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DECENTRALIZED ROBUST CONTROL DESIGN FOR SPATIALLY INTERCONNECTED SYSTEMS WITH UNCERTAINTIES

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Abstract. *This paper presents a novel decentralized control design method for spatially interconnected systems with external disturbances and model uncertainties. The uncertainties in both local subsystems and their interconnections are considered. Sufficient conditions are presented for the stability of spatially interconnected systems with guaranteed performance. The condition for the existence of decentralized robust controllers is also proposed. The main advantage is that the resulting decentralized controllers have the cooperative control capability, which is required in many applications of spatially interconnected systems. Another advantage lies in low computation cost, for the conditions are expressed as linear matrix inequalities (LMIs) which only contain the parameters of the local subsystem. Simulation results are provided to demonstrate the effectiveness of the proposed approaches.*

Keywords: Decentralized control, Robust control, Interconnected systems, Linear matrix inequality (LMI), Large-scale systems

1. **Introduction.** Recently, there has been a renewal interest in systems which consist of a large number of similar subsystems that interact with their nearest neighbors. Examples include airplane or spacecraft formation flying [1,13,15], cross-directional control in paper machine process [12], and active shape control of reflective surfaces [10] or morphing airfoils [4,7]. Usually, in these systems, sensors and actuators exist at every subsystem. Therefore, such systems have a large number of states, inputs and outputs.

The control design problem of large-scale systems has attracted a lot of attention in the last decades. Usually, decentralized control architectures are adopted to handle this kind of problem. Successful synthesis methods for decentralized controllers have been proposed to guarantee the stability and performance of large-scale systems [2,10,13,16,17]. One important characteristic of conventional decentralized controllers is that they solely use the measurement information of the local subsystem. This means that the conventional decentralized control approach is not good at making subsystems to work cooperatively.

In recent years, consensus algorithms are introduced to specify the information exchange among a subsystem and all of its neighbors. In [6] and [14], distributed consensus control problems for multi-agent systems are investigated. However, most of the literatures on consensus problems are devoted to multi-agent systems which have no physical interconnections among subsystems.

In [3,5,9], distributed control problems for spatially interconnected systems are discussed. The designed controllers have the same structure as the physically interconnected systems. The controllers not only use the information of local subsystems, but also use the information from neighboring subsystems. However, the system models considered in [3,5,9] need precise parameters.