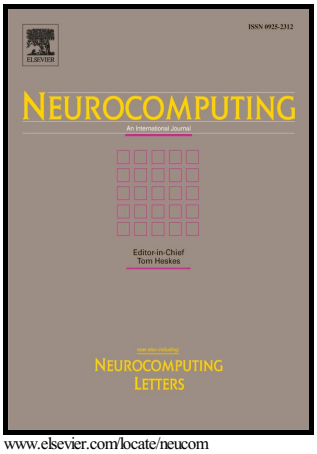

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Formation-containment Control for Second-order Multi-agent Systems with Time-varying Delays ☆

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Abstract

In this paper, formation-containment control problems for multi-agent systems with second-order dynamics and time-varying delays are studied. The states of leaders are designed to achieve the time-varying formation and the states of followers are required to converge to the convex hull spanned by those of leaders simultaneously, which differs from conventional formation control or containment control problems. Using the neighboring positions and velocities, formation-containment protocols with time-varying delays are constructed. By exploiting the space decomposition approach, formation-containment problems are transformed into the asymptotically stable problems. Sufficient conditions for second-order multi-agent systems with time-varying delays to realize formation-containment are presented. A method to obtain the unknown gain matrices in the protocols is proposed. Numerical simulations are shown to illustrate the effectiveness of the theoretical results.

Key words: Formation-containment control; second-order dynamics; multi-agent systems; time-varying delays

1. Introduction

In the past decade, cooperative control of multi-agent systems has received a lot of attention from various research fields because of its feasible applications in many areas, for example, collaboration of sensor network [1], formation control of unmanned aerial vehicle (UAV) [2], synchronization of complex networks [3], distributed optimization [4], and spacecraft formation [5]. Currently, there are many different categories in the cooperative control of multi-agent systems, where consensus control [6], formation control [7], containment control [8], and formation-containment control [9] are four of the most attractive ones.

Formation control problem is a fundamental and practical problem. Recently, consensus-based formation control approaches have been used to deal with this problem. Consensus-based formation control methods, which used local neighboring information, were presented for second-order multi-agent systems in [10]. In [11], a finite-time formation control strategy was developed for first-order multi-agent systems. Consensus-based formation

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