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SPECIAL ISSUE ON DECENTRALIZED CONTROL OF LARGE SCALE COMPLEX SYSTEMS

This special issue provides information on current and future research directions in the emerging field of Decentralized Control of Large Scale Complex Systems. There is generally adopted view that a dynamic system is large scale complex whenever it is necessary to partition its analysis or synthesis problem to manageable subproblems. Its fundamental characteristics in modeling and control are *high dimensionality, uncertainty, information structure constraints*, and *delays*. Theory of large scale complex systems is based on several new ideas, where most of them belong to one of three design concepts. *System decomposition, decentralized control*, and *robustness and approximation* have been and are being elaborated as powerful tools to overcome difficulties caused by particular properties of these systems.

The theory was initiated and developed in the 1970s and 1980s mainly for the linear time-invariant systems. Large scale complex systems gave rise to problems that were well known in multivariable system theory but have not been solved satisfactorily. There is a renewed emphasis on decentralized control systems today. The changes in the scope and implementations of control systems are motivated by strongly increasing complexity of current control design problems as well as technology driven changes. Such changes are primarily caused by network control systems and low cost processors. There is some reordering of today's priorities leading to the emphasis on the explicit consideration of the interconnections and decentralized control systems in control system analysis and design.

The current state of the art of such research is the subject of 10 papers in the present special issue. The papers can be divided into two main groups of models according to the degree reflecting the internal structure of the overall system. Multi-channel systems and interconnected systems are distinguished. Multi-channel systems consider the overall systems as one whole, while interconnected systems emphasize the influence of the interconnection in coupled subsystems.

The structure of *multi-channel systems* is considered in two papers. The paper by Gui *et al.* "Robust Decentralized H_2 Control of Multi-Channel Descriptor Systems with Norm-Bounded Parametric Uncertainties" presents two stage homotopy method to solve H_2 robust decentralized control problem based on the version of the strict bounded real lemma for descriptor systems.

In the second paper "A Study on Decentralized H_∞ Feedback Control Systems with Local Quantizers", Zhai *et al.* presents a local-output-dependent strategy for updating the quantizers parameters in the feedback loop to achieve asymptotic stability with guaranteed H_∞ performance.

Models of *interconnected systems* are included in the remaining eight papers. In the first paper "Decentralized Structural Controller Design for Large-Scale Discrete-Event Systems Modelled by Petri Nets", Aybar and İftar extend the Inclusion Principle to the design of structural controllers to avoid deadlock in Petri nets.

In the next paper "Non-Fragile Controllers for a Class of Time-Delay Nonlinear Systems", Bakule and de la Sen consider a control problem involving additive gain perturbations in the controller for a class of nonlinear symmetric composite systems. Both delay-independent and delay-dependent stability approaches are considered.

Ding in "Decentralized Output Regulation of Large Scale Nonlinear Systems with Delay" focuses on the output regulation by using decentralized adaptive controller capable of tackling uncertainty in the nonlinear system with unknown delay and the linear exosystem to ensure the overall system stability.

Kozáková *et al.* in the paper titled "A New Nyquist-Based Technique for Tuning Robust Decentralized Controllers" discusses the extension of the Nyquist-type decentralized control design. In this work, the interactions are included into the local controllers design using a selected characteristic locus of the interaction matrix to guarantee the robust stability of the closed-loop system.

The paper by Li and Jiang "Flocking Control of Multi-Agent Systems with Application to Nonholonomic Multi-Robots", describes control strategies aimed at migration and trajectory tracking of a group of agents by using the artificial potential method. The reference point is modelled by a virtual leader. Some agents called active agents (AA) use this information. A decentralized flocking controller is studied for the fixed set of AAs. The controller is applied to the flocking control of a team of nonholonomic mobile robots.

Petersen in the paper titled "Robust H^∞ Control of an Uncertain System via a Stable Decentralized Output Feedback Controller", presents results on a stable decentralized robust output controller synthesis for uncertain systems with uncertainty described by Integral Quadratic Constraints. The off-diagonal blocks of the controller full block transfer function are considered as matrix uncertainties in the decentralized controller. It enable to exploit also the plant interconnections.

In the paper "Decentralized Robust Tracking Control of Uncertain Large Scale Systems with Multiple Delays in the Interconnections", Wu reports on a problem of robust tracking of dynamic signals by using a decentralized state memoryless feedback controller for a class of uncertain large scale complex systems with time-varying delays in interconnections.

In the last paper "Decentralized Control and Synchronization of Time-Varying Complex Dynamical Network", Zhong *et al.* focuses on a synchronization problem in time-varying complex networks with similarity which are composed of coupled nodes. It includes the synthesis of a stabilizing decentralized state and output feedback controller with holographic-structure.

Finally, I would like to thank the authors for the significant time and invested effort. I would like to recognize also the contribution of the reviewers who helped the authors to focus the ideas in their manuscripts. The special issue has been organized by the WG1: Decentralized Control of Large Scale Complex Systems under the IFAC Technical Committee 5.4. Large Scale Complex Systems. The Guest Editor is grateful to the Ministry of Education, Youth and Sports of the Czech Republic by its support through the Grant LA 282.

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Guest Editor