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Editorial

Modelling, Control Methods and Applications of Chaotic Oscillators

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Nonlinear oscillations have been observed in numerous areas of science as well as engineering [1–4]. Some typical oscillations relate to nonlinear pendulums, population models, business cycles, and jerk systems [5]. Since the discovery of chaotic oscillations in a nonlinear weather model by Lorenz in 1963, chaotic oscillators, their modelling, and control have received much attention in the literature [1]. Chaotic systems and chaotic maps are widely applied in engineering domains such as mechanical oscillations [6, 7], robotics [8–10], nanosystem [11], lasers [12–14], nuclear reactor [15], neural networks [16], encryption [17, 18], cryptosystems [19], and communication devices [20].

This special issue focused on the modelling, control methods and various applications of chaotic oscillators in nature and society. This special issue contains ten articles, the contents of which are summarized as follows.

Vaidyanathan et al. [21] proposed a new four-dimensionaltwo-scroll hyperchaotic system having only two quadratic nonlinearities in their research article and elucidated a detailed bifurcation study of the proposed two-scroll hyperchaotic system. The swift advancement of various areas of chaos theory has paved way into the modelling and engineering applications of chaotic and hyperchaotic systems in various fields. The authors also present the construction of an electronic circuit for the new system using MultiSim (Version 14). With the application of the Forward Euler Method and Trapezoidal method, the authors have dealt with the implementation of the new two-scroll hyperchaotic system using the model of a field-programmable gate array (FPGA). Details have been provided of the hardware resources used for an FPGA Basys 3 Xilinx Artix-7 XC7A35T-ICPG236C.

Kammogne et al. [22] discussed the complex dynamics and properties of memristive load using current-mode-controlled in buck converter in their research article. It is well-known that electronic power converters exhibit some complex features that can be influenced by the structure parameters, load, and pulse period of the converter. In this article, the authors investigate the complex dynamic phenomena occurring in the dc/dc buck converter, where the main part of this study is consecrated to the nonlinear dynamics when the converter load is memristive. The dynamics analysis of the buck converter with memristive load is carried out with signal plots, bifurcation tools, and Lyapunov diagrams which demonstrate the rich and striking behaviors of the nonlinear dynamical system such as periodic orbits, period-doubling bifurcation, quasiperiodicity, chaos, and pinched hysteresis loops of the memristive load. Finally, the MATLAB simulation results of the buck converter with memristive load are shown to be in good agreement with the analog results obtained with PSIM.

Hosseinabadi et al. [23] proposed a new adaptive finite-time sliding mode backstepping (AFSMBS) control scheme in order to control a type of high-orderdouble-integrator systems with mismatched disturbances and uncertainties. The authors incorporate a robust sliding mode control, adaptive control method, backstepping control method, and finite-time stability notion to provide a better tracking performance over applying the techniques separately and to employ their advantages together. Finally, the authors describe simulation results for an example of a remotely operated vehicle (ROV) with three degrees of freedom to demonstrate the efficacy of the suggested control approach in their research article.

Erturk et al. [24] investigated the finding of an analytic solution for the strongly nonlinear multi-order fractional version of a Boundary Value Problem (BVP) associated with a chemical reactor. Using the generalized differential transform technique, the authors describe the procedure for the construction of an approximate analytic solution of the fractional form of a strongly nonlinear BVP with multi-fractional Caputo derivatives occurring in chemical reactor theory. The proposed method is very powerful and can be successfully applied to deal with various kinds of fractional nonlinear boundary value problems.

Yazid et al. [25] studied the asymptotic behavior of weak solutions of non-isothermal flow of Herschel–Bulkley fluid in a thin layer in associated with a nonlinear stationary, nonisothermal, and incompressible model. After formulating the problem statement and variational formulation, the authors derive the estimates for the velocity field and the pressure independently of the parameter. Finally, the authors present a specific Reynolds equation associated with variational inequalities.

Jan et al. [26] investigated the dynamics of HIV via fractional calculus in Atangana–-Baleanu framework to understand and formulate the intricate phenomena of this viral infection. The authors present a novel numerical technique for the chaotic and dynamic behaviour of the proposed model. The authors also demonstrate the effect of fractional order on the proposed system of HIV infection. Using numerical simulations, the authors highlight most critical input parameters and propose control intervention to the policy makers. The stability result and the convergence condition for the proposed numerical scheme are also discussed by the authors.

Ouyang et al. [27] designed and verified a fully integrated Chen chaotic oscillation system using OAs and multipliers. A unique feature of the proposed model is that the designed Chen chaotic oscillation system is integrated in a single chip with the advantages of smaller chip area, lower supply voltage, and power consumption. Furthermore, the fully integrated Chen chaotic system is verified with Cadence IC Tools.

Sellami et al. [28] investigated the limit cycles of a fifth-order ordinary differential equation (ODE) by using the averaging theory of the first order and detail sufficient conditions for the existence of limit cycles of the ODE.

Menaceur et al. [29] investigated the bifurcation of limit cycles from the period annulus surrounding the origin of a class of cubic polynomial differential systems by using the averaging theory of first order. In the literature of ordinary differential equations, it is well-known that limit cycles can be yielded by perturbing a system which has a centre in a suitable manner so that limit cycles bifurcate in the perturbed system.

Yang et al. [30] dealt with the multiarea power network model and specifically used the adaptive control method to analyze the cluster synchronization of a multiarea power network model consisting of a third-order chaotic power system. With a mixture of analytical considerations and numerical simulations on a small-scale multiarea power network model, the authors study on the cluster synchronous performance of the proposed system.

Data Availability

No data were used to support this study.

Conflicts of Interest

The editors declare that they have no conflicts of interest.

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