Editorial for special issue on Perception and Navigation for Autonomous Vehicles

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Special Issue on Perception and Navigation for Autonomous Vehicles

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Editorial

This Special Issue of the IEEE Robotics and Automation Magazine has been prepared in the scope of the activities of the Technical Committee on "Autonomous Ground Vehicle and Intelligent Transportation System" (AGV-ITS) (http://www.ieee-ras.org/autonomous-ground-vehicles-and-intelligent-transportation-systems) of the IEEE Robotics and Automation Society (IEEE RAS).

Its purpose is to address topics related to the challenging problems of autonomous navigation and of driving assistance in open and dynamic environments. Technologies related to application fields such as unmanned outdoor vehicles or intelligent road vehicles are considered from both the theoretical and technological point of views. Several research questions located on the cutting edge of the state of the art are addressed. Among the many application areas that robotics is addressing, individual mobility and mass transportation seem to be domains that will dramatically benefit from intelligent automation. Autonomous driving is emerging as the approach to dramatically improve efficiency while at the same time leading to the ultimate goal of zero fatalities. Clearly robotics technologies are at the very core of this major shift in the automobile paradigm.

Most of the 15 papers which have been submitted for this IEEE-RAM Special Issue are coming from speakers or active participants of the series of workshop organized by the IEEE RAS Technical Committee AGV-ITS on the hot topic of "Planning, Perception and Navigation for Intelligent Vehicles". Among these submitted papers, only 5 of them have been accepted for publication in this Special Issue after a two rounds review process.

The 1st edition PPNIV'07 of this series of workshops was held in Roma during ICRA'07 (around 60 attendees), the second PPNIV'08 was in Nice during IROS'08 (more than 90 registered people), the third PPNIV'09 was in Saint-Louis (around 70 attendees) during IROS'09, the fourth edition PPNIV'12 was in Vilamoura (over 95 attendees) during IROS'12, and the fifth edition PPNIV'13 was in Tokyo during IROS'13 (over 135 attendees) where two best papers were awarded. In parallel, several workshops closer to some other robotics issues have been organized such as SNODE'07 in San Diego during IROS'07 (around 80 attendees), SNODE'09 in Kobe during ICRA'09 (around 70 attendees), and RITS'10 in Anchrorage during ICRA'10 (around 35 attendees), and the last one PNAVHE11 in San Francisco during IROS'11 (around 50 attendees).

The subject of this Special Issue has been both motivated by the unprecedented technical advances obtained in the field of Intelligent Vehicles during the last decade, and to the currently favorable socio-economic context. After the success of the DARPA Urban Challenge in 2007, the Google Car project has shown the potential feasibility of the Driverless Car concept in some real traffic conditions; it has also pushed some State Governmental Authorities in USA to modify the legislation in order to make it possible to experiment such vehicles on normal roads. Several other challenges in the world such as the GCDC (Grand Cooperative Driving Challenge) in 2011 or the VIAC (VisLab Intercontinental Autonomous Challenge) in 2010 have also contributed to the dissemination of the Autonomous Driving

Concept and to its experimental validation in some realistic traffic conditions. For instance, the four driverless vehicles of the VIAC covered almost 16000 kilometers from Parma in Italy to Shanghai in China on various roads, by moving autonomously in a platoon during a 3 months race (http://viac.vislab.it/).

Thanks to all these recent technical advances and mediatised events, the Automotive industry is more and more interested in these new technologies and several commercial announcements have recently been done (for instance by Nissan, Toyota, or Tesla); in the same way, several Governments in the world (for instance in Japan, Korea, USA, or France) are now pushing for the industrial development of such technologies in their countries.

However, social acceptance and legislation still remains a main barrier to the deployment of such a new technology, even if several thousands of kilometers in autonomous driving mode have been already been demonstrated all over the word.

This special issue includes five papers respectively addressing five complementary topics in the field of multi-vehicle control, dynamic environment perception, vision under bad weather conditions, GNSS based localization, and motion planning.

The first paper entitled "***Adaptive and predictive formation control of autonomous vehicles: application to mobile robot cooperation***" deals with the modeling and the control of a fleet of mobile robots operating in formation using adaptive and predictive control and enabling to account for the influence of several phenomena (such as dynamic perturbations or bad grip conditions).

The second paper entitled "***Advances in the Bayesian Occupancy Filter framework using robust motion detection technique for dynamic environment monitoring***" reports the recent advances in the Bayesian Occupancy Filter paradigm which provides a framework for robust grid-based monitoring of dynamic environments. This approach allows the perception system to estimate dynamic grids, containing both probabilistic information of occupancy and velocity. The paper shows how a large number of false detection can be avoided by first classifying the grid cells as "probabilistically static" or "probabilistically dynamic". Then, the clustering step provides in a more robust way the detected moving objects of the observed scene.

The third paper entitled "***Unfocused Raindrops Detection for In-Vehicle Multipurpose Cameras***" shows one example solving important issues when visual perception is evolving in raining condition. Obviously, this work may extend the working condition of a conventional ADAS (Advanced Driver Assistance Systems).

The Fourth paper entitled "***GNSS autonomous localization: Non-Line-Of-Sight satellite detection based on digital 3D maps of city environments***" focus on GNSS autonomous localization. It is well known that such systems are not working well when evolving in inner cities. The main problem is to be able to analyze on line the reliability of the system by using the knowledge of 3D maps when receiving the satellite signals.

The last and fifth paper entitled "***Model-Predictive Motion Planning for Autonomous Mobile Robots***" proposes recent advances in motion planning using Model-Predictive Motion Planning techniques.