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EDITED AND REVIEWED BY
Alex Hansen,
Norwegian University of Science and Technology, Norway

*CORRESPONDENCE
Fei Yu,
yufeiyfyf@csust.edu.cn
Hairong Lin,
haironglin@hnu.edu.cn
Viet-Thanh Pham,
phamvietthanh@tdtu.edu.vn

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Editorial: Advances in non-linear systems and networks

Fei Yu[1]*, Hairong Lin[2]* and Viet-Thanh Pham[3]*

[1]School of Computer and Communication Engineering, Changsha University of Science and Technology, Changsha, China, [2]College of Computer Science and Electronic Engineering, Hunan University, Changsha, China, [3]Faculty of Electrical and Electronics Engineering, Ton Duc Thang University, Ho Chi Minh City, Vietnam

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Editorial on the Research Topic
Advances in non-linear systems and networks

1 Introduction

If there are non-linear elements in the system or network, and the input and output are not superimposed and uniform, such system or network is called non-linear system or non-linear network. Non-linearity makes the whole not equal to the sum of parts, and the superposition principle fails. At some joint points of non-linear system, small changes in parameters often lead to qualitative changes in the form of motion, and behaviors that are essentially different from external excitation appear. It is the non-linear effect that forms the infinite diversity, richness, tortuosity, singularity, complexity, variability and evolution of the material world.

Non-linear systems and networks have broad application prospects in the engineering fields of the Internet of Things, medical care, intelligent systems [1–5], *etc.* With the development of science and technology, according to the current research Frontier, it is not difficult to find that the research fields of non-linear systems and networks are also expanding, including chaotic systems and circuits [6–9], non-linear device models [10–12], memristors [13–16], neural networks [17–21], neural circuits [22–24], synchronous control [25–27] and application research in related fields [28–31].

Therefore, in this Research Topic, 12 articles about non-linear systems and networks and their applications are reported. For non-linear systems, a reverse single side band (RSSB) system with orthogonal frequency division multiplexing (OFDM) signal transmission is designed Chen et al., and a credible and adjustable load resource trading system based on blockchain networks is studied Jiang et al.. For non-linear networks, they have studied the zeroing neural network and its trajectory tracking Zhao et al. and Lan et al., the Hindmash-Rose neural network model Fan et al., the dynamic robustness of the directed network Sun et al., the advanced metering infrastructure (AMI) network Wang et al. and the critical brain wave dynamics of neural networks Galinsky et al.. For non-linear devices, second-order storage elements Liu et al. are studied. For the synchronization control of non-linear systems and networks, the finite-time tracking adaptive iterative learning control method of aircraft track angle system Zhang et al. and finite-time hybrid function projection synchronization Zhang et al. are studied. In addition, considering the application of non-linear systems and

networks, an image encryption algorithm based on three-dimensional (3D) chaotic Hopfield neural network is designed Yao et al.. Finally, the published articles are written by scientists working in major universities and research centers in China and the United States. However, in the second volume, more researchers from outside China should be attracted to participate.

2 Summary of papers presented in this Research Topic

Chen et al., in the paper "*Pilot Optimization for OFDM in the RSSB System*", proposed a reverse single sideband (RSSB) system with orthogonal frequency division multiplexing (OFDM) signal transmission based on the improved pilot interval scheme and pilot power scheme. The improved pilot power scheme proposed in this paper can compensate for frequency selective fading by increasing pilot power in areas with relatively poor channel conditions. The simulation results show that the improved pilot interval scheme and the improved pilot power scheme can improve the system reception sensitivity by 2 dB respectively. The authors believe that these schemes can improve the system performance without increasing the complexity of the algorithm and the cost of RSSB system.

Jiang et al., in the paper "*A Credible and Adjustable Load Resource Trading System Based on Blockchain Networks*", proposed a trusted and adjustable load resource transaction framework based on blockchain, which uses blockchain to realize trusted grid load resource transaction. This paper first proposes a two-layer blockchain architecture based on alliance chain. Then a distributed transaction processing mechanism based on hybrid consensus and fragmentation technology is designed. Finally, a two-level bidding model is proposed. Through a large number of experiments, the authors show that their proposed framework can achieve satisfactory results.

Zhao et al., in the paper "*A Novel Zeroing Neural Network for Dynamic Sylvester Equation Solving and Robot Trajectory Tracking*", proposed a new activation function to ensure fast convergence in predefined times and robustness in the presence of external noise perturbations. This paper theoretically analyzes the effectiveness and robustness of the zeroing neural network system, and verifies it by simulation results. Finally, the proposed theory is applied to robot trajectory tracking to further verify the effectiveness of the proposed method.

