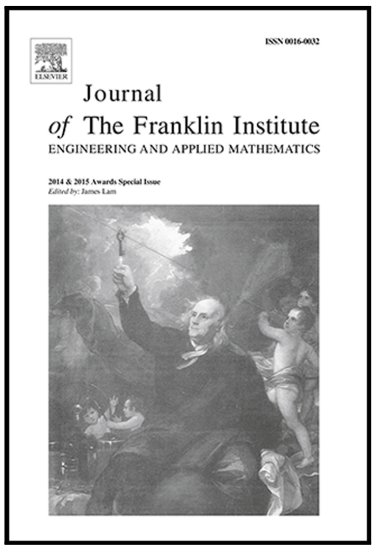


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# Adaptive cooperative tracking control for a class of nonlinear time-varying multi-agent systems

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**Abstract**

In this paper, an adaptive cooperative tracking control scheme is proposed for a class of high-order nonlinear time-varying multi-agent systems, where only the output of the leader is available for some followers. By introducing a bound estimation approach and a smooth function, the obstacle caused by unknown time-varying parameters is successfully circumvented without any restriction on their variation speed. With the aid of the dynamic surface control technique, simple distributed adaptive controllers are obtained and each follower needs only the first two states rather than the full states of its neighbor followers, which considerably reduces the computational and communication burden. It is shown that all tracking errors converge to a residual set which can be made arbitrarily small. Simulation results on robotic manipulators are presented to illustrate the effectiveness of the proposed scheme.



*Keywords:* Multi-agent systems, cooperative tracking, adaptive control, time-varying systems.

## 1. Introduction

Motivated by a large number of applications in various fields such as mobile robots, unmanned air vehicles and wireless sensors, distributed cooperative tracking control of multi-agent systems has attracted extensive attention in recent years. In this control problem, the leader agent acts as a command generator and the follower agents attempt to track the leader's trajectory. A local controller is designed for each follower using the information of itself and its neighbors. Since the leader's trajectory is only available for a small fraction of followers, the limitation of communication has stimulated active research for the problem.

In the earlier research for multi-agent systems, the main interests were focused on first-order and second-order systems and the system parameters were usually assumed to be known [1]-[6]. Since uncertainties exist in many practical systems, adaptive cooperative tracking control is becoming a hot-spot issue in the control community. In [7]-[9], the adaptive control technique was applied to first-order and second-order multi-agent systems with unknown constant parameters. With the aid of neural networks, in [10] a class of first-order multi-agent systems with unknown nonlinearities was investigated, and the result was later extended to more general systems with second-order dynamics [11] and high-order dynamics in Brunovsky form [12], [13]. In [14] and [15], the case that the leader's output is a periodic signal was studied within the framework of adaptive iterative learning control. A common drawback of [7]-[15] is that the system

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