Hindawi Publishing Corporation
Mathematical Problems in Engineering
Volume 2013, Article ID 564021, 4 pages
http://dx.doi.org/10.1155/2013/564021

Editorial

Engineering Applications of Intelligent Monitoring and Control

Qingsong Xu,[1] Pak-Kin Wong,[1] Chengjin Zhang,[2] Shane Xie,[3] and Ping-Lang Yen[4]

[1] *Department of Electromechanical Engineering, Faculty of Science and Technology, University of Macau, Avenida Padre Tomás Pereira Taipa, Macao, China*
[2] *School of Control Science and Engineering, Shandong University, Jinan, Shandong 250061, China*
[3] *Department of Mechanical Engineering, The University of Auckland, 20 Symonds Street, Auckland, New Zealand*
[4] *Department of Bio-Industrial Mechatronics Engineering, National Taiwan University, No. 1, Sec. 4, Roosevelt Road, Taipei 10617, Taiwan*

Correspondence should be addressed to Qingsong Xu; qsxu@umac.mo

Received 3 September 2013; Accepted 3 September 2013

Monitoring and control have found extensive applications in multiple domains including mechanical engineering, electrical engineering, control engineering, civil engineering, biomedical engineering, and micro/nano engineering. Intelligent systems 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 main focus of this special issue is on new and existing intelligent systems whose goal is to monitor and control diverse physical processes with no or very little human interaction. The objective of this special issue is to report and summarize the most recent developments and ideas in relevant domains of intelligent monitoring and control.

After a thorough review process, 20 out of a total of 38 submitted papers have been selected in this special issue and present interesting results.

Engine ignition patterns can be analyzed to identify the engine fault according to both the specific prior domain knowledge and the shape features of the patterns. A new framework of simultaneous-fault diagnosis to analyze ignition patterns for automotive engine ignition system diagnosis is proposed by C. M. Vong et al.'s "*Simultaneous-fault diagnosis of automotive engine ignition systems using prior domain knowledge and relevance vector machine,*" This study integrates domain knowledge features, pairwise-coupled RVM classification algorithm, some feature extraction techniques and decision threshold optimization techniques into a new diagnostic framework. The framework can automatically diagnose single and simultaneous faults. Experimental results show that the framework performs well for both single-fault and simultaneous-fault diagnoses, and is superior to the existing approach.

Pipeline transportation is an important transport style following the road, water, rail, and air, and it is the main means for the transportation of oil and gas. J. Liu et al.'s "*An algorithm of auto-update threshold for singularity analysis of pipeline pressure*" proposes a new precise auto-update threshold algorithm that automatically updates the threshold of pipeline pressure, when any abnormal situation happens. The algorithm is applied to the prediction of pipeline pressure in different real and simulation situations. Results show that the algorithm provides an effective and real-time threshold for the judgment of abnormal pressure.

Structural health monitoring involves the process of realizing the damage detection and characterization for the concerned structures. A new method which integrates principal component analysis (PCA) and support vector machines is presented by H. Fu and Q. Xu's "*Locating impact on structural plate using principal component analysis and support vector machines*" to predict the location of

impact on a clamped metallic plate structure. By extracting principal components, the PCA is capable of improving the computational efficiency. Experimental results show that the proposed strategy achieves much better locating accuracy in comparison with the conventional approach based on back-propagation neural networks.

The applications of piezoelectric actuators are restricted by their nonlinearities in terms of hysteresis and creep. A new log-type model is proposed by X. Zhao et al.'s "*Analysis of hysteresis-free creep of the stack piezoelectric actuator*" to describe the creep effect of stack piezoelectric actuator in small time scale to achieve high positioning performance. In the model, the hysteresis and creep effects are separated and tackled, respectively. Experimental studies have been carried out to investigate the creep variation and some concluding remarks have been given. The developed model has potential applications in high speed micro/nanomanufacturing equipment.

PID controllers have been widely used in various industrial processes owing to the properties of simple structure, few parameters, and easy implementation. A systematic method is presented by X. Li et al.'s "*Design of optimal PID controller with ε-Routh stability for different processes*" to design an optimal PID controller via Lyapunov approach for different processes. The optimal PID controller is obtained by minimizing the performance index of augmented integral squared error. Experimental studies of coupled water tank system under different set points are carried out. Both simulation and experiment results show the effectiveness and usefulness of the proposed method.

