Editorial

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Biographical notes: Ahmad Taher Azar received his MSc in 2006 and PhD in 2009 from the Faculty of Engineering, Cairo University, Egypt. He is currently an Associate Professor at the Faculty of Computers and Information, Benha University, Egypt. He is the Editor-in-Chief of *International Journal of System Dynamics Applications* (*IJSDA*) published by IGI Global, USA. He is also the Editor-in-Chief of *International Journal of Intelligent Engineering Informatics* (*IJIEI*), Inderscience Publishers, Olney, UK. He has been a senior member of IEEE since 2013 and has worked in the areas of control theory and applications, process control, chaos control and synchronisation, nonlinear control, robust control, computational intelligence and has authored/co-authored over 200 research publications in peer-reviewed reputed journals, book chapters and conference proceedings. He is an editor of many books in the field of intelligent control, sliding mode control, fuzzy logic control, chaos modelling and control, computational intelligence, and machine learning.

Sundarapandian Vaidyanathan is a Professor and Dean at the Research and Development Centre, Vel Tech University, Chennai, India. He received his DSc in Electrical and Systems Engineering from the Washington University, St. Louis, USA in 1996. His current research focuses on control systems, chaos theory, sliding mode control, neuro-fuzzy control, computational science, circuits and memristors. He has published over 450 Scopus-indexed research papers. He is the Editor-in-Chief of *International Journal of Nonlinear Dynamics and Control* (IJNDC), Inderscience Publishers, Olney, UK. He is also on the editorial board of many engineering journals published by Inderscience, Olney, UK.

Chaotic processes are dynamical systems arising in the engineering modelling of various processes that are highly sensitive to initial conditions. Chaotic processes also include as a special case hyperchaotic processes, which are chaotic systems having at least two positive Lyapunov exponents. Thus, hyperchaotic processes have very complex dynamical behaviour which can be used to improve the security of a chaotic communication system. Hence, the theoretical design and circuit realisation of various hyperchaotic signals have become important research topics in recent years.

In this special issue of the *International Journal of Simulation and Process Modelling*, we are delighted to select six research articles reporting on latest developments, trends, research solutions and applications of chaotic processes. It is hoped that this special issue will provide a useful reference for informing recently developed methodologies and applications of chaotic processes. The contents of the selected six articles are described briefly as follows.

The paper titled 'A new biological snap oscillator: its modelling, analysis, simulations and circuit design', by Sundarapandian Vaidyanathan, Moez Feki, Aceng Sambas and Chang-Hua Lien, proposes a new 4D autonomous biological snap oscillator model for enzyme-substrate reactions in a brain waves model. This paper investigates

the process modelling of the new autonomous biological snap oscillator via phase portraits, simulations, dissipativity, symmetry, Lyapunov exponents, Kaplan-Yorke dimension, bifurcation analysis, Poincaré map, etc. This paper also builds an electronic circuit model of the new biological snap oscillator using MultiSim and the simulations are analysed in detail.

The paper titled 'Extreme multi-stability in hyperjerk memristive system with hidden attractors and its adaptive synchronisation scheme', by Dimitrios A. Prousalis, Christos K. Volos, Ioannis N. Stouboulos and Ioannis M. Kyprianidis, investigates the phenomenon of extreme multi-stability in a novel 4D hyperjerk memristive system. The proposed system belongs to the category of dynamical systems with hidden attractors due to infinite equilibrium points. The behaviour of the system is investigated through numerical simulations, by using well-known tools of nonlinear theory, such as phase portrait, bifurcation diagram and Lyapunov exponents. Moreover, the case of chaos synchronisation of the system with unknown parameters, using adaptive synchronisation method, is investigated.

The paper titled 'Complex walking behaviours, chaos and bifurcations of a simple passive compass-gait biped model suffering from leg length asymmetry', by Hassène Gritli, Nahla Khraief and Safya Belghith deals with the analysis of the displayed nonlinear phenomena, chaos and bifurcations, in the planar passive dynamic walking of the planar compass-gait biped model under a leg length asymmetry as it goes down an inclined surface. The passive dynamic walking of the compass-gait model is modelled with an impulsive hybrid nonlinear dynamics. This paper presents a normalised dynamics expressed in terms of dimensionless ratios. The analysis and simulation of the passive bipedal gaits model is realised mainly through bifurcation diagrams where a normalised leg length discrepancy is adopted as the bifurcation parameter. This paper also reports the exhibition of complex behaviours, namely the period-doubling bifurcation, the cyclic-fold bifurcation, the period-doubling route to chaos, the period-remerging scheme, the boundary crisis, etc.

The paper titled 'String of scrolls from a time-delayed chaotic circuit', by Fadhil Rahma Tahir, Ghaida A. Al-Suhail and Mariam Hussien Abd, concerns on the design and implementation of multi-scroll chaotic attractors such as two-scrolls, three-scrolls and four-scrolls generated from a first-order delay differential equation. Modelling a time-delayed feed-back chaotic system considers a simple nonlinearity piecewise-linear (PWL) function to generate the chaotic attractors with an odd/even numbers of scrolls. The delayed feedback consists of a cascade of Bessel filter and the design of a circuit which generates string of scrolls chaotic attractors depends on the number of intersection points of nonlinearity of PWL function with a state variable. The implementation based on circuit-switching mode with simple components such as resistors, capacitors, and operational amplifiers is also presented.

The paper titled 'Secure communication and image encryption scheme based on synchronisation of fractional order chaotic systems using backstepping', by M.K. Shukla and B.B. Sharma presents the design of a backstepping-based controller for the synchronisation of two similar fractional order chaotic systems in master-slave configuration. This synchronisation scheme is further applied to address the problem of secure communication. In case of secure communication, the controller obtained is divided into two parts and one part is transmitted through the communication channel whereas the other part has to be designed at the receiver end after achieving synchronisation between master and slave system. The scheme presented here is different from the traditional one found in the literature, in the perspective of achieving synchronisation of transmitter and receiver systems. Only two signals are transmitted, one of which has the embedded message signal and the other is a complex combination of master states, which will be used for synchronisation purpose at the receiver end for recovery of the message signal. The complexity of the control signal makes it very difficult for the intruder to decode the information. The proposed schemes of secure transmission of text and the image encryption can be further extended for colour images.

The paper titled 'Stability study and dynamical analysis of the multicellular chopper', by Philippe Djondiné, Jean-Pierre Barbot and Malek Ghanes describes the dynamical properties of a two cells chopper connected to a particular nonlinear load. Some interesting and complex attractors are obtained by means of Lyapunov exponents, fractal dimension, Poincaré mapping, first return, bifurcation diagram and phase portraits, respectively. The main model is described by a continuous-time 3D non-autonomous system and displays two-scroll chaotic attractors for certain values of its parameters. The analysis of the results shows clearly that this is a new chaotic system which deserves further detailed investigation. Finally, phase portraits are obtained by using MATLAB/Simulink, which validates the theoretical analysis results.

The guest editors would like to thank all the authors for submitting their manuscripts in this special issue and acknowledge the reviewers for their valuable 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 Simulation and Process Modelling*, Professor Feng Qiao (Shenyang JianZhu University, China), for his great help and support in organising and coordinating the publication of this special issue.