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GUEST EDITORIAL

Practical Sensing Techniques for Intelligent Vehicles

In the past decades, intelligent vehicles (IVs) have attracted increasing attentions due to their great potential in enhancing vehicle safety and performance and traffic efficiency. As one of the fundamental techniques for IVs, sensing technique has attracted considerable attentions in both academic and industrial communities. For instance, the pioneers, such as Mobileye, Google and Tesla, have developed sensing products for IVs. Currently, they continue developing more efficient and robust sensing methods for the purpose of better control of IVs. However, there are still some problems that should be solved. For example, how to localize the IVs with high accuracy and low cost? How to make object recognition in a real-time manner? How to make sensing-devices for special vehicles? And many others still stand as the big challenges to design the intelligent vehicles. Many approaches will be developed to achieve better performance for IVs.

This special issue on "Practical Sensing Techniques for Intelligent Vehicles (IVs)" just targets on these topics to address new trends and challenges, emerging technologies and progress in standards on topics relevant to today's fast moving areas of IV sensing techniques.

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As one of the fundamental techniques for IVs, sensing techniques have attracted considerable attentions in both academic and industrial communities.

We accepted nine papers after at least two rounds of reviews. All papers have received at least three expert reviews. The special issue consists of nine papers organized in the following categories: (i) Vehicular congestion; (ii) Unmanned surface ship; (iii) Trajectory planning and tracking; (iv) Driving states understanding; (v) Vehicle collision risk assessment; (vi) Traffic measurement and prediction; (vii) Road vehicle detection; (viii) Wireless localization of connected vehicle; (ix) Rail robotics.

The first part of this special issue is devoted to "Fog Computing for Detecting Vehicular Congestion, An Internet of Vehicles based Approach: A review" which reviews the recent progress on vehicular congestion using fog computing. A wireless sensor network for vehicular clients is used in Internet of Vehicles (IoV) based solutions for traffic management applications. It was found that vehicular congestion detection by IoV based connected vehicles technology are practically feasible for congestion handling. Moreover, fog computing is able to enhance the communication in the vehicular wireless sensor network to support larger number of nodes. Various traffic density estimation techniques such as statistical methods, V2I communication, and V2V communication are studied to develop a practically feasible vehicular congestion detection system that performs accurately for a large coverage area and multiple scenarios.

The next part of the special issue, authors investigate the trajectory tracking control problem of surface ship subject to the dynamic uncertainties, unknown time-varying disturbances and input saturation. To handle the non-smooth input saturation nonlinearity and compensate the ship dynamic uncertainties, Gaussian error function and adaptive neural network technique are employed. In control design, to obtain the transient

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motion reference signal, finite-time nonlinear tracking differentiator is applied to generate virtual reference signal and to extract the derivative of virtual control law. Referring to the effects of the kinematics subsystem on the kinetics subsystem caused by the error of tracking differentiator, and the effects of the input saturation on the control accuracy and the dynamic quality of the trajectory tracking control system, an error-driven-based nonlinear feedback recursive design technique is proposed to design trajectory tracking control law. A new non-quadratic Lyapunov function is adopted to analyze the trajectory tracking control system stability. The proposed control scheme fully embodies the characteristics of the low-gain and high-gain control, and overcomes the effect of tracking differentiator error on closed-loop system by recursive design method. Simulation results verify the effectiveness of the proposed control scheme.

The third part of the issue addresses the challenge of trajectory planning and tracking for autonomous vehicles. Trajectory planning and tracking are essential for collision avoidance of an autonomous vehicle in critical traffic scenarios. This paper integrates trajectory planner and tracking controller to implement obstacle avoidance. The trajectory planner is based on the State Lattice approach and tracking controller is designed based on the Model Predictive Control. Numerical simulations show that the planner can generate smooth trajectories which can be selected as a reference trajectory for the tracking controller. The maximum tracking error is less than 0.2 m when the vehicle speed is below 50 km/h. Furthermore, field experiments were carried out and the analysis results demonstrated that the test vehicle can follow the reference path accurately, even at sharp corners. By using the multi-radar fusion system, the test vehicle could avoid continuous obstacles.

