IEEE Intelligent Vehicles Symposium & Workshop

It was not long ago when the first modern automobile was invented, enabling the then society to experience and enjoy the "auto-mobility" concept for the very first time. Since then, the end-user's "auto-mobility" appetite has grown significantly influencing a number of transformational advances in both the automobile design and driving pleasure.

Today's societal needs and demands for high and safe mobility, as well as more comfortable ride, are greater than ever before and extremely versatile. This stipulated not just a significant rise in intelligent vehicles research but also the rise in the versatility of the "auto-mobility" functionalities that contemporary automobiles are able and expected to offer. And indeed, the Program Scope of the 2013 IEEE Intelligent Vehicles Symposium was a true reflection of this trend as it addressed a spectrum of intelligent solutions from those offering an intelligent assisted driving to those enabling vehicles to perform an "auto-drive" this time on its own, with no interventions from human beings, i.e. autonomous driving in complex urban road traffic situations.

The 2013 IEEE Intelligent Vehicles Symposium (IEEE-IV'13) was held in the City of Gold Coast, Australia, from 23 June to 26 June 2013. The Intelligent Vehicles Workshop sessions were also part of the Symposium and were held on 22 June 2013. The Symposium, together with its Workshops, attracted 320 paper submissions (288 submissions to the Symposium and 32 submissions to Workshops). A total of 232 papers were accepted and included in the Symposium program (206 Symposium papers and 26 Workshop papers).

In recognition of the quality of its papers, the Symposium was invited to this Special Issue of the *ITS Magazine*. After the Symposium, eight symposium and workshop papers were initially invited to this Special Issue based on the scores obtained and comments received from the IEEE-IV'13 Reviewers, and the Best Paper Award Committee members. The authors of each of those eight papers were requested to submit extended versions of their papers within the given time frame. Seven symposium and workshop papers were then received and all underwent a rigorous review and revision process conducted by the Special Issue Editors and their reviewers. Finally, five papers met the paper review criteria within the given

time frame as set by the Magazine Publisher. These five papers are therefore included in this special issue and are co-authored by researchers from Australia, Germany and Spain.

The paper co-authored by a number of researchers from Daimler AG, Research & Development, Forschungszentrum Informatik (FZI) and Karlsruhe Institute of Technology, all from Germany, entitled "The Bertha Benz Memorial Route—An Autonomous Journey", elaborates on the experience obtained from autonomous driving by the Mercedes Benz S-Class S 500 INTELLIGENT DRIVE along the road route from Mannheim to Pforzheim, Germany (a historical Bertha Benz Memorial Route). The autonomous vehicle was equipped with close-to-market sensor hardware and relied solely on vision and radar sensors in combination with accurate digital maps to obtain a comprehensive understanding of complex traffic situations. The historic Bertha Benz Memorial Route is particularly challenging for autonomous driving. The course taken by the autonomous vehicle had a length of 103 km and covered rural roads, 23 small villages and major cities (e.g. downtown Mannheim and Heidelberg). The route posed a large variety of difficult traffic scenarios including intersections with and without

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traffic lights, roundabouts, and narrow passages with oncoming traffic. The autonomous vehicle had to respond to a variety of objects including parked vehicles, preceding and oncoming vehicles, bicycles, pedestrians and trams. The paper gives an overview of the autonomous vehicle and presents details on vision and radar-based perception, digital road maps and video-based self-localization, as well as motion planning in complex urban scenarios.

The paper co-authored by Daniel Meissner, Stephan Reuter, Elias Strigel and Klaus Dietmayer, all with the Ulm University Germany, entitled "Intersection-Based Road User Tracking Using a Classifying Multiple-Model PHD Filter", offers a multiple sensors-based algorithm for a safe intersection crossing. Currently, the number of fatal accidents involving pedestrians and motorbikes at urban intersections is increasing. Therefore, an intersection-based perception system provides a dynamic model of the intersection scene to the vehicles. Based on that, the intersection perception facilitates to discriminate occlusions which are expected to significantly reduce the number of accidents at intersections. Therefore this contribution presents a general purpose multi-sensor tracking algorithm, the classifying multiple model probability hypothesis density (CMMPHD) filter, which facilitates the tracking and classification of relevant objects using a single filter. Due to the different motion characteristics, a multiple-model approach is required to obtain accurate state estimates and persistent tracks for all types of objects. Additionally, an extension of the PHD filter to handle contradictory measurements

of different sensor types based on the Dempster-Shafer theory of evidence is proposed. The performance of tracking and classification is evaluated using real world sensor data of a public intersection.

