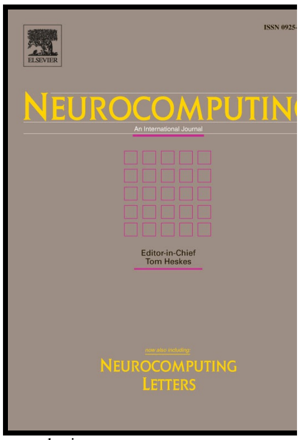

Second-order consensus in multi-agent systems with directed topologies and communication constraints

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Second-order consensus in multi-agent systems with directed topologies and communication constraints

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Abstract

The paper investigates second-order consensus problem for multi-agent systems with nonlinear dynamic and directed topologies, where each agent can only communicate with its neighbors on some disconnected time intervals. A novel intermittent consensus protocol is designed by its own and the neighbor's relative local information. Based on the Lyapunov stability theory and the intermittent control method, some novel and simple criteria are derived for consensus of multi-agent systems under a fixed strongly connected topology, it is proved that consensus can be reached if the general algebraic connectivity and the measure of communication are larger than the corresponding threshold values, respectively. Finally, two numerical examples are provided to demonstrate the effectiveness of the obtained theoretical results.

Key words: Multi-agent systems, second-order consensus, algebraic general connectivity, communication constraint, intermittent control.

1 Introduction

Collective behaviors in multi-agent systems have received a great deal of attention in recent years due to it widespread applications in the coordination and control of distributed sensor networks, unmanned-air-vehicle formations, robotic teams, etc. One common feature of such applications is that an agreement has to be reached by all agents only share information with their neighbors locally. Recently, much progress has been made in the study of consensus for multi-agent systems [1, 2, 3, 4, 5, 6]. It has been proved that consensus can be achieved in first-order multi-agent systems if and only if the time-varying network topology contains a spanning tree frequently enough as the network evolves with time[2, 7].

Up to date, most of the results on the consensus problem are based on the assumption that the agents are governed by first-order dynamics[2, 8, 9, 10, 11, 12]. Nevertheless, second-order consensus problem will contribute to the study of more complicated dynamics, and help engineers implement the consensus algorithms in real networked multi-agent systems. Therefore, second-order consensus problem is recognized as an important topic[1, 3, 4, 7, 13, 14, 15, 16, 17], it is shown that second-order consensus may fail to be reached in many cases even if the communication topology has a spanning tree[7] , which is different from the first-order consensus problems. More recently, some necessary and sufficient conditions have been obtained for second-order consensus in a network containing a directed spanning tree [18], it has been found that both the real and imaginary parts of the eigenvalues of the Laplacian matrix of the communication graph play key roles in reaching consensus.

It should be noticed that there is a common assumption in the above-mentioned results that each agent can receive measurements of states between it neighbors and itself all the time, that is, each agent can share information with its neighbors without communication constraints. However, this may not be the case in reality due to the existence of sensor failures, or the distances between them are larger than the effective sensing range. Thus, it is reasonable to assume that each agent can sense it neighbors only intermittently, that is, the agents can only communicate with their

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