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Special Section on Complex Cyberphysical Networks: Resilient Control, Optimization, and Applications

It has been recognized that the complex cyberphysical network (CCPN) is a new paradigm of complex networks, with many new and significant functions relying on tight interactions among its physical components and cybercomponents. The study of CCPNs has attracted considerable attention from various scientific and engineering fields. Computer scientists, control theorists, and power engineers, in particular, have contributed to the development of CCPNs, both in theory and in applications. Notably, the advances of CCPNs in information and communication technology not only bring out benefits but also open opportunities for malicious attackers to launch coordinated attacks on critical cyberphysical facilities in networked infrastructures literally from any Internet-accessible place. Therefore, there is an urgent demand for security protection and security control. For this reason, novel attack detection and isolation, resilient control, and optimization strategies and techniques should be comprehensively integrated into CCPNs, which leads to the present study of security and control of CCPNs.

This special section aims to collect state-of-the-art achievements in the field of security and control of CCPNs, aiming at further advancing CCPN theory and technology in related areas.

This special section offers seven high-quality articles that significantly contribute to new theories, algorithms, and applications to deal with challenging problems in CCPNs. We hope this special section will raise awareness about the secure control technologies that are working within the systems and control communities to handle challenging issues in CCPNs.

In [A1], Liu and Chen propose a novel reinforcement learning formation tracking algorithm based on a fusion reward scheme synthesizing the orbit tracking and formation objectives. They also present some experiments to show that the algorithm can improve formation accuracy.

In [A2], Chen et al. proposed a distributed finite-time event-triggered secondary controller that can effectively ensure that the average dc voltage of the converters in the multiterminal dc transmission system converges to the nominal value within a finite time. In addition, the controller optimizes power sharing among converters, enabling each converter to distribute active power according to its respective capacity. An advantage of the event-triggered mechanism is that it can conserve communication resources and reduce the load on the communication network.

In [A3], Jiang and Sun obtain some new sufficient conditions for uncertain discrete-time switched impulsive systems containing unstable subsystems to retain the exponential stability and achieve $\mathcal{H}_\infty$ performance by defining a switching time-variant Lyapunov function and mode-dependent range dwell time switching. An advantage of the sufficient conditions is that they are applicable to the case in which all subsystems are unstable. This article also applied the theoretical results to solve the consensus and $\mathcal{H}_\infty$ consensus of uncertain multiagent systems (MASs) subject to disturbance, impulse, and switching topologies.

In [A4], Wan et al. propose an event-triggered neuroadaptive controller for MASs subject to denial-of-service (DoS) attacks and continuously occurring false data injection attacks under which the consensus tracking error is ultimately uniformly bounded. Also, some sufficient conditions regarding the DoS attack indexes are quantitatively provided.

In [A5], Huang et al. propose some sufficient criteria to achieve $\mathcal{H}_\infty$ and $\mathcal{H}_2$ consensus for linear MASs under biasing faults and uncertainty in the parameters, respectively. An advantage of the criteria is that they involve little global information about the communication graph.

In [A6], Zhang proposes a predefined-time synchronous control scheme for different dimensional delayed chaotic systems.

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An advantage of the proposed scheme is that the radius of the convergence region and the convergence time can be preset.

In [A7], Bao et al. propose an event-based reset consensus controller based on relative outputs for linear MASs subject to DoS attacks. A hybrid impulsive model is also developed to describe the dynamics of MASs under the reset control protocol, the event-triggered mechanism, and DoS attacks.

In summary, the articles included in this special section represent significant advances in the security and control of CCPNs. These contributions not only report recent significant developments but also highlight potential, growing research directions and future trends that stand to benefit researchers.

We would like to express our sincere thanks to all authors who have submitted their works to this special section and to all the reviewers, whose valuable comments and suggestions have greatly improved the quality and presentation of the articles.

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Appendix: Related Articles

[A1] T. Liu and Y. Chen, "Formation tracking of spatiotemporal multiagent systems: A decentralized reinforcement learning approach," *IEEE Syst., Man, Cybern. Syst. Mag.*, vol. 10, no. 4, pp. 52–60, Oct. 2024, doi: 10.1109/MSMC.2024.3401404.

[A2] X. Chen, J. Sun, J. Feng, F. Zhao, and J. Qiu, "Event-based distributed finite-time secondary control for multi-terminal DC transmission systems: Restores average voltage and achieves power sharing," *IEEE Syst., Man, Cybern. Syst. Mag.*, vol. 10, no. 4, pp. 61–68, Oct. 2024, doi: 10.1109/MSMC.2024.3428808.

[A3] N. Jiang and Y. Sun, "Exponential stability and $\mathcal{H}_\infty$ performance of uncertain discrete-time switched impulsive systems: Applications to the consensus of multiagent systems," *IEEE Syst., Man, Cybern. Syst. Mag.*, vol. 10, no. 4, pp. 69–76, Oct. 2024, doi: 10.1109/MSMC.2023.3348761.

[A4] Y. Wan, X. Shi, X. Zhao, and J. Cao, "Distributed secure consensus tracking of multiagent systems under hybrid cyberattacks: An event-triggered neuroadaptive approach," *IEEE Syst., Man, Cybern. Syst. Mag.*, vol. 10, no. 4, pp. 77–91, Oct. 2024, doi: 10.1109/MSMC.2024.3358065.

[A5] D. Huang, Q. Wang, G. Wen, and Z. Duan, "Consensus control of multiagent systems subject to biasing faults: Relative output information-based approach," *IEEE Syst., Man, Cybern. Syst. Mag.*, vol. 10, no. 4, pp. 92–105, Oct. 2024, doi: 10.1109/MSMC.2023.3345013.

[A6] X. Zhang, "Adaptive fuzzy predefined-time synchronization of different dimensional delayed Chaotic systems: A scheme for realizing predefined time stability of nonlinear systems," *IEEE Syst., Man, Cybern. Syst. Mag.*, vol. 10, no. 4, pp. 106–115, Oct. 2024, doi: 10.1109/MSMC.2024.3358590.

[A7] Y. Bao, J. Zhou, G. Wen, D. Zheng, and Z. Li, "Event-based reset control for consensus of multiagent systems under denial-of-service attacks: An appointed-time-observer-based approach," *IEEE Syst., Man, Cybern. Syst. Mag.*, vol. 10, no. 4, pp. 116–130, Oct. 2024, doi: 10.1109/MSMC.2023.3317592.

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