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Editorial

Nonlinear Analysis of Dynamical Complex Networks 2014

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We have solicited submissions from electrical engineers, control engineers, computer scientists, and mathematicians. After a rigorous peer review process, 28 papers have been selected that provide overviews, solutions, or early promises, to manage, analyze, and interpret dynamical behaviours of complex systems. These papers have covered both the theoretical and practical aspects of complex systems in the broad areas of dynamical systems, mathematics, statistics, operational research, and engineering.

For networked control systems (NCSs), especially large-scale systems such as multiagent systems and systems over sensor networks, the complexities are inevitably enhanced in terms of their degrees or intensities because of the usage of the communication networks. This special issue starts with two survey papers on the recent advances of performance analysis with network-enhanced complexities and communication protocols for NCSs. In the paper entitled "*Performance analysis with network-enhanced complexities: on fading measurements, event-triggered mechanisms, and cyber attacks*" by D. Ding et al., the focus is to provide a timely review on the recent advances on the performance analysis and synthesis with three sorts of fashionable network-enhanced complexities, namely, fading measurements, event-triggered mechanisms, and attack behaviours of adversaries. These three kinds of complexities are introduced in detail according to their engineering backgrounds, dynamical characteristic, and modelling techniques. Accordingly, the developments of the performance analysis and synthesis issues for various networked systems are systematically reviewed. Finally, some challenges are illustrated by using a thorough literature review and some possible future research directions are pointed out. Subsequently, in the paper entitled "*Time- and event-driven communication process for networked control systems: a survey*" by L. Zou et al., a timely review on the recent theoretical developments of various sampling procedures and communication protocols in time-driven communication and event-driven communication for NCSs is given. The results discussed include, but are not limited to the following aspects: (1) NCSs with time-driven sampling procedures, (2) NCSs with event-driven sampling procedures, and (3) NCSs subject to different communication protocols. Some recent advances on the analysis and synthesis issues of NCSs with different sampling procedures (time- and event-driven sampling) and protocols (static and dynamic protocols) are provided. These sampling procedures and protocols are firstly introduced in detail according to their engineering backgrounds as well as dynamic natures. Subsequently, the recent developments of the stabilization, control, and filtering problems are systematically reviewed and discussed in great detail. Finally, future research challenges for analysis and

synthesis problems of NCSs with different communication processes are proposed.

In the past decades, the stability analysis of the dynamical complex networks has attracted much research attention. In the work entitled "*Global μ-stability of complex-valued neural networks with unbounded time-varying delays*" by X. Chen et al., the sufficient conditions are given to guarantee the desirable stability when the time delays are unbounded. By constructing an appropriate Lyapunov-Krasovskii functional and employing the free weighting matrix technique, some delay-dependent criteria are provided to ensure the global μ-stability of the addressed complex-valued neural networks by using the linear matrix inequality (LMI) approach. Two examples are given to show the effectiveness and less conservatism of the proposed criteria. The stability in mean of partial variables for coupled stochastic reaction-diffusion systems on networks (CSRDSNs) is discussed in "*Stability in mean of partial variables for coupled stochastic reaction-diffusion systems on networks: a graph approach*" by Y. Kao and H. Karimi. By transforming the integral of the trajectory with respect to spatial variables as the solution of the stochastic ordinary differential equations and using Itô formula, some novel stability criteria are proposed to ensure the uniform stability in mean, asymptotic stability in mean, uniformly asymptotic stability in mean, and exponential stability in mean of partial variables for CSRDSNs. These stability conditions have a close relation with the topology property of the network. Also, a systematic method is established to construct the global Lyapunov function for CSRDSNs by using the graph theory. The Cohen-Grossberg-type BAM neural networks model has promising potential for the tasks of parallel computation and associative memory. In the paper entitled "*Exponential stability of periodic solutions for inertial type BAM Cohen-Grossberg neural networks*" by C. Miao and Y. Ke, the existence and exponential stability of periodic solutions are studied for inertial type BAM Cohen-Grossberg neural networks. By properly choosing variable substitution, the system considered is transformed to first order differential equation. Then, by constructing suitable Lyapunov functional and using differential mean value theorem, some sufficient conditions are provided to ensure the existence and exponential stability of periodic solutions for the system. Finally, two numerical examples are used to demonstrate the effectiveness of the proposed results. The stability with mode constraint is investigated in "*Stability of infinite dimensional interconnected systems with impulsive and stochastic disturbances*" by X. Xu et al. for a class of infinite dimensional look-ahead interconnected systems with impulsive and stochastic disturbances. A set of sufficient conditions is given to guarantee the stability with mode constraint for a class of general infinite dimensional look-ahead interconnected systems with impulsive and stochastic disturbances. It is shown that the obtained conditions have less conservatism than the existing results. Secondly, by the sliding mode control method, the controller is designed for a class of look-ahead vehicle following systems with uncertainties. Also, the domain of the control parameters of the systems is proposed. Finally, a numerical simulation is given to demonstrate the usefulness of the proposed results.

