Editorial

Ahmad Taher Azar*

Faculty of Computers and Information,
Benha University,
Benha, Al Qalyubia Governorate 13511, Egypt
and
Nanoelectronics Integrated Systems Center (NISC),
Nile University,
Sheikh Zayed District, Juhayna Square,
Postal Code: 12588, 6th of October City, Giza, Egypt
Email: ahmad_t_azar@ieee.org
Email: ahmad.azar@fci.bu.edu.eg
*Corresponding author

Sundarapandian Vaidyanathan

Research and Development Centre,
Vel Tech University,
Avadi, Chennai-600 062, Tamil Nadu, India
Email: sundarcontrol@gmail.com

Abdesselem Boulkroune

LAJ Laboratory,
University of Jijel,
BP. 98, Ouled-Aissa, 18000 Jijel, Algeria
Email: boulkroune2002@yahoo.fr

The Third International Conference on Automation, Control, Engineering and Computer Science (ACECS-2016) was conducted during March 20–22, 2016 at Hammamet, Tunisia. The conference provided an excellent research forum for professionals, academics, and researchers to share knowledge and results on automation, control, engineering, computer science and information technology. Broad areas of ACECS-2016 were classified as computer science and IT, signal processing and communication, robotics, control and instrumentation, engineering and automation, and engineering management.

In practice, the implementation of control input is usually faced with the problem of nonlinearity in control input due to non-ideal characteristics of actuators used in physical implementations. Adaptive control theory for nonlinear systems has attracted much attention during the past two decades. Recently, adaptive control based on universal approximations such as fuzzy logic systems, RBF neural networks or fuzzy-neural networks have been considered extensively in the control problems of complex and ill-defined nonlinear systems in the presence of incomplete knowledge of the plant.

Observer-based robust adaptive universal approximation control schemes are very useful for tackling the problem of robust stability and the tracking control for a class of uncertain nonlinear SISO systems and MIMO systems with or without time delays. Also, adaptive universal approximation control schemes have impact for a class of nonlinear systems with dead-zone and multiple time-delays based on dynamic surface control technique.

In this part 1 of the special issue of the *International Journal of Automation and Control* (*IJAAC*), we are delighted to select eight research articles reporting on recent advances and applications in observer-based fuzzy, neural and adaptive control. This special issue contains extended papers of ACECS-2016 Conference as well as research articles of experts and research scholars.

It is hoped that this special issue will provide a useful reference for informing recently developed technologies in intelligent control and engineering informatics. The contents of the selected eight articles are described briefly as follows:

The paper titled 'A novel 4-D hyperchaotic system with two quadratic nonlinearities and its adaptive synchronisation' by Sundarapandian Vaidyanathan, Ahmad Taher Azar and Abdesselem Boulkroune describes an 11-term novel 4-D hyperchaotic system with two quadratic nonlinearities. A qualitative analysis of the properties of the novel 4-D hyperchaotic system has been presented in detail. A special feature of this novel hyperchaotic system is that it has three equilibrium points of which two are unstable and one is locally asymptotically stable. The Lyapunov exponents of the novel hyperchaotic system have been derived as $L_1 = 1.5146$, $L_2 = 0.2527$, $L_3 = 0$ and $L_4 = -12.7626$. The Kaplan-Yorke dimension of the novel hyperchaotic system has been determined as $D_{KY} = 3.1385$. This article also describes an adaptive controller design for the global hyperchaos synchronisation of identical novel hyperchaotic systems with unknown parameters. The main result of the adaptive controller design has been established using Lyapunov stability theory. MATLAB simulations have shown to describe all the main results derived in this work on the novel hyperchaotic system with two quadratic nonlinearities.

The paper titled 'Adaptive nonlinear observer augmented by radial basis neural network for a nonlinear sensorless control of an induction machine' by Mourad Boufadene, Mohammed Belkheiri and Abdelhamid Rabhi presents an adaptive neural network nonlinear observer associated with a sensorless nonlinear feedback linearisation controller for induction machine. The proposed observer is used to estimate the mechanical speed using the stator currents measurements and the supplied input voltages. Also, the load torque (unknown disturbance) is estimated using online radial basis neural network function approximation. The stability of the proposed controller-observer has been established using Lyapunov stability theory. Simulation results using MATLAB and Simulink have been detailed to illustrate the performance of the proposed algorithm.

The paper titled 'A Takagi-Sugeno fuzzy control of induction motor drive: experimental results' by Habib Ben Zina, Moez Allouche, Mansour Souissi, Mohamed Chaabane, Larbi Chrifi-Alaoui and Maha Bouattour our studies an observer-based H_∞-tracking control problem for induction motor in order to guarantee the field-oriented control (FOC) performances. First, the physical model of the induction motor is approximated by the Takagi-Sugeno (T-S) fuzzy technique in the synchronous d-q frame rotating. Then a fuzzy observer-based feedback control is synthesised to guarantee the control performances. The proposed controller is based on a T-S reference

model in which a desired trajectory has been specified. The performances of the trajectory tracking are analysed using the Lyapunov theory and the L_2 optimisation. The gains of the observer and the controller are obtained by solving a set of LMIs constraint in a single step. Experimental results are presented for a 1.5 KW induction motor to highlight the effectiveness of the T-S fuzzy controller proposed in this work.

