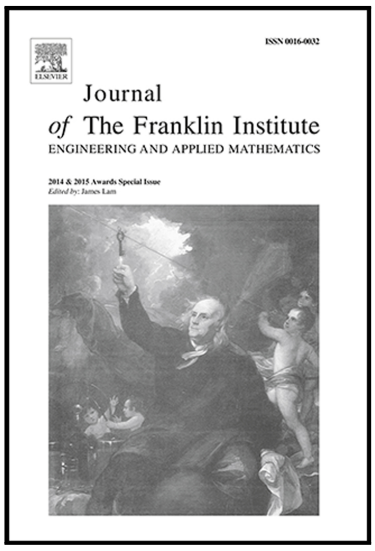

Improved Order-Reduction Method for Cooperative Tracking Control of Time-Delayed Multi-Spacecraft Network

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Abstract

This article investigates the order-reduction method for multi-spacecraft cooperative tracking control problems considering non-uniform time delays. The tracking error system is constructed as a linear time-varying (LTV) system since the orbit of the reference point is an ellipse. To facilitate the controller design, a model transformation method is proposed to transform the LTV system into a linear time-invariant (LTI) system with norm-bounded uncertainties. By using the sliding-mode control (SMC) technique, a delay-dependent cooperative tracking controller is designed to guarantee multiple followers to track the leader. Then, an order-reduction method is proposed to reduce the order of sufficient conditions in the form of linear matrix inequalities (LMIs), which make sure that the tracking error system is asymptotically stable. A numerical example is finally provided to illustrate the effectiveness of the designed controller and the improved performance of the order-reduction method.

Keywords:
Order-reduction, cooperative control, non-uniform time delays, SMC, LMI.

1. Introduction

Cooperative control of multi-agent systems (MASs) has attracted considerable attentions during the past decade, see [1]–[11] for some excellent work. In cooperative control of MASs, order reduction is a significant problem. When dealing with the cooperative control problem of MASs by using the LMI method, the order of LMIs will be very high if there exist many agents in the network, that is, the numerical complexity of LMIs is high. Therefore, it is necessary to use the order-reduction method to reduce the order of LMIs. In [12]–[20], order-reduction methods for MASs without time delays have been proposed. By using these order-reduction methods, the order of LMIs to be calculated is decoupled with the amount