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Editorial

Integration of Sensors in Control and Automation Systems 2020

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1. Introduction

The integration of sensors in control and automation systems has received a great deal of attention from a considerable number of researchers and the industrial community in the last years. Emphasis is placed on the importance of creating improvements in control and automation systems to meet the challenges of developing and refining new applications. These systems have to integrate a variety of sensory information and human knowledge for the sake of efficiently carrying out tasks with or without human intervention. In fact, the integration of sensors into intelligent devices and systems has increased the capacity to measure, analyze, and aggregate data at a local level. Autonomous and connected sensors are able to selectively sample and measure many physical properties. Built on the increasing capabilities of fixed-access and wireless networks, smart sensor developments allow the collection of raw data, which are processed into information and conveyed via a network connection.

The concept of sensor integration is close to the sensor fusion term, which is defined as "the art of processing data from multiple sensors with an aim to replicate a physical environment or induce intelligence to control a phenomenon with increased precision and reliability." Sensor fusion or integration is evolving rapidly as the basis of robust control systems that make sense of imperfect input despite the environment in which it operates. Data from multiple sensors are fused to increase response and accuracy, delivering control systems that until recently could only be theorized, drawing on techniques like artificial intelligence, pattern recognition, digital signal processing, and statistical estimation. Moreover, recent advances in sensor technology and processing techniques, combined with improved hardware, make real-time data fusion possible.

This special issue was aimed at exhibiting the latest research achievements, findings, and ideas in the integration of sensors in control and automation systems. The topics faced in this special issue were the following:

(i) Sensor systems for control and automation: sensors and sensor networks, intelligent sensors, sensor uncertainty for fault-tolerant control, distributed and multimodality sensor network for control and automation, and so on

(ii) Control: adaptive control, robust control, active disturbance rejection control, complex systems, identification and estimation, nonlinear systems, intelligent systems, sensor networks, delay systems, precision motion control, control applications, and so on

(iii) Automation: man-machine interactions, process automation, network-based systems, intelligent automation, planning, scheduling and coordination, and so on

(iv) Robotics: modelling and identification, mobile robotics, mobile sensor networks, perception systems,

visual servoeing, robot sensing and data fusion, and so on

(v) Process-based control: sensor development, system design, and control development

(vi) Control and automation systems: fault detection and isolation, sensing and data fusion, flight control and surveillance systems, rescue and field robotics, guidance control systems, industry, military, space and underwater applications, linear and nonlinear control systems, signal and image processing, and so on

(vii) Industrial informatics: embedded systems for monitoring and controlling

2. The Papers

A total of 20 papers were submitted to this special issue. After peer review, finally, 7 were accepted and published, covering a wide range of the topics proposed in the call for papers.

J. Shao et al. proposed a unified calibration paradigm for a better cuffless blood pressure (BP) estimation with modes of elastic tube (ET) and vascular elasticity (VE). The study was aimed at evaluating the performance of VE and ET models by means of an advanced point-to-point pairing calibration. With the study, a cost-effective cuffless BP monitoring approach could be emerged with an easy and durable personalized calibration. Such an approach could be anticipated to be a better choice when considering the practicality of long-term and continuous BP monitoring with both modes of elastic tube and vascular elasticity. Besides these, the study was proofed evidence about the sensitivity of BP estimation along with these models and their initial calibration methods.

G. Dai et al. proposed an industrial B-mode phased array ultrasonic imaging reconstruction algorithm based on finite rate of innovation (FRI). The new FRI sampling model had the advantages of its good stability, simple circuit, and implementation. Additionally, the B-mode phased array ultrasonic imaging algorithm was proposed based on the FRI sampling model and the mathematical model characteristics of B-mode phased array ultrasonic imaging. The simulation results indicated that the sampling point required by the proposed FRI sampling model is 0.1% of the traditional mode of B-mode phased array ultrasonic imaging, and the sampling frequency of the proposed ultrasonic imaging algorithm is 0.0077% of that of the traditional B-mode ultrasonic imaging.

S. Álvarez-Rodríguez and F.G. Peña Lecona investigated the performance of a κ-degree of freedom serial robot arm with dynamical inclusion of linear n-order sensors, showing that robot's properties with linear n-order sensor inclusion were invariant with respect to robot's theoretical dynamics, provided that the solutions of the considered linear n-order sensors exist and are unique. The proposed methodology was demonstrated by a formal proof, and additionally, the effectiveness of the proposed method was validated by means of the implementation of a trajectory tracking control problem.

X. Wang et al. developed an innovative trim method for tiltrotor aircraft take-off based on a genetic algorithm. Firstly, the genetic algorithm, which possesses strong capability in searching global optimum, was adopted to identify a coarse solution. Secondly, the coarse solution of the trim is further refined by the Levenberg-Marquardt method for precise local optimum. In addition, the innovative trim method was applied to a tiltrotor aircraft's flight control in the transition process of incline take-off. The limitation of trajectory was discussed, and the tilt corridor was constructed. Finally, the incline take-off simulations were conducted, and the effectiveness of the proposed trim method was verified through good match with the designed reference trajectory.

W. Lu et al. proposed a peak-valley detection method that detects the pair of peak-valley to overcome the problem of overcounting. Based on the fuzzy logic algorithm, a fuzzy controller was defined to make the constant coefficient in the Weinberg nonlinear step length estimation model to be adjusted adaptively to each detected step, which was suitable for different kinds of people walking at various velocities. It was also possible to estimate pedestrian walking distance accurately by accumulating every estimated step length.

R.A. Sowah et al. designed and developed a cost-effective, secure home automation using the OpenHAB 2 framework with capability for device programming and customizations. Additionally, they develop mobile and web applications for energy management and switching of connected home devices and interactive visual interface for home automation. It leveraged the developed hardware and software modules to provide optimal energy management for the home. They also implemented additional security layers of user authentication and authorization while keeping the overall cost of implementation low and maintaining the ease of deployment for everyday home use. Per our server configuration, the OpenHAB communication through the Internet is made through the JSON Web Token authentication procedure. This process makes it difficult for user identity to be hijacked by a malicious attacker. This approach proved to be more secure than the default OpenHAB server configuration. Consequently, we leveraged on the open-source OpenHAB REST API to develop a mobile or web application that is flexible and easily adaptable for traditional home use.

Finally, A. Ahmed et al. studied the application of artificial intelligence techniques in predicting the lost circulation zones using drilling sensors. In particular, they evaluated three AI techniques to predict the lost circulation zones based only on six mechanical surface drilling parameters. These techniques were functional networks, artificial neural networks, and fuzzy logic. On the other hand, the six parameters were real-time measurements of flow pump, rate of penetration, string rotary speed, standpipe pressure, drilling torque, and weight on bit. In the experiments developed, more than 4500 real-field data points from three wells were used in the evaluation.

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