Editorial

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Biographical notes: Ahmad Taher Azar received his MSc in 2006 and PhD in 2009 from the College of Engineering, Cairo University, Egypt. He is a Research Associate Professor at Prince Sultan University, Riyadh, Saudi Arabia. He is also an Associate Professor at the Faculty of Computers and Artificial Intelligence, Benha University, Egypt. He is the Editor-in-Chief of *International Journal of System Dynamics Applications* published by IGI Global, USA. Also, he is the Editor-in-Chief of *International Journal of Intelligent Engineering Informatics*, Inderscience Publishers, Olney, UK. He worked as an Associate Editor of *IEEE Trans. Neural Networks and Learning Systems* from 2013 to 2017. He is currently an Associate Editor of ISA Transactions, Elsevier, and IEEE Systems Journal. He worked in the areas of control theory and applications, robotics, process control, nonlinear control, machine learning and computational intelligence.

Sundarapandian Vaidyanathan is a Professor and Dean at the R&D Centre, Vel Tech University, Chennai, India. He received his DSc in Electrical and Systems Engineering from Washington University, St. Louis, USA, in 1996. He has published over 500 Scopus indexed research papers. His current research focuses on control systems, chaos theory, chaotic and hyper chaotic systems, sliding mode control, neuro-fuzzy control, computational science, circuits and memristors. He is the Editor-in-Chief of *International Journal of Nonlinear Dynamics and Control (IJNDC)*, Inderscience Publishers, Olney, UK. He is also in the Editorial Boards of many control journals published by Inderscience, Olney, UK.

Intelligent control is multidisciplinary in nature as it seeks inspiration from biology, and it combines and extends theories and methods from several areas such as control theory, mathematics, and computer science.

Intelligent control describes a class of control techniques that use various artificial intelligence techniques such as neural network control, fuzzy logic control, neuro-fuzzy control, expert systems, genetic control, evolutionary algorithms, multi-sensor integration, failure diagnosis, reconfigurable control, and swarm algorithms. Intelligent control systems are very useful in robotic areas when no mathematical models are available a priori and intelligent control itself develops a system to be controlled.

This special issue focuses upon theory, modelling and applications of intelligent control systems for robotic applications. It is hoped that this special issue will provide a useful reference for informing recently developed technologies in robotic intelligent control systems.

The contents of the five papers selected for this special issue are described briefly as follows:

The paper titled 'Improving the performance of medical robotic system using H_∞ loop shaping robust controller' by Ali et al., synthesises a robust controller via H_∞ loop shaping for a human swing lower limb system in order to solve the relevant and yet open problem of precise tracking. As reliable and efficient controller for a human swing leg robot system faces strong problems due to weight variations, modelling uncertainties and different disturbing effects, this research work takes into account various modelling constraints through designing a robust controller based on loop-shaping framework. This approach provides an appropriate way to compromise the robustness and

precise tracking for a prespecified variation of weight factors, and uncertainties in the dynamical models. In order to obtain the whole gesture of all muscles, two necessary control actions were developed and applied at the joints. The paper demonstrates rigorously the robust stability and tracking. The obtained results from numerical examples confirm the effectiveness of the proposed controller as well as its remarkable simplicity.

The paper titled 'Hybrid ANFIS-ants colony based optimisation for quadrotor trajectory tracking control' by Selma et al., proposes an optimal intelligent controller based on adaptive-network-based fuzzy inference system (ANFIS) and ant colony optimisation (ACO) algorithm to govern the behaviour of a three degree of freedom quadrotor unmanned aerial vehicle. The quadrotor was chosen owing to its simple mechanical structure; nevertheless, these types of aircraft are highly nonlinear. Intelligent control such as fuzzy logic is a suitable choice for controlling nonlinear systems. The ANFIS controller is used to reproduce the desired trajectory of the quadrotor in 2D vertical plane and the ACO algorithm aims to facilitate convergence to the ANFIS's optimal parameters in order to reduce learning errors and improve the quality of the controller. To evaluate the performance of the proposed ACO tuned ANFIS controller, a comparison between the proposed ANFIS-ACO controller and other controllers' performance, such as ANFIS only and proportional-integral-derivative (PID) controllers, is illustrated using the same system. It is shown that the hybrid ANFIS-ACO controller gives more satisfactory results than the others methods already developed in the same study.

The paper titled 'A novel sliding mode composite control design for fast time performance of quadrotor UAV' by Nadda and Swarup, presents a composite control approach to perform the attitude and position tracking of a quadrotor (UAV). The proposed control scheme has two steps. In the first step, the dynamical model is decomposed into two parts, i.e., a fully actuated subsystem and an under actuated subsystem. In the second step, the sliding mode control has been used to control the under actuated subsystem, and terminal sliding mode control has been exploited to control the fully actuated subsystem. The terminal sliding mode control with nonlinear sliding surface for high accuracy tracking performance is applied to the fully actuated subsystem, and sliding mode control with linear sliding surface is applied to the under actuated subsystem. The application of terminal sliding mode provides the guarantee of finite time convergence. The stability of the system has been ensured by obtaining the condition on the control parameter using Lyapunov criterion. The performance of the proposed control was evaluated and it has been found that there is substantive improvement over the performance of the conventional one.

The paper titled 'Backstepping controller design with a quadratic error for a double inverted pendulum' by Elkinany et al., focuses on presenting a conceptualisation of a double inverted pendulum system based on modelling, and controlling this model by applying only a single torque in the upper part instead of the lower part of the double inverted pendulum. Nonlinear dynamic equations were analysed using the Lagrangian dynamic formulation, while the graphical presentation of the system has been achieved through applying the bond graphs approach. The double inverted pendulum representation was incarnated using the 20-Sim software to build the system bond graphs in order to check on the motion. To achieve the system's stability, only one command was applied on the upper part. Most importantly, a control approach combining the backstepping method with the quadratic error was designed taking into consideration all nonlinearities that cannot be deleted. Indeed, the simulation results affirmed the effectiveness of the backstepping controller with the quadratic error, and a good response of the system's flexibility was ensured in the sense that it can be adjusted from the initial position to the equilibrium position.

The paper titled 'Fractal, chaos and neural networks in path generation of mobile robot' by Nasr et al., aims to solve problems involved in the path planning for the mobile robot with obstacle avoidance. Therefore, the authors have proposed three approaches for the control using:

- fractal process system
- neural networks
- a combination between chaos and fractal.

Firstly, the paper presents the fractal process system and its impact in the trajectory of robot. Secondly, a new variable structure model of neuron is used to control the robot's trajectory in presence of obstacles with different positions. Thirdly, a new controller has been designed by combining chaos and fractal process system inspired from Julia set. Several numerical examples of trajectory control for the mobile robot have been presented to illustrate the proposed control mechanisms.

The Guest Editors would like to thank all the authors for submitting their manuscripts in this special issue. We also 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 *Int. J. Modelling, Identification and Control (IJMIC)*, Professor Quan Min Zhu (University of the West of England, UK) for his great help and support in organising and coordinating the publication of this special issue.