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Editorial

Engineering Applications of Intelligent Monitoring and Control 2016

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Monitoring and control have found extensive applications in multiple domains including mechanical engineering, automotive engineering, electrical engineering, control engineering, civil engineering, biomedical engineering, and micro/nanoengineering. The intelligent system have a capability to acquire and apply knowledge in an intelligent manner and have the capabilities of perception, reasoning, learning, and making decisions from incomplete information. Therefore, intelligent system approaches for monitoring and control pave a practical way for a variety of engineering applications in the absence of human interaction. The objective of this annual issue is to summarize the recent emerging development and ideas in concerned domains of intelligent monitoring and control.

After a rigorous review process, 8 out of a total of 82 submitted papers have been selected in this annual issue, which fall into three main groups.

(I) Intelligent Monitoring and Diagnosis. Sound barriers are widely used on roadways and railways to absorb and reduce the impulsive noise and vibration energy generated by passing trains. However, the high speed of the passing trains can induce very strong impulsive wind pressure that may cause damage to the sound barrier structure. In order to investigate the influence of the impulsive wind pressure on the sound barriers, C. Zhu et al.'s "In Situ Measurement of Wind-Induced Pulse Response of Sound Barrier Based on High-Speed Imaging Technology" utilizes high-speed camera to record the vibration of the sound barriers and proposes a displacement extraction algorithm to extract the vibration response of the sound barrier from the recorded video. Results show that the proposed methodology is effective for noncontact measurement of sound barrier vibration.

In the production of seamless steel tubes, the perforation process significantly affects the quality of the seamless tubes. To ensure the tube quality, D. Xiao et al.'s "Process Monitoring and Fault Diagnosis for Piercing Production of Seamless Tube" establishes intelligent monitoring and fault diagnosis models for the perforation process. Specifically, a multiway principal component analysis (MPCA) monitoring model is firstly built. Then, by dividing the perforation process into three periods, the MPCA model is extended to a multistage MPCA model. Three different ways are used for period division, including division based on process, division based on K-means algorithm, and division based on genetic algorithm (GA). Simulation shows that the established models can effectively monitor the perforation process and successfully detect the faults. The simulation result also demonstrates that the multistage MPCA model based on GA is superior to other models.

(II) Intelligent Control. Model predictive control (MPC) has received much attention in control literature due to its superior tracking ability and the capabilities of handling constraints and time-varying behaviors simultaneously. One shortcoming of MPC is that the computational burden grows rapidly when the stabilization set is enlarged, especially for applications on uncertain systems. Aiming to enlarge the

size of the stabilization set without regard to computational burdens, S. H. Kim's "Model Predictive Control Algorithm Based on Off-Line Region Dependency" presents an efficient MPC algorithm for uncertain time-varying systems with input constraints. A numerical example is shown and the result demonstrates that the algorithm not only is useful for enlarging the stabilization set but also improves the control performance.

Multiple unmanned aerial vehicles (UAVs) formation control is an important research direction in military applications and civil applications. Based on the framework of distributed model predictive control (DMPC), S. Zhou et al.'s "Multi-UAVs Formation Autonomous Control Method Based on RQPSO-FSM-DMPC" proposes a finite state machine scheme to justify the future state of the UAVs formation and adopts the revised quantum particle swarm optimization to solve the cost function of the DMPC optimization problem. Effectiveness of the proposed control strategy is evaluated under the simulation of a battle field, and the result shows that the proposed control strategy can accomplish multiple UAVs formation autonomous reconfiguration safely and effectively.

Neural networks have been increasingly used in chemical process industry. An application of neural networks to the control of chemical pH reactors is demonstrated by M. AlDhaifallah et al.'s "A Predictive Neural Network-Based Cascade Control for pH Reactors." A cascade control structure is considered, in which a model predictive neural network controller is used in the master control loop and a fuzzy proportional-integral (PI) based controller is used as the slave controller. Simulation on a pH reactor shows that the cascade control structure is more robust than the single feedback fuzzy PI controller and can improve control performance in both transient and steady-state conditions under disturbances.

(III) System Identification and Prediction Models. Many physical and biological systems have been modelled using a Hammerstein structure, but most of existing work only assumes that the structures of both the linear and nonlinear blocks are known. Considering the fact that the structures of the blocks should be unknown in real world, B. Aissaoui's "Subspace Identification of Hammerstein Model with Unified Discontinuous Nonlinearity" presents a novel iterative subspace algorithm for identification of Hammerstein model, in which both the linear and nonlinear blocks are assumed to be unknown. Two examples are provided to verify the effectiveness of the algorithm, and the results indicate that the algorithm is reliable for approximating nonlinear systems.

Accurate and reliable wind speed forecasting is critical for wind energy utilization. Aiming to achieve high prediction accuracy for wind speed forecasting, Z. Yang and J. Wang's "Multistep Wind Speed Forecasting Using a Novel Model Hybridizing Singular Spectrum Analysis, Modified Intelligent Optimization, and Rolling Elman Neural Network" proposes a new hybrid model, which combines the singular spectrum analysis, the modified intelligent optimization, and the rolling Elman neural network to forecast the multistep wind speed. 10 min and 60 min wind speed data from Shandong, China, are used to verify the model prediction performance, and the result shows that the prediction accuracy of the proposed model is the best among other conventional forecasting models.

Precise motion prediction of tracked vehicles is essential for maintaining safety and stability during steering control and other challenging circumstances. A slip model based on the instantaneous centers of rotation (ICRs) of treads is developed by H. Lu et al.'s "Motion Predicting of Autonomous Tracked Vehicles with Online Slip Model Identification" to predict the motion of the tracked vehicle in the short term. An extended Kalman filter is employed to identify and estimate the ICRs location based on position measurement in real time, so that no velocity measurement is necessary. Experiments on a tracked vehicle of 13.6 tons are conducted to evaluate the model, and the result indicates that the proposed model can achieve high prediction accuracy even in the absence of real-time kinematic global positioning system.

We hope that the readers will find the special issue interesting and stimulating and expect that the involved papers can contribute to the further advance in the domain of intelligent monitoring and control.

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