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Editorial: Advances in nonlinear systems and networks, volume II

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Editorial on the Research Topic
Advances in nonlinear systems and networks, volume II

1 Introduction

Nonlinear systems and networks refer to physical, chemical, biological, or engineering systems and networks that have nonlinear relationships within them. Compared to linear systems and networks, the characteristic of nonlinear systems and networks is the nonlinear relationship between input and output. In nonlinear systems and networks, the relationship between input and output does not follow the principle of linear superposition, so simple linear equations cannot be used to describe the behavior of systems and networks.

Nonlinear systems and networks are widely present in various fields, such as mechanics, circuits, chemical reactions, encrypted communication and biology [1–5]. The study of nonlinear systems is of great significance for us to deeply understand the essence of natural phenomena and improve engineering design. Due to the complexity, unpredictability, and adaptability of nonlinear systems and networks, their applications and research face significant challenges. But with the continuous development of science and technology, the research and application of nonlinear systems and networks are also deepening in various fields, such as chaotic systems [6–10], chaotic circuits [11–14], nonlinear devices [15–17], neural networks [18–24], neural circuits [25–28], memristors [29–31], system synchronization and control [32–36], system optimization [37–39], and related application fields [40–43].

Due to the success of the first Research Topic of "Advancements in Nonlinear Systems and Networks" [44], we have decided to continue to focus on the continuous progress of Nonlinear Systems and Networks in the second volume. In this Research Topic, 10 articles about nonlinear systems and networks and their applications are reported. For nonlinear networks, dynamic displacement estimation of structures using onedimensional convolutional neural network is studied (Zhou and He), and two-layer complex propagation network with individual heterogenous decreased behavior is analyzed (Tian et al.). A robust and fast representation learning model RFRL for heterogeneous networks is studied (Lei et al.). A reputation-based user electricity scheduling scheme for the complex network of user electricity consumption is proposed (Tang et al.). For nonlinear devices,

Ternary combinational logic gates (Li et al.) and current mode multi scroll chaotic oscillator (Lin et al.) are studied. For the synchronization control of nonlinear systems and networks, effective vibration control in Nano-Beams (Alsubaie), brain-like coupling synchronization (Fu et al.) and pinning synchronization (Yu et al.) are studied. In addition, considering the application of nonlinear systems and networks, a novel grid multi-structure chaotic attractor and its application in medical image encryption is researched (Hu et al.).

2 Summary of papers presented in this Research Topic

Zhou and He, in the paper "Dynamic displacement estimation of structures using onedimensional convolutional neural network," proposed a structural dynamic displacement estimation method based on one-dimensional convolutional neural networks and acceleration data. To verify the reliability of the method, this paper established a finite element-based framework structure. Collect the acceleration and displacement of each node in the framework model under earthquake response. In addition, a typical neural network was used for comparative research. The results show that the error of the neural network model in dynamic displacement estimation task is 9. 52 times that of the one-dimensional convolutional neural network model. Meanwhile, the proposed modeling scheme has strong noise resistance. To verify the practicality of the proposed method, the authors collected data from actual framework structures. The experimental results show that the mean square error of this method in actual dynamic displacement estimation tasks is only 5. 097, which meets the engineering needs.

Tian et al., in the paper "Dynamics analysis on two-layer complex propagation network with individual heterogenous decreased behavior," constructed a double-layer network model to describe individual behavioral contact and proposes a threshold function to represent individual heterogeneous decreased behavior (IHDB). Meanwhile, the authors use partition theory to explain the mechanism of information dissemination. Through experiments, it has been proven that there is a sustained information explosion in the final adoption scale when an individual exhibits positive IHDB. However, when individuals exhibit passive IHDB, the final adoption of scale will result in discontinuous information bursts. Finally, the experiment shows that the theoretical analysis is consistent with the simulation results.

Lei et al., in the paper "Robust and fast representation learning for heterogeneous information networks," studied a robust and fast representation learning model RFRL for heterogeneous networks. Firstly, the global features of heterogeneous networks are divided into multiple intra type local features and inter type local features, and a type aware biased sampling is designed to generate training samples for each local feature. Secondly, shallow representation strategies using node type perception and link type perception are used to learn intra type and inter type features, respectively. Finally, adversarial learning is used to integrate the above two representation strategies to address invisible network noise and enhance the robustness of representation learning. A large number of experiments on three network analysis tasks and three public datasets have demonstrated the good performance of the RFRL model proposed in this paper.

