Editorial

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Biographical notes: Feng Qiao received his BEng in Electrical Engineering and MSE in Systems Engineering from the Northeastern University, Shenyang, China in 1982 and 1987, respectively, and his PhD in Intelligent Modelling and Control from the University of the West of England, UK in 2005. From 1987 to 2001, he worked at the Automation Research Institute of Metallurgical Industry, China as a Senior Engineer in Electrical and Computer Engineering. He is currently a Professor of Control Systems at the Shenyang JianZhu University, China. His research interests include fuzzy systems, neural networks, non-linear systems, stochastic systems, sliding mode control, wind energy conversion systems, structural vibration control and robotic manipulation. He is acting as an Associate Editor of the *International Journal of Modelling, Identification and Control*.

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In control engineering practice, various control methodologies have been developed to tackle the problems of non-linearity, uncertainty and disturbance within systems which make the modelling and control of the systems very difficult and deteriorate the performance of the systems when model-based approaches are employed. Among them, sliding mode control has recently been one of the most exciting research topics in variety of fields in control engineering since it emerged in 1960s. It has attracted much attention both in scientific research and practical engineering due to its inherent robustness to non-linearities, uncertainties and disturbances. Recently, there have been numerous reports of very successful academic achievements and engineering applications of sliding mode control systems. Several leading control journals published special issues on the advancements of sliding mode control theory and applications in the last decade. The application areas of sliding mode techniques have been extended to power electronics, motion control, automotive engine regulation, robotics, fault detection and diagnosis, etc.

The purpose of this special issue of *IJMIC* is focused on the state of the art solutions in the field of sliding mode control system design and their industrial applications. After careful selection from many submissions, ten papers are finally included in this issue. We believe that the collection in this special issue on sliding mode control will provide a valuable reference for scientists and engineers who are interested in theoretical study and engineering applications dealing with system analysis, synthesis, and design with structure uncertainties, parameter perturbations and external disturbances.

In the paper, 'A new fractional interpolation-based smoothing scheme for variable structure control', J-X. Xu and Y-J. Pan propose a new fractional interpolation-based smoothing scheme for variable structure control. The new scheme achieves the designated tracking precision bound with an adequate and yet moderate gain. Comparing with the well known saturation scheme, the new scheme achieves a smoother control profile and possesses extra flexibility in adjusting the equivalent control gain while retaining the same precision bound.

In the paper, 'Sliding mode-like learning control for SISO complex systems with T-S fuzzy models', F. Tay, Z. Man, Z. Cao, S.Y. Khoo and C.P. Tan develop a sliding mode-like learning control scheme for a class of single input single input complex systems. The advantages of this scheme are that

1. the information about the uncertain system dynamics and the system model structure is not required for the design of the learning controller
2. the closed loop system behaves with a strong robustness with respect to uncertainties
3. the control input is chattering-free.

The sufficient conditions for the sliding mode-like learning control to stabilise the global fuzzy model are discussed in detail.

In the paper, 'Finite-time cooperative attitude control of multiple spacecraft using terminal sliding mode control technique', H. Du and S. Li address the problem of finite-time cooperative attitude control of multiple spacecraft with leader-follower architecture. Using terminal sliding mode control technique, a distributed finite-time attitude control law has been proposed. It has been shown that all the followers can track the leader in a finite time.

In the paper, 'Neural network-based adaptive sliding mode control for uncertain non-linear MIMO systems', N. Goléa, G. Debbache and A. Goléa design a neural network-based adaptive sliding mode controller (SMC) for uncertain unknown MIMO non-linear systems. A special architecture adaptive neural network, with hyperbolic tangent activation functions, is used to emulate the equivalent and switching control terms of the classic SMC. The bounded motion of the system around the sliding surface and the stability of the global system, in the sense that all signals remain bounded, are guaranteed.

In the paper, 'Sliding mode controllers for second order and extended Heisenberg systems', M.R. Zarrabi, M.H. Farahi, S. Effati and A.J. Koshkouei present a method to design an SMC for extended Heisenberg system which is a class of non-linear systems. Some sufficient conditions are introduced.

In the paper, 'Fault-tolerant sliding mode control for the interferometer system under the unanticipated faults', Y. Shi, C. Zhou, X. Huang and Q. Yin present an active FTC scheme for the interferometer system in the presence of micro-gravity, micro-vibration and thermal disturbances in space. Kinds of unanticipated faults are quickly detected by the residue detection. Neural network is used to estimate the unanticipated faults online. The sliding mode control with a reaching law is designed for the normal control with a fixed upper bound and for the FTC with an adaptive upper bound adjusted by the neural network to recover the system performance under the faults.

In the paper, 'GPI observer-based non-linear integral sliding mode control and synchronisation of uncertain chaotic systems', D. Zhao, Y. Wang and L. Liu propose an output feedback control scheme for a class of triangular chaotic systems in the presence of system uncertainties, unknown disturbances, parameter perturbations and measurement noises. A high gain general proportional integral observer is used for the accurate linear estimation of the error states, non-linear endogenous and exogenous disturbances from the noisy output signals of the system, and then a non-linear integral SMC with active disturbance cancellation is proposed for the tracking control and synchronisation of the chaotic systems.

In the paper, 'Fuzzy sliding PDC control for some non-linear systems', Y-J. Mon and C-M. Lin propose a new design method of fuzzy sliding PDC controller applied to deal with some non-linear systems subject to unpredictable but bounded disturbances. A new fuzzy integral sliding surface vector based on the PDC concept is defined for the proposed fuzzy sliding PDC control. The Lyapunov stability condition is guaranteed in this design to develop strictly robust sliding PDC gains F_i. This fuzzy sliding PDC controller is applied to control the ecological system and pendulum system.

In the paper 'Adaptive sliding mode control for uncertain discrete-time systems using an improved reaching law', T. Yoshimura proposes an adaptive SMC, which is composed of the equivalent and the modified switching controls, and it is designed so that the time variation of the sliding surface is expressed as a discrete-time polynomial. The estimates for the un-measurable states and the uncertainties are obtained by the proposed weighted extended Kalman filter (WEKF) using a set of the noisy measurements. It is proved that the estimation errors will converge to zero as time tends to infinite under some conditions, and that the states for the dynamic systems are ultimately bounded under the action of the proposed adaptive SMC.

In the paper, 'Adaptive fast finite-time multiple-surface sliding control for a class of uncertain non-linear systems', S. Khoo, S. Zhao and Z. Man propose an adaptive fast finite-time multiple-surface sliding control approach for a class of high-order uncertain non-linear systems of which the upper bounds of the system uncertainties are unknown. By using the fast control Lyapunov function and the method of so-called adding a power integrator merging with adaptive technique, a recursive design procedure is provided, which guarantees the fast finite-time stability of the closed-loop system. Further, it is proved that the control input is bounded.