Guest Editorial Special Issue on Event-Triggered Control and Filtering of Distributed Networked Systems

I. Introduction

With the rapid development and widespread utilization of advanced communication, sensing, and computation technologies, increasing attention has been paid to develop new techniques of control and filtering for distributed networked systems. Note that the utilization of communication networks can improve efficiency, flexibility, and scalability in designing networked controllers and filters. However, communication networks usually suffer from communication resource constraints with detrimental consequences, such as long latency, increased packet dropout, reduced throughput, and so on. In order to address the challenges caused by limited communication resources, an event-triggered communication paradigm is an effective and promising technique that can significantly reduce computation/communication utilization while maintaining the desired estimation and the control performance. As a result, a variety of event-triggered control and filtering techniques for distributed networked systems have been proposed.

II. This Special Issue

This Special Issue presents a collection of 20 high-quality papers regarding event-triggered control and filtering, which are selected from the papers accepted from May 2018 to December 2018 by the IEEE Transactions on System, Man, and Cybernetics: System, and one invited survey paper prepared by Guest Editors. It is expected that this Special Issue can stimulate extensive interests of researchers so as to produce more theoretical and practical results in this significant and timely subject. This Special Issue starts with the invited survey paper "Dynamic Event-Triggered Distributed Coordination Control and Its Applications: A Survey of Trends and Techniques" by Ge *et al.*, which provides an up-to-date overview of dynamic event-triggered distributed coordination control. The motivation of dynamic event-triggered scheduling is first introduced in the context of distributed coordination control. Then some techniques of dynamic event-triggered distributed coordination control are discussed in detail. Furthermore, two applications of dynamic event-triggered distributed coordination control in the fields of microgrids and automated vehicles are provided. Several challenges are suggested to direct the future research. From a "problem-oriented" perspective, we have classified 20 selected papers into the following four groups.

A. Event-Triggered Control

The first group includes eight papers which mainly focus on addressing event-triggered control issues for linear and nonlinear networked systems. The paper "Guaranteed Cost Control of Uncertain Networked Control Systems With a Hybrid Communication Scheme" by Zhang and Peng uses a hybrid communication scheme including time-triggered control and periodic event-triggered control to address the issue of guaranteed cost control of uncertain networked control systems. The paper "Self-Triggered and Event-Triggered Control for Linear Systems With Quantization" by Zhou *et al.* develops a self-triggered and event-triggered control method based on four asynchronous clocks to solve the problem of observer-based output control for networked control systems with quantization. In the paper "Event-Triggered Robust Stabilization of Nonlinear Input-Constrained Systems Using Single Network Adaptive Critic Designs" by Yang and He, the problem of event-triggered robust stabilization of nonlinear systems subject to mismatched perturbations and input constraints is studied, where a single network adaptive critic design is used to solve an event-triggered Hamilton–Jacobi–Bellman equation. The paper "Event-Triggered Adaptive Critic Control Design for Discrete-Time Constrained Nonlinear Systems" by Ha *et al.* investigates the problem of constrained near-optimal control for a class of nonlinear discrete-time systems by an event-triggered heuristic dynamic programming technique. A nonquadratic performance index is introduced to overcome the control constraints and reduce the computational burden. The paper "Robust Optimal Control Scheme for Unknown Constrained-Input Nonlinear Systems via a Plug-n-Play Event-Sampled Critic-Only Algorithm" by Zhang *et al.* proposes an event-sampled robust optimal controller for a class of continuous-time constrained input nonlinear systems with unknown dynamics, where an online data-driven identifier using an event-sampled critic-only adaptive dynamic programming method is established to construct the system dynamics. In the paper "Event-Triggered Adaptive Output Regulation for a Class of Nonlinear Systems With Unknown Control Direction" by Lei *et al.*, an event-triggered adaptive control method is employed to achieve the global robust output regulation for a class of uncertain nonlinear systems regardless of the unknown control

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direction, meanwhile the Zeno behavior can be excluded. The paper "Event-Triggered Adaptive Dynamic Programming for Zero-Sum Game of Partially Unknown Continuous-Time Nonlinear Systems" by Xue *et al.* develops an event-triggered adaptive dynamic programming method such that the zero-sum game problem is solved for partially unknown continuous-time nonlinear systems. The paper "Self-Triggered State-Feedback Control for Stochastic Nonlinear Systems With Markovian Switching" by Xie and Zhu uses a self-triggered sampling rule to deal with a state-feedback control scheme for nonlinear stochastic systems with Markovian switching.

