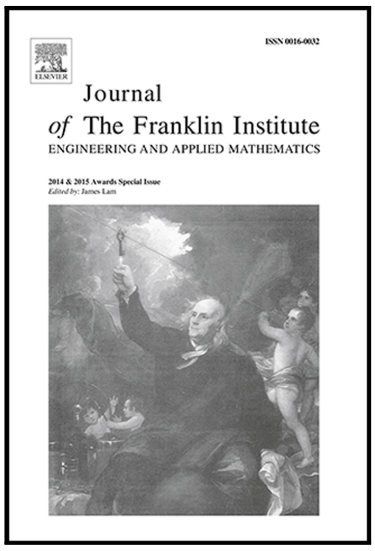

Projective synchronization in fixed time for complex dynamical networks with nonidentical nodes via second-order sliding mode control strategy

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Projective synchronization in fixed time for complex dynamical networks with nonidentical nodes via second-order sliding mode control strategy

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Abstract

This paper is concerned with the global projective synchronization in fixed time for complex dynamical networks (CDNs) with nonidentical nodes in the presence of disturbances. Firstly, in order to realize the fixed-time projective synchronization of CDNs with matched disturbances, the second-order sliding mode is established, and the global fixed-time reachability of sliding manifolds is analyzed. The fixed-time stability of the sliding mode dynamics is also proved analytically based on Lyapunov stability theory. Moreover, the fixed convergence time of both reaching and sliding mode phases can be adjusted to any desired values in advance by the choice of the designable parameters. Secondly, in order to realize the fixed-time projective synchronization of CDNs with mismatched disturbances, a super-twisting-like (STL) controller, which does not require the information of the derivative of the sliding variable, is designed, and the synchronization condition is addressed in terms of linear matrix inequalities (LMIs). By the proposed controllers, continuous control signals can be provided to reduce the chattering effect and improve the control accuracy. Finally, two numerical examples are given to demonstrate the validity of the theoretical results and the the feasibility of the proposed approaches.

Keywords: Complex dynamical networks, Fixed-time stability, Second-order sliding mode control, Projective synchronization, Mismatched disturbances.

1. Introduction

In recent decades, rapidly increasing attention has been devoted to the research of various CDNs in many fields of science and engineering [1, 2]. The main reason is that, in nature and human societies, there are many large-scale systems that can be described by CDNs. Generally, a CDN is composed of a large number of interconnected dynamical nodes, in which a node is defined by a basic unit of the physical network. Recently, the synchronization issue of CDNs has stirred much research interest on account of its fruitful applications in various fields, such as engineering, power grids, ecology, climatology, sociology and biology, see [3, 4].

So far, some results in the literature were concerned with the global asymptotic synchronization of CDNs, see [4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14], and references therein. It should be pointed out that, the asymptotic synchronization means that the complete synchronization can not be achieved in finite time. Whereas, it is more beneficial to synchronize CDNs within a desired time in practical engineering applications. In this line, many researchers proposed a lot of schemes for finite-time synchronization of CDNs, see [15, 16, 17, 18, 19, 20, 21, 22]. It is notable that, the settling-time of finite-time synchronization of CDNs is dependent on the initial conditions of the networks. This drawback of finite-time technique can make troubles in the practical applications of CDNs, when the initial conditions of the networks are not known for any reason. To overcome this difficulty, Polyakov introduced the concept of fixed-time stability [23], which is a special finite-time stability and whose settling-time is independent on the initial conditions.

Very recently, several studies were devoted to realize the fixed-time synchronization for CDNs. In [24] and [25], the fixed-time cluster synchronization of CDNs was investigated by using adaptive control and pinning

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