Guest Editorial
Distributed Signal Processing for Security and Privacy in Networked Cyber-Physical Systems

NETWORKED cyber-physical systems (CPSs) are engineering systems with integrated computational and communication capabilities that interact with humans through cyber space. The CPSs have recently emerged in several practical applications of significant engineering importance including aerospace, industrial/manufacturing process control, multimedia networks, transportation systems, power grids, and medical systems. The CPSs typically consist of both wireless and wired sensor/agent networks with different capacity/reliability levels where the emphasis is on real-time operations, and performing distributed, secure, and optimal sensing/processing is the key concern. To satisfy these requirements of the CPSs, it is of paramount importance to design innovative "Signal Processing" tools to provide unprecedented performance and resource utilization efficiency. The spirit and wide scope of distributed signal processing in revolutionized CPSs calls for novel and innovative techniques beyond conventional approaches to provide precise guarantees on security and privacy of CPSs. In light of these considerations, it is not difficult to appreciate the timeliness of this special issue. The articles appearing in the issue help illustrate the fundamental role that distributed signal processing plays for making networked CPSs secure and protect our privacy.

I. Introduction

A significant challenge for implementation of signal processing solutions in CPSs is the difficulty of acquiring data from geographically distributed observation nodes and storing/processing the aggregated data at the fusion centre (FC). As such, there has been a recent surge of interest in development of distributed and collaborative signal processing technologies where adaptation, estimation, and/or control are performed locally and communication is limited to local neighbourhoods. Distributed signal processing over networked CPSs, however, raise significant privacy and security concerns as local observations are being shared by neighbouring nodes in a collaborative and iterative fashion. On the one hand, applications of CPSs are severely safety critical where potential cyber and physical attacks by adversaries on signal processing modules could lead to a variety of severe consequences including customer information leakage, destruction of infrastructures, and endangering human lives. On the other hand, the need for cooperation between neighbouring nodes makes it imperative to prevent the disclosure of sensitive local information during distributed information fusion step. At the same time, efficient usage of available resources (communication, computation, bandwidth, and energy) is a prerequisite for productive operation of the CPSs. To accommodate these critical aspects of CPSs, it is of great practical importance and theoretical significance to develop advanced "Secure and Privacy Preserving Distributed Signal Processing" solutions.

The objective of this special issue is to further advance recent developments of distributed signal processing to practical aspects of CPSs for real-time processing and monitoring of the underlying system in a secure and privacy preserving manner while avoiding degradation of the processing performance and preserving the valuable resources. To provide a systematic base for future advancements of CPSs, this special issue aims to provide a research venue to investigate distributed signal processing techniques with adaptation, cooperation, and learning capabilities which are secure against cyber attacks and protected against privacy leaks. The emphasis of this special issue is on distributed/network aspects of security and privacy in CPSs.

II. Summary of Articles

The Guest Editors would like to express their deepest gratitude to the many reviewers who have helped them to improve the quality of the final articles. They are confident that readers will find this collection of articles interesting and appealing.

1) *"Differentially Private Distributed Online Algorithms Over Time-Varying Directed Networks"* by Zhu *et al.* The authors consider a private distributed online optimization problem (PDOOP) where a set of agents aim to minimize the sum of locally convex cost functions while each desires that the local cost function of individual agent is kept differentially private.
2) *"Mitigation of Byzantine Attacks on Distributed Detection Systems Using Audit Bits"* by Hashlamoun *et al.* The authors propose a novel mechanism to mitigate Byzantine attacks by partitioning sensors into groups developed for distributed detection problems in the presence of Byzantines who seek to degrade detection performance by falsifying data.
3) *"Two-Tier Device-Based Authentication Protocol Against PUEA Attacks for IoT Applications"* by Lin *et al.* The authors consider a hierarchical cognitive internet of things (IoT) architecture and propose a novel methodology of spectrum management that can guard against common types of security threats despite the limitations of the local processing.
4) *"Distributed Attack Detection and Secure Estimation of Networked Cyber-Physical Systems Against False Data Injection Attacks and Jamming Attacks"* by Guan and Ge. The authors construct resilient attack detection estimators to provide locally reliable state estimations and

Digital Object Identifier 10.1109/TSIPN.2018.2801659

detect the false data injection attack for the problem of joint distributed attack detection and distributed secure estimation for a networked cyber-physical system under physical and cyber attacks.

5) *"Resilient Consensus With Mobile Detectors Against Malicious Attacks"* by Zhao *et al.* The authors investigate the problem of resilient consensus under malicious attacks for multi-agent systems by considering a general attack model, where malicious agents can neighbor and collude with each other and the number of tolerable attacks is not limited by the network connectivity. In this regard, the resilient consensus algorithm with mobile detectors (MRCA) is designed.
6) *"A Distributed Control Paradigm for Smart Grid to Address Attacks on Data Integrity and Availability"* by Farraj *et al.* The authors propose an adaptive cyber-enabled parametric feedback linearization (PFL) control scheme for transient stability of smart grids, which utilizes a distributed energy storage system to modify the dynamics of the power system during transients.
7) *"Privacy Aware Stochastic Games of Distributed End-User Energy Storage Sharing"* by Yao *et al.* The authors propose a game theoretical framework to capture the competitive behaviors of users sending messages through a communication network to an independent battery controller with an infinite horizon limiting average signaling game formulation.
8) *"Distributed Joint Attack Detection and Secure State Estimation"* by Forti *et al.* The authors address the joint task of detecting attacks and securely monitoring the state of a cyber-physical system over a cluster-based network wherein multiple fusion nodes collect data from sensors and cooperate in a neighborwise fashion in order to accomplish the task.
9) *"Secure Information Sharing in Adversarial Adaptive Diffusion Networks"* by Ntemos *et al.* The authors consider information sharing over adversarial adaptive networks, and for defense against adversarial attacks propose an attack detection mechanism that guides the diffusion strategy in the parameter estimation task and the transmission decisions of agents.
10) *"A Novel Data Fusion Algorithm to Combat False Data Injection Attacks in Networked Radar Systems"* by Yang *et al.* The authors take the first attempt to investigate the false data injection (FDI) attack's effects on a networked radar system, and propose a novel data fusion algorithm to combat this attack.
11) *"Distributed Graph-based Statistical Approach for Intrusion Detection in Cyber-Physical Systems"* by Sadreazami *et al.* The authors propose a novel distributed blind intrusion detection framework by modeling sensor measurements as the target graph-signal and utilizing the statistical properties of the graph-signal for intrusion detection.
12) *"Distributed Privacy-Preserving Collaborative Intrusion Detection Systems For VANETs"* by Zhang and Zhu. The authors propose a privacy-preserving machine learning based collaborative intrusion detection system (PML-CIDS) for vehicular ad hoc network (VANET).

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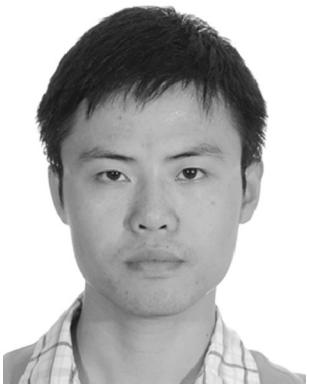

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