The fourth part is "Understanding Individualization Driving States via Latent Dirichlet Allocation Model." This paper aims to develop an unsupervised method for deeply understanding the individualization driving for the purpose of promoting automatic driving technology. First, an encode method is proposed to extracted driving behavior from vehicle motion data. Then, Latent Dirichlet Allocation (LDA) model is developed to understand latent driving states and quantified structure of the driving behavior patterns (topics) from individualization driving (documents) using driving behaviors (words). In order to validate the performance and effectiveness of the proposed method, twenty-two drivers (15 males and 7 females) were recruited to carry out road experiments in Wuhan, China for experiments data collection. In addition, two typical unsupervised methods, including k-means and the random method are employed to compare with LDA in the experiments. Analysis results verify the superiority of proposed method. The information including the proportions of driving states for individualization driving and the distribution of driving behavior for each driving state can be used in automatic driving technology.

The fifth part addresses the issue of vehicle collision risk assessment through inferring driver's braking actions in near-crash situations. The rough set based method is used to explore driving safety problems based on a systematic "driver-vehicle-road" arrangement. The involvement in near-crash situation is linked with the related attributes (driver behavior, vehicle motion, etc.) through an improved rough set model. The rule bases are used to make judgement for identifying whether a new case in near-crash scenario is involved with crash risk. Furthermore, the proposed rough set model reveals the input-output relationships by extracted rules in an easily interpretable way, while existing black box models cannot interpret the input-output relationships. Transparent input-output relationships are very important for retro designing driver assistance system. Expert knowledge can be incorporated in rough set based models as constraints, or the initial value of training parameters in the proposed model can be set by experts intuitively whenever possible, leading to an expert-data driven system.

The sixth part of the special issue addresses the traffic measurement and prediction problem. The location-based vehicle sensor data (LB-VSD) is used to improve the efficiency of traffic control and management. Similar to the GPS system, BeiDou satellite navigation system (BDS) can collect LB-VSD. In China, the key operation vehicles on the expressway are equipped with BDS to monitor the travel path. This provides a basis for predicting the traffic speed on expressway accurately. In this paper, considering the abnormal data collected by BDS, the screening and processing rules are made, and then the traffic speed sequence is extracted. Considering the data-missing problem caused by equipment failure or abnormal data elimination and the data sparse problem caused by small size of sample, a filling method based on trend-historical data is proposed. Traffic flow evolution is a complex process. Sudden accidents or bad weather can cause a sudden change in traffic flow and non-recurrent traffic congestion. The prediction accuracy of traditional machine learning methods is low when non-recurrent congestion occurred. In order to solve this problem, this paper adopts

a Long Short-Term Memory (LSTM) to predict the traffic speed. Moreover, three-regime algorithm is used while building the prediction model. The prediction method is compared with Support Vector Regression (SVR) method. The results show that the prediction accuracy of the proposed method is higher than that of SVR algorithm, and the robustness is better in the case of non-recurrent traffic congestion.

In the seventh part, road vehicle detection using deep learning algorithms is discussed. Although there have been a large number of studies that thoroughly explored various types of deep learning methods for vehicle detection, there are a few studies that compare and evaluate the detection time and detection accuracy of the mainstream deep learning object detection algorithms for vehicle detection. To this end, this article compares five mainstream deep learning object detection algorithms in vehicle detection, namely the faster R-CNN, R-FCN, SSD, RetinaNet, and YOLOv3 on the KITTI data and analyze the obtained results. The detection time and detection accuracy of the five object-detection algorithms on the KITTI test set are compared and analyzed, and the PR curve and AP value are used to evaluate the detection accuracy.

The eighth part of the special issue discusses the wireless localization of connected vehicles (CVs). As one of key technologies of connected vehicles (CVs) applications, wireless localization can provide accurate and reliable vehicle location for high occupancy tolling and safety critical vehicle applications. Several artificial intelligence methods, such as back propagation neural network (BPNN) and particle swarm optimization (PSO) method, have been employed to optimize the pass-loss model and to improve the accuracy of wireless localization algorithm. However, in view of the stochasticity of initial weights and thresholds in BPNN, it is difficult to reach the global convergence. In this study, a novel double-layer architecture for wireless localization algorithm is proposed based on the optimization of initial weights and thresholds in BPNN and the refinement of search direction and step in PSO algorithm. Based on the architecture, the wireless localization algorithm integrating BPNN with mind evolutionary algorithm (MEA) and quantum-behaved PSO (QPSO) method is proposed and validated using the experiment data in field environment. The validation results show that the proposed localization algorithm has better localization accuracy by comparison with the other localization algorithms, which the average error of the proposed localization algorithm in field environment is about 19 meters. In addition, the localization accuracy shows an improving tendency with the increasing of the number of base stations connected to moving vehicle. The location error is less than 10 meters when the number of base stations connected to the moving vehicle is greater than 7. For the wireless localization in field environment, the accuracy is acceptable for CVs applications.