Recently, the synchronization of dynamics complex networks has attracted a great deal of research interest. In the paper entitled "*Nonlinear dynamic analysis and synchronization of four-dimensional Lorenz-Stenflo system and its circuit experimental implementation*" by C.-H. Yang and C.-L. Wu, the adaptive generalized synchronization is discussed for four-dimensional Lorenz-Stenflo system with uncertain chaotic parameters strategy. By electronic circuit implementation of the proposed four-dimensional Lorenz-Stenflo system, it is shown that the chaotic attractors do exist physically. The problem of the impulsive projective synchronization is considered in "*Projective synchronization analysis of drive-response coupled dynamical network with multiple time-varying delays via impulsive control*" by S. Zheng for a drive-response coupled dynamical network with dynamical nodes delay and both nondelayed coupling and multiple delayed couplings. Sufficient conditions are given to guarantee the projective synchronization by using the stability analysis of the impulsive functional differential equation. An impulsive controller is also designed. The problem of exponential synchronization is investigated in "*Exponential synchronization of two nonlinearly coupled complex networks with time-varying delayed dynamical nodes*" by W. Shao for two nonlinearly coupled dynamical networks with identical time-delayed dynamical nodes via adaptive control. Based on the Lyapunov theory and by conducting extensive mathematical analysis, some synchronization criteria are proposed. Numerical examples are provided to illustrate the usefulness of the developed synchronization conditions. Further research attention can be made to discuss the exponential synchronization problem for drive-response nonlinearly coupled dynamical network with noise. Similarly, the cluster projective synchronization problem is discussed in "*Cluster projective synchronization of fractional-order complex network via pinning control*" by L. Yang et al., for complex dynamical networks with fractional-order dynamical nodes. The pinning controllers are designed according to the nodes property. Some simple criteria are established for cluster synchronization for any initial values through an effective control scheme. In the paper entitled "*Exponential outer synchronization between two uncertain nonlinearly coupled complex networks*" by Y. Wu et al., the exponential outer synchronization and parameter identification are investigated for two uncertain time-varying complex dynamical networks with nonlinear coupling, time delays, and different topological structures. Based on the Lyapunov stability theory, an adaptive control scheme is proposed to achieve exponential outer synchronization between drive and response networks. A network model with a scale-free feature and cluster structure is constructed in "*Hub-induced synchronization in scale-free networks with cluster structure*" by J. Zhang et al. Some sufficient conditions are proposed to achieve the cluster synchronization. It is shown that the cluster synchronization can be guaranteed by increasing the coupling strength of the cluster hubs. Moreover, in the paper entitled "*Eigenvalue based approach for global consensus in multiagent systems with nonlinear dynamics*" by W. Qian and L. Wang, the problem of global consensus is discussed for nonlinear multiagent systems with asymmetrically coupled identical agents.