Protection of large structures against external disturbances such as earthquakes and wind has been a major concern to researchers for decades. A. H. El-Sinawi et al.'s "*Optimal control of magnetorheological fluid dampers for seismic isolation of structures*" presents the modeling and control of a magnetorheological (MR) damper, installed in Chevron configuration, at the base of a 20-story benchmark building. The MR damper model is derived from Bouc-Wen hysteresis model. Kalman filter and LQG technique are employed to control the MR damper under earthquake loads. The effectiveness of the MR damper control strategy is validated by extensive simulation studies. Results of the optimally controlled model demonstrate superior performance in comparison to uncontrolled model.

Bearing failure is one of the main causes of breakdown in rotating machinery. H. Liu et al.'s "*Rolling bearing fault detection based on the teager energy operator and elman neural network*" presents an approach to bearing fault diagnosis based on the Teager energy operator (TEO) and Elman neural network. The TEO exhibits a good time resolution and self-adaptability to transient signals, showing better robustness in bearing fault detection. Experimental results indicate that the proposed approach is able to detect bearing faults effectively under variable conditions.

The transport aircraft frequently experiences high loads which may cause structural damage, fatigue cracking, or nontypical structural deformation. A structural health monitoring method based on the concept of static aeroelasticity is presented by R. C. Chang and C. E. Lan's "*Structural health monitoring of transport aircraft with fuzzy logic modeling*" to estimate aeroelastic effects on aircrafts without having the values of structural flexibility matrix. The method is based on the flight data extracted from the flight data recorder to predict the aeroelastic effects for a twin-jet transport in severe atmospheric turbulence. This method could be used to assist airlines to monitor the structural integrity as a complementary tool to improve aviation safety and operational efficiency.

Friction affects the performance of the systems that control a mechanism, producing positioning errors during the execution of a given task. A new friction model assuming the maximum static friction coefficient as a function of the rate of change of the external force is proposed by S. Sánchez-Mazuca and R. Campa's "*An improvement proposal to the static friction model*." The procedure to estimate the parameters of the proposed model is given. The application of such procedure to obtain the parameters and experimental validation of the proposed approach are outlined in detail.

Grain drying process is a typical multivariable, time-varying, nonlinear, and large delay industrial production process. A grain drying parameters detection system is developed by L. Zhang et al.'s "*Parameters online detection and model predictive control during the grain drying process*" according to the structural characteristics of the cross-flow circulation grain dryer, process, and system control objectives and requirements. A drying model predictive control system is set up. The control plant is designed by combining PC with PLC based on LabVIEW software. It is shown that the system can automatically detect and display the parameters of the grain temperature, hot air temperature, and grain moisture.

Motivated by the complex product with the feature about error-prone assembly system and supply chain inventory inaccuracy, W. Xu et al.'s "*The Impact of RFID investment on complex product in three-level assembly supply chain*" elaborates on the impact of information technology investment on complex product. This paper mainly studies the impact of RFID technology on a three-stage assembly supply chain. It provides analyses under both decentralized decision making and centralized decision making. Each scenario is analyzed in two situations (with the RFID technology or without), respectively. Numerical studies have been conducted. The results of this paper could contribute to making the price and ordering decisions on whether RFID should be adopted among members of the supply chain.

Cloud computing technology has become a standard model for application and database hosting in today's IT industry, even to serve mission-critical applications. The main obstacle in mass adoption of cloud computing for database operations is the data security issue. C.-H. Tan and Y.-W. Teh's "*Secure hardware performance analysis in virtualized cloud environment*" presents an algorithm that employ machine learning and linear regression analysis on TPC-H benchmark data to support resource performance evaluation in virtual machine (VM). Linear programming technique is utilized to construct the stress-testing scenarios in the VM for resource threshold and transactions' response time verification when the VM undergoes hardware change.

The presented results are beneficial to organizations that have stringent requirement on data access.

An adaptive network-based fuzzy inference system (ANFIS) integrated with fuzzy controller is proposed by R. Tapia-Herrera et al.'s "*Tuning of a TS fuzzy output regulator using the steepest descent approach and ANFIS*" to obtain the optimal fuzzy membership functions yielding adequate combination of the local regulators such that the output regulation error in steady state is reduced. It is shown that the nonlinearity of the plant is not necessarily the same nonlinearity needed by the regulator to ensure reference tracking. In comparison with the steepest descent method employed for tuning fuzzy controllers, ANFIS approximates the mappings between local regulators with membership functions which are not necessary known functions such as Gaussian bell, sigmoidal, and triangular membership functions.

