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: EDITORIAL

IEEE ACCESS SPECIAL SECTION EDITORIAL:
RECENT ADVANCES ON HYBRID COMPLEX
NETWORKS: ANALYSIS AND CONTROL

Complex networks typically involve multiple disciplines due to network dynamics and their statistical nature. When modeling practical networks, both impulsive effects and logical dynamics have recently attracted increasing attention. Hence, it is of interest and importance to consider hybrid complex networks with impulsive effects and logical dynamics. Relevant research is prevalent in cells, ecology, social systems, and communication engineering. In hybrid complex networks, numerous nodes are coupled through networks and their properties usually lead to complex dynamic behaviors, including discrete and continuous dynamics with finite values of time and state space. Generally, continuous and discrete sections of the systems are described by differential and difference equations, respectively. Logical networks are used to model the systems where time and state space take finite values. Although interesting results have been reported regarding hybrid complex networks, the analysis method and relevant results could be further improved with respect to conservative impulsive delay inequalities and reproducibility of corresponding stability or synchronization criteria. Therefore, it is necessary to devise effective approaches to improve the analysis methods and results dealing with hybrid complex networks.

This Special Section of IEEE ACCESS on “Recent Advances on Hybrid Complex Networks: Analysis and Control” provides a valuable and timely platform for exchanging the latest advances in hybrid complex networks.

The Call for Papers generated great enthusiasm in the scientific community. Of the 51 submissions received, 17 articles were accepted for inclusion in the Special Section after a thorough review process by at least two independent referees. The 17 accepted articles are broadly categorized into two groups: 14 articles report theoretical results dealing with analysis and control of hybrid complex networks including multi-agent networks, logical networks, and fuzzy systems, while the remaining three articles discuss applications in the fields of electric vehicles, social networks, and forecasting stock prices.

In the first group, the article “Distributed event-triggered control for prescribed finite-time consensus of linear multi-agent systems,” by Lu considers the prescribed finite-time consensus problem of linear multi-agent systems

based on distributed event-triggered control strategies. Different from most existing prescribed finite-time consensus control rules that are based on continuous communication between agents and their neighbors, the proposed control laws are built based on the event-triggered mechanism.

In the article “Bifurcation analysis and probabilistic energy landscapes of two-component genetic network,” Zhu *et al.* investigate the global kinetics of an activator–repressor genetic oscillator through the bifurcation analysis and probabilistic energy landscape. The proposed approach is quite general and provides a realistic pathway for analyzing the global stability, robustness, and kinetics of a complex gene network.

The article “Pinning stabilization of probabilistic boolean networks with time delays,” by Liu *et al.* discusses the stabilization issues for probabilistic Boolean networks with time delays. Using the semi-tensor product of matrices, three algorithms are proposed for designing minimum pinning controllers.

In the article “Output tracking of boolean control networks with impulsive effects,” Li *et al.* discuss the output tracking of Boolean control networks with impulsive effects (BCNs-IE). By constructing an auxiliary BCN-IE and using obtained stable complex attractors, a necessary and sufficient condition and an algorithm to design state feedback controllers for the output tracking problem are proposed.

The article “Robust stability and stabilisation of delayed Boolean networks with disturbance,” by Jiang *et al.* considers a type of delayed Boolean networks (DBNs) affected by disturbances. Using the semi-tensor product method, the robust stability of DBNs without control and the robust stabilization are considered. Several necessary and sufficient conditions are proposed.

In the article “Event-triggered H_∞ filtering for networked systems under hybrid probability deception attacks,” Lu *et al.* consider the deception attacks of wide concern in cyber-attacks and discuss the feasibility of H_∞ filtering for a networked system based on event-triggered mechanisms.

The article “Static output feedback control for fuzzy systems with stochastic fading channel and actuator faults,” by Chen *et al.* focuses on the issue of static output feedback control for Takagi–Sugeno fuzzy systems in the discrete-time

domain. Using the Lyapunov–Krasovskii function, sufficient conditions for calculating controller gains are established.

In the article “Couple-group consensus for first order discrete-time multiagent systems with competition-cooperation and input saturation constraints,” Han *et al.* deal with the couple-group consensus for the first-order discrete-time systems with input saturation constraints. Based on the idea of competition and cooperation, a novel control protocol is proposed to achieve group consensus.

The article “Further results on large-scale complex logical networks,” by Liu *et al.* presents a brief survey on the recent efforts of dealing with large-scale logical networks (LNs), including their approximation, network aggregation approach, and logical matrix factorization technique. Using the network aggregation approach, the stability of a large-scale version of network pairing problem and the topological structure of large-scale probabilistic LNs are considered.

In the article “Impulsive control via variable impulsive perturbations on a generalized robust stability for Cohen–Grossberg neural networks with mixed delays,” Cao *et al.* propose an impulsive control strategy via variable impulsive perturbations for robust stability with respect to manifolds for a class of Cohen–Grossberg neural networks with mixed delays and uncertain parameters. The results generalize and extend some known robust stability results considering stability with respect to manifolds rather than isolated states.

The article “A systematic analysis of link prediction in complex network,” by Gul *et al.* gives a precise assessment of prevail link mining approaches, develops a scientific system for interface expectation in complex organizations, and addresses various difficulties and techniques.

In the article “Nonlinear PI control for high-order agents with unknown high-frequency gain signs under switching topologies,” Wang proposes the nonlinear proportional-integral control algorithms for consensus of high-order agents with unknown high-frequency gain signs (UHFGSs) in switching topologies and investigates the output leaderless consensus of heterogeneous agents with UHFGSs.

The article “Asynchronous control for Markov switching Lur’e systems with round-robin protocol,” by Luan *et al.* addresses the asynchronous control design problem for discrete-time Markov switching Lur’e systems (MSLSs). By adopting the round-robin protocol in scheduling the information exchange order, the mode-dependent stochastic Lur’e type Lyapunov function is analyzed and several sufficient criteria with prescribed performance are presented to guarantee that the resulting discrete-time MSLSs are stochastically stable.

The article “Exponential synchronization of partially coupled heterogeneous networks with time-delays and heterogeneous impulses,” by Feng *et al.* focuses on exponential synchronization for a class of partially coupled heterogeneous networks with time-delays and heterogeneous impulses. The common equilibrium solution and the average trajectory are selected as the synchronization targets.

Synchronization criteria are deduced by using Lyapunov function and comparison principle.

In the second group, the article “A comprehensive evaluation on variable sampling intervals of power battery system for electric vehicles,” by Yang *et al.* describes a comprehensive approach relevant to sampling intervals for future cloud-database controlling design. Diverse precision and robustness investigations for various intervals are presented and the content is verified based on information entropy theory.

In the article “Network opinion evolution model incorporating the influence of media heterogeneity,” Luo *et al.* add the role of social media users into the opinion interaction evolution model and consider the influence of its heterogeneity on the opinion evolution process and final state. Aiming to characterize information transmission with the participation of media users, an opinion dynamics model is proposed to reproduce a realistic process of opinion interaction between regular and media users.

The article “Forecasting stock price based on frequency components by EMD and neural networks,” by Shu and Gao, proposes a novel hybrid model to predict stock prices. It combines empirical mode decomposition (EMD), convolutional neural network, and long short-term memory.

In conclusion, the authors would like to thank the authors for submitting their high-quality research articles to this Special Section. They highly appreciate the contributions of the reviewers and their constructive comments and suggestions. They also acknowledge the guidance from the IEEE ACCESS Editor-in-Chief and staff members.

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