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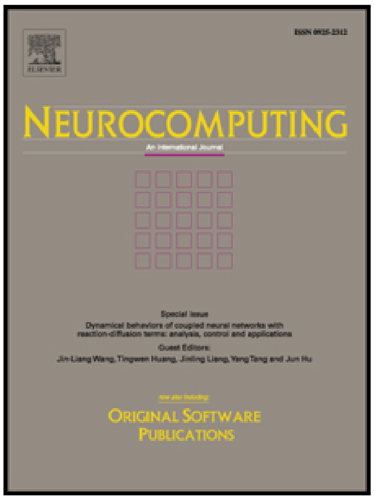

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Containment control of leader-following multi-agent systems with jointly-connected topologies and time-varying delays

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Abstract: This paper considers the containment control problem for leader-following multi-agent systems in the presence of dynamically switching topologies with communication delays. Two types of control algorithms are proposed for containment control with first-order dynamics and second-order dynamics. By applying modern control theory and algebraic graph theory, the stabilities of two containment control algorithms are analyzed on Lyapunov-Krasovskii method. Moreover, some sufficient conditions are provided through further researching the connected portion of multi-agent systems, which can ensure that the containment control can be achieved asymptotically when communication topologies are jointly-connected. Finally, some simulation examples are provided to demonstrate the effectiveness of two proposed algorithms.

Keywords: containment control, multi-agent systems, jointly-connected, time-varying delays

1. Introduction

Distributed cooperative control of multi-agent systems (MASs) has attracted significant attention in recent years, due to its potential in the study of animal group behaviors such as swarms [1] and flocking [2], and its broad applications in both military and civilian sectors, such as the formation control of mobile robots, cooperative control of unmanned aerial vehicles, attitude adjustment and position of satellite, and so on [3-5]. The motivation of multi-agent distributed cooperative control is to guarantee a group of autonomous agents to complete some specific tasks via the distributed control strategy.

As one of the critical and fundamental research issues arising from distributed cooperative control of MASs, consensus problem, which means to reach an agreement on a common value for a group of agents by developing some distributed controllers based on the relative local information, has received increasing attention. The different investigation scenarios include leaderless consensus [6-9], leader-following consensus [10-13], and containment control [14-17]. The leaderless consensus means to reach agreement state of each agent through interaction and coordination with the evolution of time, and the leader-following consensus means a leader is designated and all the followers track the leader using the consensus protocol. Containment control has been paid much attention as a special kind of consensus with multiple leaders, which aims to design appropriate control protocols to drive the followers to a target area (convex hull formed by the leaders) asymptotically.

In practical applications, communication delays and dynamically networked topologies always emerge in MASs. With this background, the consensus problem of MASs in the presence of jointly-connected topologies with diverse time-delays is investigated in [18], and sufficient conditions for consensus are derived by a contradiction approach. For high-order integral MASs, the consensus problem under switching directed topology is considered in [19], and two distributed protocols are proposed for consensus. For the uncertain nonlinear MASs, the consensus problem with probabilistic time-varying delay is investigated in [20], and several novel delay-dependent sufficient conditions are established by the Lyapunov-Krasovskii approach. For a class of complex dynamical networks, the issue of synchronization with uncertain inner coupling strength is discussed in [21], and two successive time-varying delays

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