Peer-to-Peer Networking and Applications (2019) 12:1624–1626
https://doi.org/10.1007/s12083-019-00811-6

Guest editorial: Networked cyber-physical systems: Optimization theory and applications

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Published online: 30 August 2019

Cyber-Physical Systems (CPSs) represent a bold new generation of systems that integrate computation and communication capabilities with the dynamics of physical and engineering systems. A critically essential charismatic of modern CPSs is that such systems are actually networked via the Internet, cloud, or special logical or physical networks including but not limited to industrial 4.0, wireless sensor networks, social networks, to name a few.

In recent years, distributed and large-scale monitoring and distributed control applications have awaken a growing interest in networked CPSs, and considerable research efforts have been dedicated to analysis and control for networked CPSs. However, there still exist many open problems regarding theory and practical applications in the area of networked CPSs. These call for an urgent quest to explore and investigate the new challenging issues in networked CPSs.

This special issue seeks latest significant contributions on optimization approaches for networked CPSs in both theoretical and industrial applications, and aims to identify new research issues, opportunities and directions in the emerging theory and technologies. A number of manuscripts have submitted to our special issue, and 16 of them have been accepted for publication. The topics of these selected papers include networked system optimization, networked control systems, multi-agent systems, etc.

The first paper, titled "Cascading failure model of scale-free networks for avoiding edge failure" by J. L. Ma and Z. C. Ju, considers enhancing the robustness of the complex network. It proposes a new model based on the combination of the degree and betweenness centralities. The proposed model is more useful for designing protective strategies in the area of reducing cascading-failure-induced disasters.

The second paper, titled "A Deep Learning Based Data Forwarding Algorithm in Mobile Social Networks" by Q. S. Wang, et al., studies the data packet propagation scheme adapted to the emergence of mobile social networks with large-scale mobile trajectories. It proposes a deep learning-based data forwarding algorithm to explore and make full use of network paths composed of instantaneous high-probability links.

The third paper, titled "A robust controller design for networked hydraulic pressure control system based on CPR" by W. Shen and J. Wang, considers the control issue of introducing the networked control system (NCS) into the new hydraulic common pressure rail (CPR) system. It designs an adaptive fuzzy sliding mode controller based on function approximation that can compensate the input delay and solve the nonlinear problems to guarantee the robustness of the system.

The fourth paper, titled "Centrality prediction based on K-order Markov chain in Mobile Social Networks" by H. Zhou et al., solves the problem of centrality prediction in Mobile Social. They use the information entropy to analyze the past and future regularity of the nodes' centrality in the real

This article is part of the Topical Collection: *Special Issue on Networked Cyber-Physical Systems*
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mobility traces, and verify that nodes' centrality is predictable. Then, they propose a K-order Markov Chain-based method to predict the future centrality values.

The fifth paper, titled "Pipeline slot based fast rerouting scheme for delay optimization in duty cycle based M2M communications" by Q. Li, A. Liu, et al., proposes a Pipeline Slot based Fast Rerouting (PSFR) Scheme to reduce delay in duty cycle based WSNs. This method can overcome the shortcomings of the traditional random slot rerouting (RSR) scheme for data transmission.

The sixth paper, titled "Distributed adaptive consensus control for networked robotic manipulators with time-varying delays under directed switching topologies" by Y. Jiang, Y. Zhang, et al., studies consensus control problem for networked multiple robotic manipulators with and without time-varying delays under directed switching topologies. They present distributed adaptive consensus control protocols with and without the communication delay. The theoretical results show that these protocols can guarantee the system stability.

The seventh paper, titled "The Express Decay Effect of Time Delays for Globally Exponentially Stable Nonlinear Stochastic Systems" by K. L. Sun, S. Zhu, considers the express decay effect of time-varying delays for nonlinear stochastic systems. For almost surely globally exponentially stable stochastic systems, they obtain upper bounds of the time delays directly from the coefficients of stability conditions such that the perturbed stochastic delayed systems still be stable and decay rate faster than before.

