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Guest Editorial

Special Section on Advanced Control Theory and Techniques based on Data Fusion

Advanced control theories and techniques based on Data Fusion provide higher-quality information from multiple sensor data by spatio-temporal data integration, the exploitation of redundant and complementary information, and the available context. Important applications exist in distributed sensor network, aerospace, robotics, monitoring and control of manufacturing processes. Techniques for such data fusion are drawn from a broad set of disciplines including: control theory, statistical estimation, signal and image processing, artificial intelligence, information sciences. Particular emphasis should be placed on advances in the theory of distributed sensing and processing, localization and tracking, nonlinear filtering, network resource management, selection and integration of algorithms, data fusion based on heterogeneous sensors.

Recently, a wide range of research has been reported dealing with the related problems. The current state of the art of such research is the subject of 5 papers in the present "Special Section on International Journal of Control, Automation, and Systems". We briefly summarize the content of this special issue.

The first paper titled "High Speed Train Navigation System based on Multi-sensor Data Fusion and Map Matching Algorithm", written by Kim *et al*., reports a sensor fusion-based navigation system for high speed trains with non-holonomic constraints, where multiple sensors, such as accelerometers, gyroscopes, tachometers, Doppler radar, differential GPS, and RFID, are considered. A navigation filter for sensor fusion and a map matching algorithm are proposed. Also, the characteristics of each sensor are investigated to derive the equations of six local filters for navigation, and the estimates of the local filters are combined in the master filter.

In the next paper, "Data Fusion-based Resilient Control System under DoS Attacks: A Game Theoretic Approach", Yuan *et al.* present a resilient control method for a system encountered the Denial-of-Service (DoS) attack under the framework of Joint Directors of Laboratories (JDL) data fusion model. The JDL data fusion process is characterized by the so-called Game-in-Game approach, where decisions are made at different layers. The interactions between different JDL levels are considered which take the form of Packet Delivery Rate of the communication channel. This paper provides some criterions to judge the ability of cyber defense system to protect the underlying control system.

Xiao *et al.* in the third paper titled "RGB-D Sensor-based Visual Target Detection and Tracking for an Intelligent Wheelchair Robot in Indoors Environments", develop a scheme of visual target detection and tracking for a wheelchair robot equipped with Microsoft Kinect capturing RGB images along with per-pixel depth information (RGB-D camera). The speeded-up semi-supervised on-line boosting algorithm is used to provide the robust description of feature for environments and the target person from RGB images. Based on the environmental Haar-like features, extended Kalman filter (EKF) based localization is utilized to estimate robot pose. The obstacle avoidance navigation approach and optimization methods are employed for the wheelchair robot.

In the fourth paper, "Visual Odometry based on a Bernoulli Filter", Zhang *et al.* consider visual odometry in urban scenarios. A Bernoulli filter is proposed to estimate a vehicle's trajectory under random finite set (RFS) framework. Especially, ego-motion vector is considered as the state of an extended target, while the features are considered as multiple measurements originated from the target. The Bernoulli filter estimates the state of the extended target instead of tracking individual features, which presents a recursive filtering framework in the presence of high association uncertainty. Finally, some experimental results demonstrate that the given approach exhibits good robustness under real traffic scenarios.

In the last paper of the special issue, "A Novel Data Fusion Scheme using Grey Model and Extreme Learning Machine in Wireless Sensor Networks", Luo *et al.* present a dual prediction-based data fusion scheme, named grey model and optimally pruned extreme learning machine (GM-OPELM), to improve the performance of wireless sensor networks. GM-OPELM adopts a double prediction mechanism to guarantee that the data sequence at both sensor nodes and sink node are synchronous. During the data fusion process, GM-OPELM uses GM to implement the initial prediction with a small number of data items, and then employs an OPELM-based single-hidden layer feedforward network to modify the predicted value with lower computational cost and extremely fast speed. It has been shown that the proposed data fusion scheme can significantly reduce redundant transmissions and extend the lifetime of the whole network with low computational cost.

All these papers make important contributions to the field of advanced control theories based on data fusion and their applications. We wish this special issue will

lead advanced developments in this area.

Last, but not the least, we would like to thank all the authors and reviewers who have contributed to the preparation of this special issue. Particularly, we would like to thank Prof. Young Hoon Joo, Editor-in-Chief, for his constant encouragement while completing this special issue.

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