# Preface

Large-scale network systems (LSNSs) include a group of interconnected nodes and have attracted increasing attentions from researchers because of their extensive applications in various fields of practical systems. Based on the network topology, some of the nodes in LSNSs are coupled, which give rise to a variety of collective complexities in the overall dynamical properties of LSNSs. The performances of the nodes can be modified by a control law to perform collective behaviours. Among the collective phenomena, the synchronization of all nodes with or without leader is one of the most significant phenomenon that has been extensively addressed and several efficient techniques have been developed. In the case that a leader-type node is involved, the behaviours of all nodes need to be adjusted by the designed controller and eventually approach to trajectory of the target node. Furthermore, because of the limited bandwidth and unreliable channels in the physical implemented, the information of leader is only available at some discrete time instants. Therefore, we need to investigate the sampled-data control to formulate the synchronization of LSNSs. This kind of control can reduce the amount of transmitted information and increase the efficiency of bandwidth usage.

The nodes exchange information through a communication network, which can be a time-varying channel or a time-invariant channel. The dynamics of individual nodes in the LSNSs can be identical or non-identical. In a homogeneous network of identical nodes, state synchronization among all nodes can be guaranteed by distributed control. In a heterogeneous network of nonidentical nodes, output synchronization among all agents can be achieved via the theory of output regulation. As shown by the internal model principle, if the outputs of the agents in the heterogeneous network track a trajectory, this trajectory needs to be the output of autonomous system. Therefore, we need to investigate the output regulation control law to guarantee the output synchronization of LSNSs.

This book provides the recent advances in analysis and synthesis of LSNSs with sampled-data communication and non-identical nodes. The first chapter of this book is an overview of recent developments of LSNSs with sampled-data control or output regulation control, which is concluded in Chap. 1. Then, this book will present two parts:

Part I: Some developments of LSNSs with sampled-data control are introduced. In Chap. 2, the aperiodic sampled-data synchronization problem of LSNSs incorporate dynamics of actuators saturation is discussed. In Chap. 3, the sampled-data synchronization problem of LSNSs with constant delay is investigated. Based on the vector extension of Wirtinger's inequality, the proposed method can lead to simplified and efficient stability conditions. In Chap. 4, we consider sampled-data exponential synchronization of LSNSs with time-varying coupling delay. Based on the derived condition, the design method of the desired sampled-data controllers is proposed to make the LSNSs exponentially synchronized and obtain a lower bound estimation of the largest sampling interval. In Chap. 5, the event-based leader-following strategy to synchronization of LSNSs is considered. The proposed model-based approach can predict the relative internode states between intermittent communications.

Part II: Some developments of LSNSs with nonidentical nodes are introduced. In Chap. 6, some stability conditions are constructed on the separation principle to guarantee the output synchronization of heterogeneous LSNSs with uncertain linear nodes. In Chap. 7, the hierarchical structure of communication network is proposed to force the outputs of uncertain non-identical nodes to track the output of the uncertain leader in the LSNSs. In Chap. 8, a distributed static output feedback control law is designed to investigate the synchronization problem of LSNSs subjected to exogenous disturbance. In Chap. 9, the proposed distributed static output feedback and robust output regulator can prevent the attack and ensure the security of the entire network. In Chap. 10, the designed distributed control law and adaptive control law can force that the outputs of the reference generators locally exponentially converge to the output of the uncertain leader, and the robust output regulation control law guarantees that the output of each nonidentical follower robustly tracks the output of the corresponding reference generator.

Guangzhou, China — Yuanqing Wu
Guangzhou, China — Renquan Lu
Hangzhou, China — Hongye Su
Adelaide, Australia — Peng Shi
Hangzhou, China — Zheng-Guang Wu
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Wu, Y.; Lu, R.; Su, H.; Shi, P.; Wu, Z.-G.

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