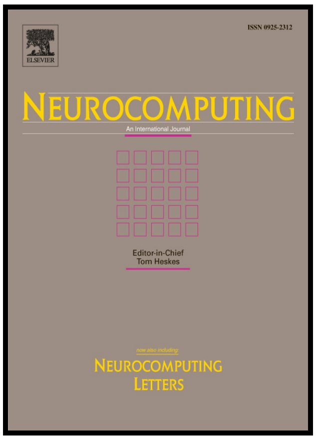

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LMI conditions to global Mittag-Leffler stability of fractional-order neural networks with impulses

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Abstract

This paper is concerned with the global Mittag-Leffler stability issue for fractional-order neural networks with impulse effects. Based on the properties of topological degree, the existence of the network equilibrium point is proved, and the expression of solution is given.An inequality for the Caputo fractional derivative, with $0 < \gamma < 1$, is improved, which plays central roles in the investigation of the global Mittag-Leffler stability. Applying the fractional Lyapunov method with impulses, the global Mittag-Leffler stability condition is presented in terms of linear matrix inequalities (LMIs). Finally, an illustrative example is given to demonstrate the effectiveness of the theoretical results.

Keywords: Fractional-order neural networks; Mittag-Leffler stability; LMIs; Impulses; Topological degree

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1. Introduction

As a branch of mathematical analysis, fractional calculus can date back to the contribution of Leibniz and L'Hospital about 300 years ago(Podlubny, 1999; Butzer & Westphal, 2000). But because of its complexity and lacking of the application background, fractional calculus hasn't draw much attention from researchers for a long time. Recently, some researchers have begun to study and have applied fractional calculus into many aspects, such as economics, physics, engineering and so on(Kilbas, Srivastava & rujillo, 2006; Hilfer, 2001; Meral, Royston & Magin, 2010; Arena, Caponetto, Fortuna & Porto,2000).

It is well known that compared with integer-order models, fractional-order calculus provide a more accurate instrument for the description of memory and hereditary properties of various processes. 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 much efforts have been made. In the existing literature (Arena, Caponetto, Fortuna & Porto, 1998), the authors firstly proposed a fractional-order cellular neural network. In Petr*áš* (2006), the author pointed out a fractional-order three-cell network and also put forward limit cycles and stable orbits for different parameter values about the network. Besides, it is important to point out that fractional-order neural networks are expected to play a important role in parameter estimation (Chon, Hoyer & Armoundas, 1999; Huang, Huang & Chen, 2013; Beer, 2006; Raol, 1995). Therefore, it is significant and interesting to study the dynamics of fractional-order neural networks whatever in the area of theoretical research or in practical applications(Kilbas, Srivastava & Trujillo, 2006).

Recently, the dynamical analysis of fractional-order neural networks has received considerable attention and some excellent results have been presented(Kaslik & Sivasundaram, 2011; Song & Cao,2014). Fractional-order three-dimensional Hopfield neural networks where chaotic behaviors could emerge was pointed out in Zhang et al. (2010). Moreover, a fractional-order four-cell cellular neural network was presented and its complex dynamical behaviors were investigated using numerical simulations in Huang et al. (2012). Bifurcation and chaos of fractional-order neural networks were firstly pointed out in Arena et al. (1998). In addition, several results with respect to chaotic synchronization of fractional-order neural networks were also proposed in Zhu et al. (2008) and Zhou et al. (2008, 2010). Very recently, there have some advances in stability theory of fractional-order systems(Li & Zhang, 2011; Sabatier & Farges,2012; Lanusse, 2012; Tavazoei & Haeri,2009).

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