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Observer-Based Leader-Following Consensus of Nonlinear Fractional-Order Multi-Agent Systems

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Abstract : The coordination of the multi-agent systems has been one of the interesting topic in recent years, because of its potential applications in many branches of science and engineering such as sensor networks, flocking, underwater vehicles and etc. In the most of the related studies, it is assumed that the dynamics of the multi-agent systems are integer-order and linear and the multi-agent systems with the fractional-order nonlinear dynamics are rarely considered. However many phenomena in nature cannot be described within integer-order and linear characteristics. This paper investigates the leader-following consensus problem for a class of nonlinear fractional-order multi-agent systems based on observer-based cooperative control. In the system, the dynamics of each follower and leader are nonlinear. For a multi-agent system with fixed directed topology firstly, an observer-based consensus protocol is proposed based on the relative observer states of neighboring agents. Secondly, based on the property of the stability theory of fractional-order system, some sufficient conditions are presented for the asymptotical stability of the observer-based fractional-order control systems. The proposed method is applied on a five-agent system with the fractional-order nonlinear dynamics and unavailable states. The simulation example shows that the proposed scenario results in the good performance and can be used in many practical applications.

Keywords : fractional-order multi-agent systems, leader-following consensus, nonlinear dynamics, directed graphs
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