Tang et al., in the paper "Reputation-based electricity scheduling scheme for complex network of user electricity consumption," proposed a reputation-based user electricity scheduling scheme for the complex network of user electricity consumption. In the scheme of the paper, the authors first model the complex network of user electricity consumption. Then, a method for calculating the reputation of power users was constructed. In addition, the paper uses machine learning methods to train computational models to calculate the adjustment coefficients of power loads, and then adjusts power scheduling tasks based on the calculated adjustment coefficients. Finally, the corresponding power dispatch tasks are assigned to the selected power users for adjusting their electricity consumption. The experimental results demonstrate the effectiveness of the scheme.

Li et al., in the paper "Ternary combinational logic gates design based on tri-valued memristors," proposed a design method for ternary circuits without cascading basic ternary logic gates on the basis of ternary memristors. The proposed method can directly achieve specific logic functions through series memristors. At the same time, this method was used to implement a ternary encoder, ternary decoder, ternary comparator, and ternary data selector. Finally, the authors verified the effectiveness of the circuit through LTspice simulation.

Lin et al., in the paper "Current mode multi scroll chaotic oscillator based on CDTA," proposed a current mode chaotic oscillation circuit based on a current differential transconductance amplifier (CDTA). This circuit fully utilizes the advantages of current differential transconductance amplifiers. The linear and nonlinear parts of the proposed circuit operate in current mode, achieving a true current mode multi scroll chaotic circuit. Finally, the authors conducted simulations using Pspice, and the results showed that the proposed current type chaotic circuit can generate multi scroll chaotic attractors.

Alsubaie, in the paper "a neural state-space-based model predictive technique for effective vibration control in nano-beams," proposed a system recognition method based on deep neural networks and combines it with MPC. In addition, the paper ensures the robustness and convergence of the closed-loop system by adding control terms. Then, the control equation for non local strain gradient (NSG) nanobeams was given. Finally, the proposed control scheme will be applied to the vibration suppression of NSG nanobeams. To verify the effectiveness of the proposed method, the controller is applied to an unknown system. The simulation results ultimately proved the significant performance of the method proposed by the authors in effectively suppressing vibration.

Fu et al., in the paper "Multi-scroll Hopfield neural network under electromagnetic radiation and its brain-like coupling synchronization," proposed a new non-volatile magnetic controlled memristor and uses it to simulate the effects of membrane flux changes caused by neuronal exposure to electromagnetic radiation. Through dynamic analysis, a series of complex chaotic phenomena were discovered, including multi vortex chaotic attractors controlled by memristors, symmetric bifurcation behavior, and coexisting phenomena with enhanced initial offset. Secondly, the authors also proposed a dual memristive HNN coupled synchronization model to simulate synchronization schemes between different regions of the human

brain. The feasibility of the synchronization scheme was verified by establishing a Simulink model and conducting simulation experiments.

Yu et al., in the paper "Moment-based analysis of pinning synchronization in complex networks with sign inner-coupling configurations," investigated the pinning synchronization problem of complex networks with symbolic intra coupling configuration using a moment-based analysis method. Firstly, two representative nonlinear systems with dynamic parameter changes are presented. Then, a detailed study was conducted on the impact of symbol internal coupling configuration on network synchronization. Research has found that adding negative parameters to the internal coupling matrix can significantly improve the synchronization of the network. Finally, the authors provided explanations through numerical simulations.

Hu et al., in the paper "A novel grid multi-structure chaotic attractor and its application in medical image encryption," proposed a memristive Hopfield neural network model using the memristor synaptic control method. This model can generate new grid multi structure chaotic attractors. Firstly, the generation mechanism of grid multi structure chaotic attractors were analyzed from the perspectives of equilibrium points and stability. Secondly, its basic dynamic characteristics were analyzed. Thirdly, the simulation circuit of the neural network model was designed and implemented using Multisim. Finally, combining the principle of chaotic encryption, the authors designed an image encryption scheme based on a generated grid multi structure attractor. The experimental results show that compared with existing schemes, this scheme has greater information entropy, higher key sensitivity, and good application prospects.

3 Concluding remarks

Overall, the research on the application and development of nonlinear systems and networks requires continuous advancement from multiple aspects, in order to better respond to challenges and explore their broad application prospects. The exploration and research of nonlinear systems and networks will undoubtedly bring us more new modeling, control, prediction, and optimization methods in the future.

Finally, we would like to thank all the authors of the 10 articles in this Research Topic for their outstanding contributions, all of which are well suited to the scope of this Research Topic. In addition, we would also like to sincerely thank all the reviewers, editors, and editorial staff of Frontiers in Physics journal for their support.

Author contributions

FY: Conceptualization, Formal Analysis, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing–original draft, Writing–review and editing. H-CI: Conceptualization, Methodology, Project administration, Supervision, Validation, Visualization, Writing–review and editing. HL: Conceptualization, Investigation, Methodology, Project administration, Supervision, Validation, Writing–review and editing. V-TP: Formal Analysis, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing–review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Publisher's note

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