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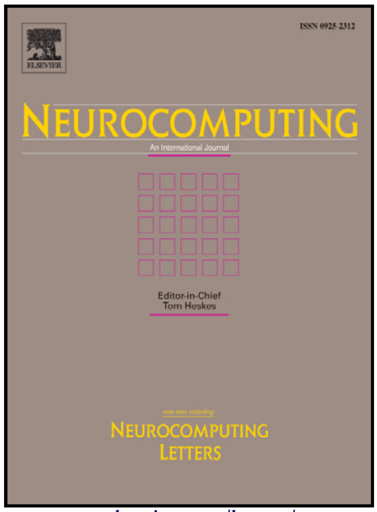

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Synchronization of Complex Dynamical Network with Piecewise Constant Argument of Generalized Type

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Abstract

This paper studies synchronization problems of complex dynamical network with mixed coupling via impulsive control. The model involves both advanced and delayed arguments, and the problem of the existence of the model is analyzed. Based on the stability theory for impulsive differential equations, an effective impulsive control scheme is proposed to achieve synchronization for complex dynamical networks. Finally, an example with numerical simulations is given to illustrate our results.

Keywords: Complex dynamic network; impulsive control; synchronization; Piecewise Constant Argument of Generalized Type

1. Introduction

Complex dynamical network (CDN) is a large set of interconnected nodes, in which each node represents an individual element in the network and edges represent the relations between them. Model of CDN has been widely used to describe many natural and man-made systems, such as internet, social systems, electrical power grids and so on.

Recently, the synchronization problems of CDN have become an active area of research and attracted substantial attentions [1]-[16], [17]-[21] (and the references cited therein). In fact, synchronization is a ubiquitous phenomenon in nature. Synchronization phenomena has been found both in nature and in man-made systems, such as fireflies in the forest, applause, description of hearts, distributed computing systems, routing messages in the internet, chaos-based communication network, and so on. Various control schemes such as pinning control [3]-[11], impulsive control [20]-[24], linear matrix inequality [25], and algebraic graph theorem [26], etc were reported to achieve network synchronization.

It has been proved, in the study of CDN synchronization, that impulsive synchronization approach is effective and the controllers used usually have a relatively simple structure. So this approach is very useful in practical applications. A unified criterion which is simultaneously effective for both synchronizing impulses and desynchronizing impulses was derived in [21]. Robust impulsive synchronization of uncertain dynamical networks is studied in [22]. By utilizing the concept of impulsive control and the stability results for impulsive systems, several criteria for robust local and robust global impulsive synchronization are established for complex dynamical networks. In [23] the approximate synchronization problem of two nonidentical nonlinear systems is investigated. Based on the impulsive control method, a sufficient condition is given to guarantee the approximate synchronization. An impulsive control scheme is proposed to achieve impulsive synchronization for complex dynamical networks with unknown coupling in [24]. The globally exponential synchronization of delayed complex dynamical networks with impulsive and stochastic perturbations is studied in [27]. The concept named "average impulsive interval" with "elasticity number" of impulsive sequence is introduced to get a less conservative synchronization criterion. In [14] a new control strategy is proposed for the synchronization of stochastic dynamical networks with nonlinear coupling.

Moreover, since time-delay is inevitable in communication, the study of delayed complex networks with impulsive effects is meaningful. The exponential synchronization of a CDN with delayed coupling and impulses is investigated in [28]. Besides, authors in [29]-[30] discussed the dynamical behaviors of complex systems with piecewise constant argument which introduced discontinuity to the system. The arguments in the model are not only delayed but also advanced. Models with advanced arguments have been investigated by [33]-[34]. In [35], the author give another proof that the future can influence the present. We proceed from the fact that delayed as well as advanced arguments play a significant role in electromagnetic fields.

Motivated by the aforementioned literatures, the system discussed in this work contains both delayed coupling and advanced coupling in order to simulate the finite speed for signal propagation and anticipate for nodes' behavior. We employ an unified model to describe these distinct effects, based on the stability theory for impulsive differential equations, an impulsive control scheme is proposed to achieve synchronization in CDN.

An outline of this paper is as follows: In Section 2, some notations as well as the model are described. Sufficient conditions of synchronization of CDN are stated in Section 3. In Section 4, one numerical example is given, and conclusion is made in

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