The paper titled 'Fuzzy fractional sliding mode observer design for a class of nonlinear dynamics of the cancer disease' by Saeed Rooka and Reza Ghasemi proposes a design to optimise controller parameters for improvement of the performances of cancer dynamic by combining both T-S fuzzy sliding mode method and fractional variable structure control. The fractional fuzzy controller matched is formulated here. The main stability conditions are established based on linear matrix inequalities (LMIs), where the fractional-order a belongs to $0 < a < 1$. Furthermore, this method investigates T-S fuzzy method to design fractional observer to estimate states of the fractional nonlinear dynamic of drug administration in cancer chemotherapy based on the sector nonlinearity method. This approach presents a mathematical model to expand the dynamics between tumour cells, normal cells, immune cells, chemotherapy drug concentration and drug toxicity. The stability of the closed-loop system and the convergence of both the observer and the tracking error to zero are the main merits of the proposed method. The simulation results show the promising performance of both the observer and controller scheme.

The paper titled 'Discrete-time sliding mode control of a class of linear uncertain saturated systems' by Borhen Torchani, Chaker Zaafouri, Anis Sellami and Germain Garcia proposes a new design approach of discrete-time sliding mode control of a class of linear uncertain systems in presence of saturation constraint. The saturation constraint is reported on inputs vector and it is subject to constant limitations in amplitude. The uncertainty is being norm bounded reported on both dynamic and control matrices. In general, sliding mode control strategy consists on two essential phases. The design of the quasi-sliding surface is the first phase which is formulated as a pole assignment of linear uncertain and saturated system in a specific region through convex optimisation. The solution to this problem is therefore numerically tractable via LMIs optimisation. The controller design is the second phase of the sliding mode control design, which leads to the development of a continuous and nonlinear control law. An approximation on the trajectory deviation of the uncertain saturated system compared to the ideal behaviour is proposed to provide robustness of the nonlinear control. Finally, the validity and the applicability of this approach are illustrated by a multivariable numerical example of a robot pick and place.

The paper titled 'Adaptive fuzzy control strategy for greenhouse micro-climate' by Mouna Boughamsa and Messaoud Ramdani describes a model predictive controller design to regulate the greenhouse micro-climate, where the controller outputs are computed to optimise the future behaviour of the greenhouse's environment, concerning the set-point accuracy of the internal temperature and humidity described by T-S model. Modelling procedure is based on two steps. First, the identification of the antecedent part where local linear models are valid using the well-known fuzzy C-means clustering algorithm. Then, recursive least squares (RLS) algorithm is used for consequent part parameters adaptation. An adaptive T-S fuzzy model is considered within the control scheme for prediction of the future greenhouse behaviour. The main way of controlling the greenhouse micro-climate is to use heating and ventilation to regulate both internal temperature and humidity. The simulation results show that the proposed

approach maintains successfully both temperature and humidity within the greenhouse around the desired set-points in the presence of disturbances. The numerical simulation results are also compared between MPC controller based on T-S fuzzy model and MPC based on a single linear model.

The paper titled 'Load frequency control of multi-area interconnected thermal power system: artificial intelligence-based approach' by Kaliannan Jagatheesan, Baskaran Anand, Nilanjan Dey, Amira S. Ashour and Valentina E. Balas proposes an artificial intelligence (AI)-based optimisation technique for load frequency control issue for oscillations suppression in the power system response, namely frequency, tie-line power exchange and area control error. Proper control mechanism in the system during sudden load changes affects the quality represented by the consistency and the adequacy of the generating unit power. The investigated system consists of three equal thermal generating units. Each unit equipped with proportional-integral-derivative (PID) controller, reheater unit and appropriate nonlinearity. The PID controller gain values are obtained by using three different cost functions including the integral square error (ISE), integral time absolute error (ITAE) and integral absolute error (IAE). Load perturbation of 1% and 2% is considered in thermal area 1 for the performance analysis of the AI optimisation technique. Additionally, time domain specifications of the settling time and overshoot are considered in the system response analysis. The experimental results demonstrate that the proposed optimisation-based ACO algorithm has achieved tuning performance for the PID controller gain values, which depends on the cost functions.

The paper titled 'Modelling, stability analysis and computational aspects of nonlinear fuzzy PID controllers using Mamdani minimum inference' by N.K. Arun and B.M. Mohan presents two new mathematical models of the simplest fuzzy PID controller which employ two fuzzy sets (negative and positive) on each of the three input variables (error, change in error and double change in error) and four fuzzy sets (–2, –1 +1, +2) on the output variable (incremental control). *L*-type, Γ-type and Π-type membership functions are considered in fuzzification process of input and output variables. Controller modelling is done via algebraic product AND operation, maximum/bounded sum OR operation, Mamdani minimum inference method, and centre of sums (CoS) defuzzification. The new models obtained in this manner turn out to be nonlinear, and their properties are studied in detail. Since digital controllers are implemented on the digital processors, the computational and memory requirements of the fuzzy controllers and conventional (non-fuzzy) controller are compared. Stability analysis of closed-loop systems containing the fuzzy controller models is done using the small gain theorem.

The guest editors would like to thank all the authors for submitting their manuscripts in this special issue. We would want to acknowledge the reviewers for their contributions in reviewing the papers and providing constructive and useful comments to the authors. Finally, the guest editors would like to specially thank the Editor-in-Chief of *International Journal of Automation and Control* (*IJAAC*), Professor N.P. Mahalik (California State University, Fresno, USA) for his great help and support in organising and coordinating the publication of this special issue.