Lan et al., in the paper "*Towards Non-linearly Activated ZNN Model For Constrained Manipulator Trajectory Tracking*", proposed a non-linear activation function (NAF), and established a non-linear activation ZNN (NAZNN) model based on NAF. In this paper, the NAZNN model is applied to solve the exact solution of constrained TVLME (CTVLME), and the constrained robot manipulator trajectory tracking (CRMTT) problem is completed. In addition, the authors have also carried out theoretical analysis on the track tracking fault of wheeled robots with physical constraints, and applied the NAZNN model to the problem of manipulator track tracking fault. The experimental results of this paper prove that the NAZNN model can also effectively deal with the problem of manipulator track tracking fault.

Fan et al., in the paper "*Hidden firing patterns and memristor initial condition-offset boosting behavior in a memristive Hindmarsh-Rose neuron model*", proposed a 3D memristive Hindmash-Rose (mHR) neuron model based on an ideal flux-controlled memristor with sinusoidal memductance function and non-linearly modulated input. The numerical results show that the mHR neuron model can generate rich hidden dynamics. Then, memristor initial condition-offset boosting behavior is revealed. This can trigger the generation of an infinite number of coexisting excitation patterns along the variable coordinates of the memristor. Finally, this paper designs an analog circuit to implement the mHR neuron model, and carries out circuit simulation based on PSIM.

Sun et al., in the paper "*A New Effective Metric for Dynamical Robustness of Directed Networks*", studied the dynamic robustness of a directed complex network with additive noise. In the framework of mean square stochastic stability, a new robustness metric is proposed to characterize the synchronization of the network against additive noise. It is found that node dynamics plays a key role in the dynamic robustness of the directed network. They explained and verified it through numerical simulation.

Wang et al., in the paper "*Intrusion detection framework based on homomorphic encryption in AMI network*", proposed an advanced metering infrastructure (AMI) network intrusion detection method based on joint learning client security. First, calculate the direction similarity of the model trained by the data processing center and the model trained by each client. Then, normalize the size of each client model update to the same size as the data processing center model update. Finally, the normalized update and adaptive weights are weighted average. The research results show that this method can effectively resist inference attack and poisoning attack.

Galinsky et al., in the paper "*Critical brain wave dynamics of neuronal avalanches*", studied the potential collective process behind the phenomenological statistics of neuron avalanches, and analyzed that neuron avalanche is only the manifestation of different non-linear sides of the rich wave process in cortical tissue. In this paper, it is found that the wave mode system generates an anharmonic wave mode with time and space scale property through all possible combinations of the third-order non-linear terms described by the general wave Hamiltonian.

Liu et al., in the paper "*AC Power Analysis for Second-order Memory Elements*", deduced the real power, reactive power and apparent power of the proposed second-order memory element, and revealed the difference between the ideal memory element and the traditional passive memory element. The authors quote the corresponding curves, which prove the difference between storage elements, and verify that the harmonic value in the element means that it will continue to provide energy when AC power is used.

Zhang et al., in the paper "*Adaptive iterative learning control method for finite-time tracking of an aircraft track angle system based on a neural network*", proposed an adaptive iterative learning control method based on a neural network. This method can control the aircraft track inclination through the designed control input rudder deflection angle, so as to track the preset trajectory in a limited time interval. Through Lyapunov stability analysis, it can be seen that the designed controller and adaptive laws can stabilize the whole closed-loop system and realize the tracking of target trajectory in a limited time interval. Finally, the paper verifies the feasibility and effectiveness of the theory through a simulation example.

Zhang et al., in the paper "*A new adaptive iterative learning control of finite-time hybrid function projective synchronization for unknown*

time-varying chaotic systems", proposed a new adaptive iterative learning control scheme to solve the finite-time hybrid function projection synchronization problem of chaotic systems with unknown periodic time-varying parameters. Through Lyapunov stability analysis, two different chaotic systems achieve asymptotic synchronization in a finite time interval according to different proportion functions. Finally, the authors proved the feasibility and effectiveness of this method through simulation examples.

Yao et al., in the paper "*An image encryption algorithm based on a 3D chaotic Hopfield neural network and random row-column permutation*", proposed a color image encryption algorithm based on 3D chaotic Hopfield neural network and random row and column arrangement. Firstly, this paper proposes a 3D chaotic Hopfield neural network to generate random sequences for generating diffusion keys and permutation keys. Then, the rows and columns of the original image are randomly arranged according to the arrangement key. Finally, the separately encrypted sub-images are spliced together to obtain the final encrypted image. The simulation results and security analysis show that the encryption scheme has good performance.

3 Concluding remarks

It can be seen that in this Research Topic, we focus on multidisciplinary scientific research by considering non-linear systems and networks. They can be applied to different research fields, including non-linear physics, mathematics, medicine, economics, computer science and engineering. Through this Research Topic, we hope to encourage more scholars and researchers to promote innovative research in non-linear systems and networks and their applications.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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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.

Publisher's note

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