The eighth paper, titled "Mapping Imprecise Computation Tasks on Cyber-Physical Systems" by L. Mo and A. Kritikakou, considers the problem of mapping QoS-aware IC-task on the nodes of CPS and formulates it as an MINLP problem, which takes the energy supply, task dependency and real-time constraints, as well as the sensing, acting, and data routing into account. To find the global optimal solution with the reduced computational complexity, a problem decomposition based solution is proposed. This method divides the original problem into a master subproblem and a slave subproblem and then finds the optimal solution by iterating the subproblems.

The ninth paper, titled "Cooperative Attitude Control for a Wheel- Legged Robot" by H. Peng, J. Z. Wang, et al., considers the speed consensus control issue. It designs a speed consensus strategy that can coordinate the four wheels of a wheel- legged robot by combining distributed active disturbance rejection control (ADRC) with consensus algorithm.

The tenth paper, titled "Distributed Consensus of Networked Markov Jump Multi-agent Systems with Mode-dependent Event-triggered Communications and Switching Topologies", by C. Ma and E. Kang considers the networked multi-agent system issue. It studies the distributed leaderless consensus problem of networked Markov jump multi-agent systems with mode-dependent switching topologies. In particular, a novel mode-dependent sampling and event-triggered communication strategy is proposed to reduce the network burden with less conservatism. The desired event-triggering function parameters and the controllers are designed based on mode-dependent Lyapunov-Krasovskii method.

The eleventh paper, titled "Quantized Control for Nonhomogeneous Markovian Jump T-S Fuzzy Systems with Missing Measurements" by X. Ji and Y. Wang, considers the quantization control issue. In terms of the T-S fuzzy technique, the designs are resolved for a class of nonhomogeneous Markov jump systems (MJSs) with partially unknown transition probabilities which are time-variant in the MJSs. By the cone complementarity linearization (CCL) procedure, the solutions of the dynamic output feedback controller (DOFC) are gained efficiently. Finally, the validity of the suggested technique is showed via a simulation example.

The twelfth paper, titled "Predictive control for visual servoing control of cyber physical systems with packet loss" by J. Wu, X. Chen, A. Liu, et al., considers the point stabilization issue for networked robotic visual servoing system by using horizon optimization strategy. It designs an efficient iterative algorithm that can steer the robot to the desired pixel under the network environment.

The thirteenth paper, titled "Cyber-physical battlefield perception systems based on machine learning technology for data delivery" by J. Zhao, C. Han, et al., provides an air-ground coordination communication transmission network. They present a K-Nearest Neighbor (KNN) machine learning system to estimate the movement and path of vehicles based on the mobile information obtained. They further utilize the genetic algorithms (GA) to determine the relative location of UAVs.

The fourteenth paper, titled "A code protection method against function call analysis in P2P network" by F. Xiang, D. Gong, et al., proposes a code protection method against function call analysis. The method can effectively increase the difficulty for attackers to analyze function calls and achieve the purpose of resisting reverse attacks.

The fifteenth paper, titled "Guaranteed performance control of switched linear systems: A differential-Riccati-equation-based approach" by D. Wang, S. Wang, et al., considers the performance issue for switched systems. It proposes a new performance certificate, of which an upper bound is obtained via a Lyapunov function that is decreasing at and between two switching instants. This interesting decreasing property of the Lyapunov function is guaranteed by solving a family of matrix inequalities that stems from solutions to differential Riccati equations.

The sixteenth paper, "UAV-assisted wireless relay networks for mobile offloading and trajectory optimization" by

G. Feng, C. Wang, et al., designs a UAV-assisted mobile offloading scheme to achieve a near-optimal offloading solution in consideration of the UAV's mobility. The scheme can not only utilize the UAV to perform user tasks locally, but also take the UAV as a relay to offload user tasks to the base station or cloudlet in some remote areas under extremely scarce computation and communication resources.

To conclude this editorial, we would like to thank Editor-in-Chief Prof. Xuemin Shen for all the advice regarding this special issue, as well as Senior Editor Melissa Fearon and Journal Administrator Genesis Obero for the help during the publication process. Further, we would like to thank all the contributing authors and the reviewers, without whom we would not have this special issue.