The ninth part of the special issue discusses the rail robotics for fault detection in a coal mine hoisting system. Aiming at the problem of rail inspection in coal mine hoisting system, this paper presents a new rail inspection robot (RIR) robot and a fault detection method using the robot's own attitude change to evaluate rail defects. The mechanical structure of the RIR is designed, and the magnetic wheel with both practicability and adsorption capacity is designed using the finite element software. The types of rail defects in the hoisting system are classified, and the kinematic characteristics of the robot passing the defects of rails are analyzed. The variation curve of the robot's attitude angle is analyzed when the robot passes through different rail defects. Lastly, the climbing ability of the RIR robot on the vertical rail and the detection ability of rail defects detection method are verified by experiments. The analysis result demonstrates that the detection rate of the proposed RIR is below 7%. The proposed RIR detection scheme can also be extended to railway rail inspection.

The Guest Editors would like to thank the authors and reviewers for the time and efforts they have devoted to providing detailed comments towards improving the quality of the accepted papers.

The Guest Editors would like to thank the authors, the Magazine Editor-in-Chief Ljubo Vlacic, and the reviewers for the time and efforts they have devoted to provide detailed comments which have contributed to significantly improving the quality of the accepted papers.

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NOVEMBER

IEEE/RSJ INTERNATIONAL CONFERENCE ON INTELLIGENT ROBOTS AND SYSTEMS (IROS 2019)
November 3–8, 2019
Macao, China
Paper submission deadline:
passed
http://www.iros2019.org

IEEE INTERNATIONAL CONFERENCE ON CONNECTED VEHICLES AND EXPO (ICCVE 2019)
November 4–8, 2019
Graz, Austria
Paper submission deadline:
May 5, 2019
http://www.iccve2019.com

DECEMBER

IEEE SYMPOSIUM SERIES ON COMPUTATIONAL INTELLIGENCE (SSCI 2019)

IEEE SYMPOSIUM ON COMPUTATIONAL INTELLIGENCE IN VEHICLES AND TRANSPORTATION SYSTEMS (CIVITS 2019)
December 6–9, 2019
Xiamen, China
Paper submission deadline:
July 10, 2019
http://ssci2019.org

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IEEE Intelligent Transportation Systems Magazine.

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Dr. Fernando García Fernández is a full Professor at Universidad Carlos III de Madrid, where he focuses his researches in Intelligent Vehicles and Intelligent Transportation Systems, involving the use of Computer Vision, Sensor Fusion, and Human Factors, as well as Vehicle Communication. He received the Master in Robotics and Automation Scholarship at Universidad Carlos III de Madrid in 2008, the Barreiros Foundation Award in the domain of Automotive and Vehicle Applications in 2014, finalist to the best PhD Thesis Dissertation Award in the period 2013–2015 given by ITSS Spanish Chapter, and the award to the innovation in the automotive sector, diagnosis at "Galeria de innovación Motortec 2015." He is a member of the BoG of the IEEE-ITSS since January 2017, Chair of the Spanish Chapter of this society since 2019, and has organization experience in the most important conferences of this society (ITSC, IV and ICVES). He has been involved in more than 40 research projects, 16 of which are funded by public entities. He has given lectures in different international Universities such as University of Buffalo, Universidad de las Fuerzas Armadas de Quito (ESPE), and Universidad Politécnica de Madrid. He is a Column Editor of IEEE Intelligent Transportation Systems Magazine.

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Dr. Zhaozheng Hu received the Bachelor and PhD degrees from Xi'an Jiaotong University, China, in 2002 and 2007, respectively, both in Information and Communication Engineering. He is currently a full professor in Wuhan University of Technology (WHUT), Wuhan, China. Before joining in WHUT, he visited as a researcher at Chinese University of Hong Kong, Georgia Tech, and Kyoto University for many years. He received the awards of Chutian scholar of China and JSPS scholar of Japan. He has published more than 50 papers in international journals and conferences. His research topics mainly focus on 3D Computer Vision, Intelligent Vehicles, and Intelligent Transportation Systems.

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