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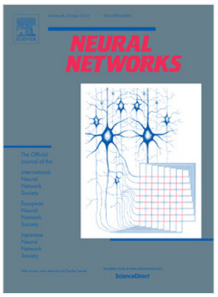

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Global exponential synchronization of multiple coupled inertial memristive neural networks with time-varying delay via nonlinear coupling ☆

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Abstract

In this paper, global exponential synchronization of multiple coupled inertial memristive neural networks with time-varying delay is investigated. First, by choosing suitable variable substitution, the inertial memristive neural networks are transformed into first-order differential equations. Next, a novel coupling scheme with linear diffusive term and discontinuous sign function term depending on the first order derivative of state variables is introduced. Based on this coupling scheme, several sufficient conditions for global exponential synchronization of multiple inertial memristive neural networks are derived by using Lyapunov stability theory and some inequality techniques. Finally, several numerical examples are presented to substantiate the effectiveness of the theoretical results.

Keywords: Inertial memristive neural network, global exponential synchronization, nonlinear coupling, time-varying delay.

1. Introduction

The memristor was proposed by Prof. Chua (Chua, 1971), which is the fourth fundamental circuit element. Great attention has been attracted to the memristor due to its promising applications, such as device modeling and signal processing, one of which is to emulate synaptic behavior. Therefore, in the circuit implementation, we could use memristors instead of resistors to simulate synapses among the neurons to build a memristive neural network model. Due to the memory function that the resistor does not possess, memristive neural networks are superior to traditional neural networks in simulating human brains (Itoh & Chua, 2009, Jo et al., 2010, Guo et al., 2013).

Synchronization is an important dynamical behavior that can be applied to many fields. As we know, many results on drive-response synchronization of memristive neural networks have been obtained (Wang et al., 2014, Guo et al., 2015a, Cai et al., 2016, Abdurahman & Jiang, 2016). In Wang et al. (2014), the synchronization control of memristive recurrent neural networks with impulsive perturbations or boundary perturbations was studied by using differential inclusion theory and Lyapunov functional method. In Guo et al. (2015a), the authors investigated global exponential synchronization of two memristive recurrent neural networks with time delays via static or dynamic coupling. The authors studied exponential synchronization of memristive neural networks by using differential inclusion theory in Cai et al. (2016). The exponential synchronization of delayed memristive neural networks with discontinuous activation functions was discussed by using some new techniques and differential inclusion theory in Abdurahman & Jiang (2016). Moreover, synchronization is a kind of collective behaviors that can explain many natural phenomena, such as, birds migration, firefly dancing. Synchronization of multiple coupled memristive neural networks means that they have a common trajectory eventually. Because the connection weights are state-dependent, memristive neural networks with different initial states may switch asynchronously, which leads to the difficulty in studying the synchronization of multiple coupled memristive neural networks. So far, there only exists a little work on synchronization of multiple coupled memristive neural networks (Guo et al., 2015b, Yang et al., 2015).

As we know, the inertial term in nonlinear system is taken as a critical tool to generate bifurcation and chaos (He et al., 2012). The neural networks with inertial term, called inertial neural networks, was first put forward by Babcock and Westervelt (Babcock & Westervelt, 1987). However, only a few results on inertial neural networks, especially, inertial memristive neural networks have been reported, see (Hu et al., 2015, Rakkiyappan et al., 2016).

Motivated by the above discussions, this paper aim-

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