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Editorial
Cyber-Physical Control

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It has recently become evident that the so-called enabling technologies in various fields are reaching a level of maturity that allows us to build large-scale intelligent production systems, bionic devices, or even autonomously controlled infrastructures never seen before. Such enabling technologies are high-speed computing, large bandwidth and low-latency telecommunications, data storage, sensor and actuator technologies, precise mechatronic devices (robotics), efficient learning algorithms and knowledge representations, and computational neurosciences to name a few. All of these advances in combination with modern control theory are automatically leading to new complex solutions and change a given field disruptively. These systems over a certain scale of complexity are often referred to as cyber-physical systems (CPS).

Cyber-physical control (CPC) as a multidisciplinary research field investigates existing methodologies in the context of regulating CPSs at different levels from sensing and actuation to system-level orchestration.

In this special issue, we have invited research teams and experts of various supporting disciplines to contribute with recent original research and review articles to help to uncover the indirect impact of novel mathematical methods, computing technologies, and other research results to the conceptual framework of CPC.

After the careful selection and review process, six articles were selected, representing the most critical aspects of the broad CPS horizon:

H. Khan et al. provided a study that applies the achievements of modern control theory for physiological problems, namely, the type 1 diabetes mellitus, contributing this way to the global research efforts on the artificial pancreas. Authors applied the so-called receding horizon controller that were designed via nonlinear programming using the generalized reduced gradient method. Simulated performance test scenarios with different disturbance patterns show promising results.

J. Kuti and P. Galambos's work contributes to the mathematical apparatus of polytopic system modeling and control synthesis supporting the cyber-physical control concepts in a generic problem-independent level. The proposed affine tensor product model transformation is a powerful methodology applicable for quasi-linear parameter varying systems covering a wide range of real-world engineering applications. The affine TP model is introduced as a unique intermediate representation of qLPV systems, bringing significant benefits in complexity reduction and enclosing polytope generation and convex optimization-based controller design.

The paper of J. Zhang et al. investigates the cluster-delay synchronization in directed networks governed by an intermittent control approach. The study presents proof of the viability of synchronization of oscillators in intra- and intercluster cases. Besides the theoretical study, the paper comprises a benchmark study comparing the proposed structure to other controllers in the literature. Numerical examples are also provided to underpin the practical usefulness of the proposed schemes. This study underpins the importance of networked control systems within the scope of CPC.

Aligned to the previous papers, the short article of P. Li et al. investigates the input-to-state stability of nonlinear switched systems. The proposed approach relaxes the stability condition via eliminating the necessity of the negativeness of the derivative of the Lyapunov function. Since a wide range of industrial control systems is implemented as switched system, the practical significance of such theoretical results is outstanding.

The last two papers of the issue deal with the higher level, practical information technology of CPC applications, and Industry 4.0. R. Lovas et al. propose a unified and scalable cloud-based back-end platform that is specially designed for large-scale sensor networks. The novel framework exploits the synergy of existing functional blocks resulting in a cutting-edge solution with relatively low entry barriers for most of the recently emerging industrial applications. This study represents very well the close relationship of CPC to the latest achievements of cloud computing technologies.

Finally, U. H. Govindarajan et al.'s study reviews the literature and the patents related to the immersive technologies (VR, AR, BMI, BCI, etc.) in the context of Industry 4.0. The analysis considers 197 publications and 2672 patents through 10 years in the period 2007–2016. These resources have been analyzed via text mining and probabilistic analysis resulting in different analytics and conclusions including a domain ontology, technology specifications, patent statistics, and a technology function matrix (TFM). This study clearly shows the crucial role of advanced human-machine interfaces in complex cyber-physical systems.

Each paper of the issue represents a specific field of systems and control science with a clear relationship to cyber-physical systems. At first sight, the topics are quite different, but the collection reveals a broader context that connects all of them.

As the editors of this special issue, we hope that the heavily theoretical systems and control science and the application-oriented R&D can coevolve in a fruitful synergy leading to disruption in the new age of cyber-physical control.

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