Semi-active air suspension is increasingly used on heavy-duty vehicles. A new low cost and effective approach of fuzzy-wheelbase preview controller with wavelet denoising filter is presented by Z. Xie et al.'s "*A noise-insensitive semi-active air suspension for heavy-duty vehicles with an integrated fuzzy-wheelbase preview control*" for semi-active air suspension system. By adopting a sensor on the front axle, the road prediction model can predict more reliable road information for the rear wheel. Simulation results show that the integrated fuzzy-wheelbase preview controller of semi-active suspension can effectively improve the ride quality and road holding capacity. With the adoption of wavelet filter, it is shown that the impact of sensor noise on the suspension performance can be minimized.

Frame interpolation plays an important role in intelligent monitoring systems. L. Zi et al.'s "*Frame interpolation based on visual correspondence and coherency sensitive hashing*" presents a region-guided frame interpolation algorithm to improve the quality of surveillance video. The main feature of this method lies in its ability to obtain relatively high quality of interpolated frames according to spatial and temporal correlations in video sequences. Experimental results show that the proposed algorithm outperforms the other five representative frame interpolation algorithms which are examined based on qualitative and quantitative measures.

Neural-network-based techniques have been widely applied in nonlinear control systems. An effective supervised adaptive control scheme is proposed by Y.-Z. Chang et al.'s "*Adaptive neuron-like control of time-delay systems enhanced with feedforward and supervisory strategies*" for tracking control of delayed nonlinear systems. The scheme is composed of an adaptive control as well as a supervisory control to enhance robustness against disturbance and model uncertainties. A design methodology based on Lyapunov analysis is presented. Experimental results validate its effectiveness and show that the feedforward of disturbance, if available, can achieve further improvements. As compared with PD control, the proposed scheme exhibits an excellent regulation performance.

Solar arrays are the main source of energy for on-orbit satellites. Monitoring and forecasting the output power of solar arrays by using the real-time observational data are very important for the study on satellite design and on-orbit satellite control. H. Fang et al.'s "*Intelligent monitoring and predicting output power losses of solar arrays based on particle filtering*" presents a dynamic prediction method based on particle filter for the prediction of output power losses of solar arrays. It puts forward the algorithm of particle filter dynamic prediction based on the empirical model and historical data. It provides an important reference in the field of satellite energy measurement prediction. The results are helpful for satellite design and on-orbit satellite control.

The gas turbine generator system is commonly used in many power plants. Z. Yang et al.'s "*Simultaneous-fault diagnosis of gas turbine generator systems using a pairwise-coupled probabilistic classifier*" proposes an effective framework to determine simultaneous-fault diagnosis in large-scale power generation equipment using feature extraction, pairwise coupling, and relevance vector machine. The effectiveness of the approach has been verified through experiment study on a gas turbine generator system. Results reveal a high accuracy in fault diagnosis, in particular, determination of simultaneous fault by the training with single-fault patterns only. This research provides a useful solution which overcomes ambiguous region for multiclass classification, and it is applicable to other similar industrial problems.

Online monitoring of instantaneous resistance variation during the A.C. resistance spot welding is of paramount importance for the weld quality control. An artificial neural network (ANN) based dynamic resistance measuring method is proposed by L. Gong et al.'s "*Embedded artificaial neual networks-based real-time half-wave dynamic resistance esimation during the A.C. resistance spot welding process*" to achieve better real-time performance during the resistance spot welding process. A new method is presented to measure the transformer primary-side signal for estimating the secondary-side resistance in each 1/4 cycle. A DSP-based resistance spot welding monitoring system is developed to perform ANN computation. Experimental results indicate that the proposed method is applicable for measuring the dynamic resistance in single-phase, half-wave controlled rectifier circuits.

The resolution quality of video sequences plays an important role in accurate recognition of moving targets and tracking of the intelligent monitoring and control system. Aiming to improving the spatio-temporal resolution of the video sequences, a novel spatio-temporal super-resolution reconstruction model (STSR) is proposed by M. Liang et al.'s "*Spatiotemporal superresolution reconstruction based on robust optical flow and Zernike moment for video sequences*" based on robust optical flow and Zernike moment. The model integrates the spatial resolution reconstruction and temporal resolution reconstruction into a unified framework. Experimental results demonstrate that the proposed method outperforms the existing approaches in terms of both subjective visual and objective quantitative evaluations, and has higher rotation invariance effectiveness and noise robustness.

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

Acknowledgment

We would like to express our heartfelt thanks to all the authors who submitted their papers and all the reviewers who helped improving the papers for this special issue.

Qingsong Xu
Pak-Kin Wong
Chengjin Zhang
Shane Xie
Ping-Lang Yen