Accepted Manuscript

Global synchronization in finite time for fractional-order neural networks with discontinuous activations and time delays

Xiao Peng, Huaiqin Wu, Ka Song, Jiaxin Shi

PII: S0893-6080(17)30147-8
DOI: http://dx.doi.org/10.1016/j.neunet.2017.06.011
Reference: NN 3776

To appear in: *Neural Networks*

Received date : 30 November 2016
Revised date : 17 May 2017
Accepted date : 22 June 2017

Please cite this article as: Peng, X., Wu, H., Song, K., Shi, J., Global synchronization in finite time for fractional-order neural networks with discontinuous activations and time delays. *Neural Networks* (2017), http://dx.doi.org/10.1016/j.neunet.2017.06.011

Global synchronization in finite time for fractional-order neural networks with discontinuous activations and time delays

Xiao Peng, Huaiqin Wu*, Ka Song, Jiaxin Shi

School of Science, Yanshan University, Qinhuangdao 066001, China

Abstract

This paper is concerned with the global Mittag-Leffler synchronization and the synchronization in finite time for fractional-order neural networks (FNNs) with discontinuous activations and time delays. Firstly, the properties with respect to Mittag-Leffler convergence and convergence in finite time, which play a critical role in the investigation of the global synchronization of FNNs, are developed, respectively. Secondly, the novel state-feedback controller, which includes time delays and discontinuous factors, is designed to realize the synchronization goal. By applying the fractional differential inclusion theory, inequality analysis technique and the proposed convergence properties, the sufficient conditions to achieve the global Mittag-Leffler synchronization and the synchronization in finite time are addressed in terms of linear matrix inequalities (LMIs). In addition, the upper bound of the setting time of the global synchronization in finite time is explicitly evaluated. Finally, two examples are given to demonstrate the validity of the proposed design method and theoretical results.

Keywords: Fractional-order neural networks; Global Mittag-Leffler synchronization; Synchronization in finite-time; Discontinuous activation function; Time delays

1. Introduction

In the past decades, neural networks have been found extensive applications in optimization, classification, solving nonlinear algebraic equations, signal and image processing, pattern recognition, automatic control, associative memories, and so on [1-5]. In the literature, a lot of results with respect to integer-order neural networks have reported, see [6-14], and references therein.

With the development of the theory of differential and integral calculus, the fractional-order differential and integral calculus concept have been proposed, and its practical applications make it more vigorous. Compared with integer-order calculus, fractional-order calculus own better description for the memory and hereditary properties of various processes [15,16]. Taking these facts into account, the incorporation of the fractional-order calculus into a neural network model could better describe the dynamical behavior of the neurons, and many efforts have been made [17-20]. In [17], the authors firstly developed the fractional-order cellular neural network model and revealed the existence of chaotic behavior. In [18], the authors presented a fractional-order three-cell network, which put forward limit cycles and stable orbits for different parameter values. In [19], the authors point out that FNNs can be expected to play an important role in parameter estimation. As noted in [20], it is very significant and interesting to study FNNs both in the area of theoretical research and in practical applications.

Recently, some excellent results about the dynamic analysis of FNNs have been presented in [21-29]. For instance, the authors in [21] discussed the chaotic and hyperchaotic behaviors in a fractional-order four-cell cellular neural network, by using numerical simulations. In [24], the authors investigated the dynamics of fractional-order delayed Hopfield neural networks, including stability, multistability, bifurcations, and chaos. Stability analysis of fractional-order Hopfield neural networks with discontinuous activation functions was made in [25]. In [26,27], the global Mittag-Leffler stability and asymptotic stability were considered for FNNs with or without delays and impulsive effects.

*Corresponding author
Email address: huaiqinwu@ysu.edu.cn (Huaiqin Wu)
[1]This work was jointly supported by the National Natural Science Foundation of China (61573306) and High level talent support project of Hebei province of China(C2015003054).