Over the past decades, the design of the controllers has long been the mainstream of research topics and much effort has been made for dynamical complex networks. In the paper entitled "*Impulsive control and synchronization of complex Lorenz systems*" by S. Aly et al., the problems of impulsive control and synchronization are studied for complex Lorenz systems. The impulsive control technique is employed to synchronize the chaotic attractors of the addressed complex Lorenz systems. Some new criteria are provided to guarantee the global exponential stability and asymptotical stability of impulsively controlled complex Lorenz systems. To improve the tracking performance and to shorten the response time, an improved PID intelligent control algorithm is developed in "*PSO-RBF neural network PID control algorithm of electric gas pressure regulator*" by Y. Zhong et al. and then applied to the electric gas pressure regulator. Theoretical analysis and experimental results demonstrate that the proposed algorithm improves the control accuracy, response speed, and tracking performance of electric gas pressure regulator. In the work entitled "*Nonlinear dynamic surface control of chaos in permanent magnet synchronous motor based on the minimum weights of RBF neural network*" by S. Luo, a new design of the nonlinear dynamic surface controller based on the minimum weights of RBF neural network is proposed for permanent magnet synchronous motor with the unknown parameters, disturbances, and chaos. The RBF neural network is employed to approximate unknown nonlinear functions and the adaptive method is introduced to deal with the unknown control gain in the system. The proposed controller can guarantee the boundedness of all the signals in the closed-loop system and the tracking error converges to a small neighbourhood of the origin. To guarantee the finite-time stability of the error system between the master system and the slave system, an active control method is proposed in "*Finite-time synchronizing control for chaotic neural networks*" by C. Zhang et al. for the slave system based on the terminal attractor. To realize the desired controller, an effective state observer based on a special tracking differentiator is designed to estimate all the uncertainties and disturbances. The approximate finite-time stability of the closed-loop system is analyzed based on the singular perturbation theory. Moreover, the developed results are applied to some chaotic neural networks. Numerical simulations are employed to demonstrate the effectiveness of the proposed control strategy. In the paper entitled "*Adaptive control of nonlinear discrete-time systems by using OS-ELM neural networks*" by X.-L. Li et al., by using online sequential extreme learning machine (OS-ELM) neural networks, the identification and control are discussed for nonlinear dynamic plants. The adaptive controller based on OS-ELM neural network model is constructed. A guaranteed-cost observer-based control problem is studied in "*Observer-based robust control for spacecraft rendezvous with thrust saturation*" by N. Wan et al. for thrust-limited rendezvous in near-circular orbits. An optimal observer-based rendezvous controller with a less conservative saturation control law is developed. Finally, in the work entitled "*Discrete-time event-triggered control of nonlinear wireless networked control systems*" by S. Hu et al., the stabilization problem is investigated for nonlinear discrete-time NCSs with event-triggering communication scheme with signal transmission delay.

As is well known, the analysis on the applications of the dynamical complex networks has important significance. In the paper entitled "*The degree analysis of an inhomogeneous growing network with two types of vertices*" by H. Huang, an inhomogeneous growing network with two types of vertices is discussed. The degree sequences of two different types of vertices are investigated. It is shown that the asymptotical degree distribution of type for this process is power law and the strong law of large numbers for degree sequences of two different types of vertices is given. The dissipative property is considered in "*On the global dissipative and multipeakon dissipative behavior of the two-component Camassa-Holm system*" by Y. Wang et al., for two-component Camassa-Holm system after wave breaking. The global dissipative solutions of the two-component Camassa-Holm system and the multipeakon dissipative solutions are obtained. In the work entitled "*Observation of a class of disturbance in time series expansion for fractional order systems*" by Y. Wei et al., the methods of observer for fractional order systems in time series expansion disturbance are discussed. According to the maximum degree of disturbance polynomials, the disturbances are divided into three categories. New developed approaches have greater design freedom and the designed observers have a faster convergent speed. The behaviour preferences of Wechat users in knowledge propagation are summarized and a Wechat knowledge propagation model is introduced in "*Study on knowledge propagation in complex networks based on preferences, taking Wechat as example*" by S. Chen and W. He. A knowledge propagation network according to the individual characteristics and interactive rules is constructed. In the paper entitled "*Algorithms for finding inverse of two patterned matrices over Z_p*" by X. Jiang and K. Hong, two new patterned matrices are discussed. Accordingly, the basic properties are discussed. Two different algorithms are developed based on the Newton-Hensel lifting and Chinese remaindering. Moreover, the cost in terms of bit operations for each algorithm is given. The European option pricing problem with transaction costs is investigated for a risky asset price model with Lévy jump in "*European option pricing with transaction costs in Lévy jump environment*" by J. Li et al. By the aid of arbitrage pricing theory and the generalized Itô formula including Poisson jump, the explicit solution to the risk asset price model is provided. According to the arbitrage-free principle, the discrete-time model is first obtained. Then, the transaction costs are introduced in each small time interval. The explicit solutions of the European options pricing formula with transaction costs are given for the risky asset price model with Lévy jump. In the work entitled "*On skew circulant type matrices involving any continuous Fibonacci numbers*" by Z. Jiang et al., the invertibility of the skew circulant type matrices is discussed and the explicit determinants are given by constructing the transformation matrices. In the paper entitled "*Fault detection for wireless networked control systems with stochastic switching topology and time delay*" by P. Guo et al., the fault detection problem is studied for a class of discrete complex wireless NCSs. By using

the Lyapunov method and stochastic analysis techniques, sufficient conditions are given to guarantee the existence of the filters satisfying the desired performance requirement.

Acknowledgments

This special issue is a timely reflection of the research progress in the area of nonlinear analysis of dynamical complex networks. We would like to acknowledge all authors for their efforts in submitting high-quality papers. We are also very grateful to the reviewers for their thorough and on time reviews of the papers.

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