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*Editorial*

# Advanced Control in Micro-/Nanosystems

**Qingsong Xu,[1] Pak-Kin Wong,[1] Minping Jia,[2] Micky Rakotondrabe,[3] and Li Zhang[4]**

[1] *Department of Electromechanical Engineering, Faculty of Science and Technology, University of Macau, Avenue Padre Tomás Pereira Taipa, Macau*
[2] *School of Mechanical Engineering, Southeast University, Nanjing, Jiangsu 211189, China*
[3] *Automatic Control and Micro-Mechatronic Systems (AS2M) Department, FEMTO-ST Institute, UMR CNRS 6174-UFC/ENSMM/UTBM, 24 rue Alain Savary, 25000 Besancon, France*
[4] *Department of Mechanical and Automation Engineering, The Chinese University of Hong Kong, Hong Kong*

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

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Micro-/nanosystems have attracted plenty of attention at both academia and industry within the last two decades. Micro-/nanosystems include miniaturized systems whose physical dimensions lie in micro-/nanoscale and macro-/mesoscale systems which perform tasks at the micro-/nanoscale. Such systems find extensive applications in micro-/nanomanipulation, micro-/nanoassembly, nanometer-resolution imaging and metrology, health and environmental monitoring, data storage, material science, biomedicine and biotechnology, and so forth. The scale and performance requirement of micro-/nanosystems present a number of challenges to the control system design. In the micro-/nanoworld, the displacements ranging from nanometers to tens of microns and forces from piconewtons to tens of micronewtons are mostly involved. The system performances are very sensitive to external environmental conditions in terms of vibration, temperature, humidity, air velocity, and so on. Due to the precision requirement, the control system design for the micro-/nanoworld concerns with actuation and sensing, monitoring and modeling, dynamics, characterization, position/force measurement techniques, signal processing, controller design, motion planning, hardware implementation, material fabrication, and so on.

The objective of this special issue is to report some most recent developments and contributions in the micro-/nanosystems control. After a thorough review process, a total of 6 out of the submitted papers have been accepted for this special issue and present interesting results.

Piezoelectric actuators are widely used in nano-/micro-positioning systems owing to their attractive properties of fast frequency response, nanometer scale resolution, and high stiffness. In order to achieve a precise positioning, the hysteresis nonlinearity needs to be well understood and suppressed. To tackle this issue, G. Zhang et al. develop a memory-based parabola model to capture the hysteresis behavior using the mathematical transformation. A new converging point was updated to compensate for the prediction error when the hysteresis path hits the upper converging point. The experimental and simulation results demonstrate that the prediction accuracy of the proposed model is noticeably improved as compared with the model without memory operator.

Air pollution is one of the most challenging problems in many cities nowadays. The increased use of motor vehicles causes the amount of exhaust emissions to increase dramatically, which makes the problem more serious. Diesel engines are used extensively in buses and trucks; thus they are the major roadside emitters, posing a significant threat to the health of the road users. In order to reduce these emissions, the combustion process of the engines has to be controlled. A new approach for modeling the performance and emissions of diesel engine is proposed by P.-K. Wong et al. The adopted relevance vector machine (RVM) method is stated clearly and a feasible learning algorithm is given with technical details. The conducted experimental comparative studies demonstrate the superiority of proposed RVM modeling

approach over the conventional ANN ones. This paper represents a new attempt using RVM.

The status of microparticle in air is crucial for our daily life. Forecasting of air pollution is a popular and important topic in recent years due to the health impact caused by air pollution. It is necessary to build an early warning system, which provides forecast and also alerts health alarm to local inhabitants by medical practitioners and the local government. C. M. Vong et al. propose the air pollutant regression modeling and time series prediction using support vector machines technique. The air pollutant modeling and prediction for Macau area can also be extended to other areas. By acquiring the real data, five SVM models with different kernel functions are established and their performances are well investigated. With a series of comparative studies, it is concluded that the SVM with linear or RBF kernel is capable of predicting the air pollutant accurately.

Engine power, brake-specific fuel consumption, and emissions relate closely to air ratio (i.e., lambda) among all the engine variables. An accurate and adaptive model for lambda prediction is essential to effective lambda control for long term. H. C. Wong et al. present a new model predictive control algorithm for air ratio regulation based on an emerging technique, relevance vector machine (RVM). This work gives good supporting evidence that RVM predictive controller may be used as a useful scheme to replace the conventional proportional-integral controller. The methodology has been clearly described while RVM model for engine air-ratio had been successfully implemented and tested on a real car with a satisfied performance, on which RVM model had not been done before.

Flexible electronics is an emerging technology with a tremendous challenge, but has a great potential for applications in display, portable electronics, healthcare, and so forth. So far, flexible electronics has been limited to electronic devices such as diodes and transistors. J. Zhou et al. present the fabrication of high frequency surface acoustic wave (SAW) devices on AlN films, which have potentials in flexible microfluidic applications. The structural properties of AlN films on polymer substrate are also characterized. The obtained resonant frequencies of the SAW devices show no severe deterioration in acoustic speed on the soft substrate, and the results are consistent with the theoretical modeling.

Finally, aiming at portable applications, P. Jin et al. present a new integrated tiny mass sensor based on the thin film bulk acoustic resonator (FBAR) and CMOS technology. The fabricated FBAR the has resonance frequency of 1.878 GHz and Q factor of 1200. The precision of the whole processing chip is 1 KHz with the FBAR frequency gap from 25 kHz to 25 MHz. The whole FBAR signal processing circuit is verified with 0.18 $\mu$m RF/Mixed-signal CMOS process. It is shown that the size of the entire chip with pads is only 1300 $\mu$m $\times$ 950 $\mu$m, which can be connected with FBAR to process its RF sensor signal and show mass change value directly.

We hope that the readers will find the special issue interesting and stimulating and expect that the included papers contribute to the further advance in the domain of micro-/nanosystems control. In addition, we would like to express our heartfelt thanks to all the authors who have submitted their papers and all the reviewers who helped handling the papers for this special issue.

*Qingsong Xu*
*Pak-Kin Wong*
*Minping Jia*
*Micky Rakotondrabe*
*Li Zhang*