Introduction to the Special Issue on Unmanned Intelligent Vehicles in China

THE goal of this special issue is to present some recent advances in ongoing research of unmanned intelligent vehicles in China. Recently, unmanned intelligent vehicles have attained much attention in the world. Many companies, institutions, and universities are taking great efforts to research and develop various types of unmanned intelligent vehicles and related technologies. In 2008, the National Natural Science Foundation of China (NSFC) started a major research plan, Cognitive Computing of Visual and Auditory Information, in which the unmanned intelligent vehicle is chosen as the physical verification platform of scientific issues. Furthermore, in order to promote the original innovations of this major research plan and to make better progress in the research and development of unmanned intelligent vehicles, the Intelligent Vehicle Future Challenge (IVFC) has been launched and held annually in China since 2009.

In preparing this special issue, we primarily asked the researchers and/or research teams who participated in the IVFC to submit papers on the new results obtained and latest technologies developed. In addition, there was an open call for this special issue, which indeed contains some papers that were not from the research teams in the IVFC.

In total we received 10 contributions. They were subjected to the regular review process of this journal. Subsequently, six papers were accepted after a two-stage review process and are now included in this special issue.

The list of papers included in this special issue is as the following.

Towards Real-Time Traffic Sign Detection and Classification

Y. Yang, H. Luo, H. Xu, and F. Wu

This paper discusses real-time traffic sign detection and classification. An extremely fast detection module is proposed, which is 20 times faster than the existing best one. The detection module is based on traffic sign proposal extraction and classification, and is built upon the color probability model (CPM) and color histogram of oriented gradients. Then, the outcomes from the convolutional neural network (CNN) are harvested to further classify the detected signs into their subclasses within each super class.

Integrated Longitudinal and Lateral Control for Kuafu-II Autonomous Vehicle

L. Xu, Y. Wang, H. Sun, J. Xin, and N. Zheng

The driving control system, which is responsible for trajectory tracking and driving safety, is one of the most important technologies for autonomous vehicles. This paper describes the design of a driving control system for a Kuafu-II autonomous vehicle. Compared with most of the previous research, which inevitably require a large amount of parameters, the presented control system design integrates several typical and efficient controllers to significantly reduce the system sensitivity to these parameters, achieving system robustness under diversified circumstances.

Robust H_∞ Path Following Control for Autonomous Ground Vehicles With Delay and Data Dropout

R. Wang, H. Jing, C. Hu, F. Yan, and N. Chen

A robust state-feedback controller with delay and data dropout considerations is proposed to achieve path following and vehicle lateral control simultaneously. A generalized delay representation is formulated to include the delays and data dropouts in the measurement and transmission. The uncertainties of tire-cornering stiffness and external disturbances are also considered to enhance the system robustness. Simulation results verify the effectiveness and robustness of the proposed control approach.

Where Does the Driver Look? Top-Down-Based Saliency Detection in a Traffic Driving Environment

T. Deng, K. Yang, Y. Li, and H. Yan

A traffic driving environment is a complex scene. During driving, drivers always allocate their attention to the most important and salient areas or targets. Based on the eye-tracking data of drivers and nondrivers, a classical bottom-up and top-down combined traffic saliency detection model is proposed to simulate the driver's attention areas.

Composite Nonlinear Feedback Control for Path Following of Four-Wheel Independently Actuated Autonomous Ground Vehicles

R. Wang, C. Hu, F. Yan, and M. Chadli

The path-following control problem for four-wheel independently actuated autonomous ground vehicles through integrated control of active front-wheel steering and direct yaw-moment control is studied. A modified composite nonlinear feedback strategy is proposed to improve the transient performance and eliminate the steady-state errors in the path-following control considering the tire force saturations in the presence of the time-varying road curvature for the desired path. The path following is achieved through vehicle lateral and yaw control, i.e., the lateral velocity and yaw rate are simultaneously controlled to track their respective desired values, in which the desired yaw rate is generated according to the path-following demand. CarSim-Simulink joint simulation results indicate that the proposed controller can effectively improve the transient response

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performance, inhibit the overshoots, and eliminate the steady-state errors in path following within the tire forces saturation limits.

On-Road Vehicle Detection and Tracking Using MMW Radar and Mono-Vision Fusion

X. Wang, L. Xu, H. Sun, J. Xin, and N. Zheng

A robust and reliable vehicle detection and tracking system is one of the key modules for intelligent vehicles to perceive the surrounding environment. The millimeter-wave radar and monocular camera are two vehicular sensors commonly used for vehicle detection and tracking. Despite their advantages, the drawbacks of these two sensors make them insufficient when used separately. Thus, the fusion of these two sensors is considered as an efficient way to address the challenge. This paper presents a collaborative fusion approach to achieve the optimal balance between vehicle detection accuracy and computational efficiency. The proposed vehicle detection and tracking design is extensively evaluated with a real-world dataset collected by the developed intelligent vehicle. Experimental results show that the proposed system can detect on-road vehicles with a 92.36% detection rate and 0% false alarm rate, and it only takes 10 frames (0.16 s) for the detection and tracking of each vehicle. This system is installed on a Kuafu-II intelligent vehicle for the fourth and fifth autonomous vehicle competition in China called Intelligent Vehicle Future Challenge.

Finally, we would like to thank all researchers who have communicated with us and submitted papers to this special issue, and we hope to see many of these contributions published in future issues. We also would like to thank the Journal editorial staff for their careful organization and smooth planning of publishing this special issue.

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