In their paper on "Fault Detection for Vehicular Ad Hoc Wireless Networks", Stewart Worrall, Gabriel Agamennoni, James Ward and Eduardo Nebot, all with the University of Sydney Australia, introduce a technique for fault detection in mobile ad hoc networks by comparing collected data indicating the ability to communicate with a probabilistic model generated by analyzing data collected from a fleet of vehicles. An increasing number of intelligent transportation applications require robust and reliable wireless ad hoc communication. The process of communicating using radio requires a series of software and hardware modules to be functioning correctly. For many, vehicle safety and automation applications communication is relied upon to the point where undetected faults can result in potentially dangerous situations, for example if a warning cannot be given in time to prevent a collision. The consequence of problems with any of the network components can be a partial or complete loss of radio communication. Generally, most systems will consider network failure when there is no communication, but this overlooks problems where a partial fault causes degradation in the communication performance. There is a fundamental requirement to detect and respond to the partial failure of a network to ensure that communication is not intermittent, or performs poorly after a certain range. The partial loss of communication is difficult to detect, and is often overlooked in mobile ad hoc network applications. This paper introduces a novel method for model-

ing the antenna performance using collected data, and using the model to determine the probability that an antenna has some level of performance degradation.

The "Impact of an Anticipatory Eco-Driver Assistant System in Different Complex Driving Situations on the Driver Behavior" is discussed in the paper by Christoph Rommerskirchen, Magnus Helmbrecht and Klaus Bengler, all with the TU München Germany, which is included in this Special Issue under the same title. The anticipatory advanced driver assistance system (ADAS) developed at the Institute of Ergonomics at the TU München assists to reduce the individual fuel consumption of each driver by anticipating earlier. The goal is to achieve improvements in as many road situations as possible. The paper gives an overview on the different options to support the driver to reduce its fuel consumption. Then it discusses the possibilities of an extension of anticipation to support the driver in eco-driving. Related work shows that anticipatory advanced driver assistance systems help to save fuel, but they focus on the general potentials of the system. The presented study in this paper, however, deals with the question of the impact of different road traffic situations on an anticipatory driver assistance system. Different traffic scenarios were chosen and varied in its complexity to evaluate the impact of the complexity of different driving situations on an anticipatory ADAS. A driving simulator study was conducted with 27 participants. The results showed that the fuel consumption is reduced with the assistant system due to earlier and better reaction but that there is no influence of the complexity of different driving situations. The influence of the situation on the driver in their use of the ADAS can be shown by their visual behavior. The percentage of the gaze time on the human machine interface (HMI) on the system is significantly reduced in the more complex situations.

A considerable research into, and a number of industrial developments of, the Intelligent Parking Assist Systems have so far taken place, including both the assistance and automatic parking approaches. Most of these systems have been designed to assist the driver when parking in parallel, perpendicular or angle parking lots. However, the development of intelligent systems designed to assist the driver when leaving the parking lots has been somewhat neglected in the literature. This issue is now addressed and discussed in the paper by David Fernández-Llorca, Iván García-Daza, Sergio Álvarez, Agustín Martínez-Hellín and Miguel Ángel Sotelo (all with the University of Alcalá, Spain), entitled "Parking Assistance System for Leaving Perpendicular Parking Lots: Experiments in Daytime/ Nighttime Conditions". Backing-out and heading-out manoeuvres in perpendicular or angle parking lots are one of the most dangerous manoeuvres, especially in cases where side parked cars block the driver view of the potential traffic flow. In this paper a new vision based Advanced Driver Assistance System (ADAS) is proposed to automatically warn the driver in such scenarios. A monocular gray-scale camera was installed at the back-right side of a vehicle. A Finite State Machine (FSM), defined according to three CANBus variables

and a manual signal, provided by the user is used to handle the activation/ deactivation of the detection module. The proposed oncoming traffic detection module computes spatiotemporal images from a set of pre-defined scan-lines which are related to the position of the road. A novel spatio-temporal motion descriptor is proposed (STHOL) accounting for the number of lines, their orientation and length of the spatio-temporal images. Some parameters of the proposed descriptor are adapted for night time conditions. A Bayesian framework is then used to trigger the warning signal using multivariate normal density functions. Experiments are conducted on image data captured from a vehicle parked at different locations of an urban environment, including both daytime and night time lighting conditions. The authors demonstrate that the proposed approach provides robust results maintaining processing rates close to real-time.

The IEEE-IV2013 Symposium and, thus, the papers in this special issue, has demonstrated that an interdisciplinary approach is necessary in order to progress the intelligent vehicles research to the next qualitative stage, since the contemporary intelligent vehicles challenge falls outside the boundaries of a single scientific discipline.

The editors of this special issue are indebted to co-authors of the spe-

cial issue papers for their contributions, and strongly believe that this issue will inspire the future quality research into, and deployment of, the intelligent vehicle concepts and related technologies. The great social benefit from the intelligent vehicles research is in inspiring us to innovate towards enhancing people's lives and making it qualitatively better for much more people than ever before.

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PRESIDENT'S MESSAGE *(continued from page 4)*

where certainly ITSS can play a key role. I encourage all ITSS members to get involved in these different initiatives based on your interests; it is one of the best ways to stay connected with other IEEE members and areas.

Matt Barth
President IEEE ITSS, 2014–2015

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