B. Event-Triggered Distributed Cooperative Control

The ever-increasing demand for guaranteeing coordinated tasks of several practical applications has stimulated widespread research interests in developing effective and efficient distributed cooperative control strategies for distributed networked systems. The second group consists of five papers that concentrate on an issue of event-triggered cooperative control. The paper "Sampled-Data Synchronization of Network Systems in Industrial Manufacture" by Wu *et al.* proposes a distributed sampled-data control strategy to ensure that all nonidentical nodes and the leader achieve output synchronization. The paper "Event-Based Distributed Tracking Control for Second-Order Multiagent Systems With Switching Networks" by Duan *et al.*, designs a class of distributed event-triggered control protocols with and without velocity measurements to deal with the tracking problem of networked second-order systems with unknown inertias and switching networks. The paper "Quantized Consensus of Multiagent Systems by Event-Triggered Control" by Ma *et al.* proposes an event-triggered distributed control protocol based on a dynamic quantizer to achieve the quantized consensus for general linear multiagent systems. The paper "Dynamic Event-Triggered Control for Leader-Following Consensus of Multiagent Systems" by Du *et al.* presents a distributed dynamic event-triggered mechanism including an internal variable to tackle the leader-following consensus problem of multiagent systems. In the paper "Distributed Continuous-Time Optimization With Scalable Adaptive Event-Based Mechanisms" by Wu *et al.*, an adaptive distributed consensus-based algorithm with event triggering communications is introduced to drive the participating agents to achieve the global continuous-time optimization and exclude Zeno behavior.

C. Event-Triggered Filtering

Estimation/filtering is a fundamental issue for networked systems since it allows a remote control center to acquire full knowledge of the current system state, as accurate as possible, so as to make informed control decisions. There are three papers entering into this group and dealing with several event-triggered estimation and filtering issues by taking into consideration the effects of limited communication resources. The paper "Dynamic Event-Triggered State Estimation for Discrete-Time Singularly Perturbed Systems With Distributed Time-Delays" by Ma *et al.* deals with the problem of state estimation for a class of discrete-time singularly perturbed systems with distributed time-delays, where a dynamic event-triggered scheme is employed to schedule the data communication from the sensors to the designed estimators. In the paper "Distributed Event-Triggered H_∞ Filtering for Discrete-Time T-S Fuzzy Systems Over Sensor Networks" by Wang and Yang, the problem of distributed event-triggered H_∞ filtering is considered for discrete-time T–S fuzzy systems over sensor networks, where piecewise fuzzy distributed filters are established to address the challenges caused by the distributed event-triggered mechanisms. In the paper "A Bank of Decentralized Extended Information Filters for Target Tracking in Event-Triggered WSNs" by Yang *et al.*, a hierarchical estimation method is presented to realize maneuvering target tracking in event-triggered wireless sensor networks.

D. Applications

The last group is composed of four papers that demonstrate several practical applications of event-triggered control and estimation techniques in rigid spacecrafts, mobile robots, smart grids, and 2-DOF quarter-car suspension systems. The paper "Event-Triggered Sliding Mode Control for Attitude Stabilization of a Rigid Spacecraft" by Liu *et al.* designs an event-triggered sliding mode controller to achieve attitude stabilization of a rigid spacecraft subject to external disturbances and model uncertainties. The paper "Event-Based Tracking Control of Mobile Robot With Denial-of-Service Attacks" by Tang *et al.* addresses the issue of tracking control for wireless mobile robots subject denial-of-service attacks by using an efficient event-triggering control strategy. In the paper "Co-Design of Distributed Model-Based Control and Event-Triggering Scheme for Load Frequency Regulation in Smart Grids" by Liu *et al.*, a distributed load frequency regulation approach to the co-design of event-triggering communication scheme and distributed model-based controller is proposed for smart power system operation under the limited communication resource and speed droop parametric uncertainty. The paper "Event-Triggered H_∞ State Estimation of 2-DOF Quarter-Car Suspension Systems With Nonhomogeneous Markov Switching" by Yan *et al.* investigates the problem of event-triggered H_∞ state estimation for a two-degree-of-freedom quarter-car suspension system operated over a switching-channel network.

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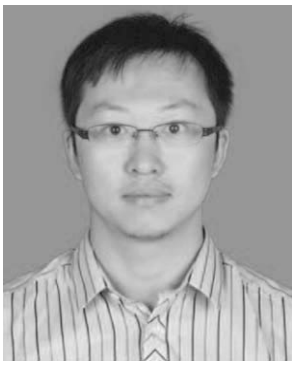

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