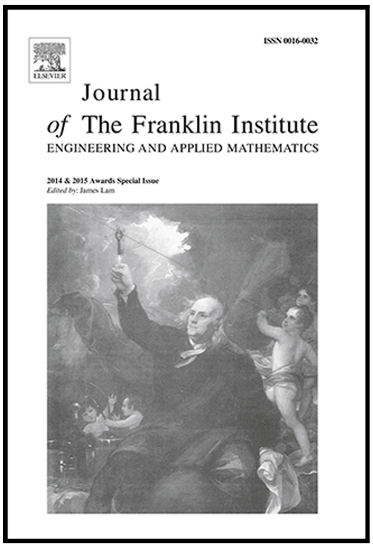
Accepted Manuscript



Asymptotic stability of delayed fractional-order fuzzy neural networks with impulse effects

Jiyang Chen, Chuandong Li, Xujun Yang

PII: S0016-0032(18)30517-9
DOI: https://doi.org/10.1016/j.jfranklin.2018.07.039
Reference: FI 3586

To appear in: *Journal of the Franklin Institute*

Received date: 30 November 2017
Revised date: 10 April 2018
Accepted date: 5 July 2018

Please cite this article as: Jiyang Chen, Chuandong Li, Xujun Yang, Asymptotic stability of delayed fractional-order fuzzy neural networks with impulse effects, *Journal of the Franklin Institute* (2018), doi: https://doi.org/10.1016/j.jfranklin.2018.07.039

Asymptotic stability of delayed fractional-order fuzzy neural networks with impulse effects

Jiyang Chen, Chuandong Li*, Xujun Yang

National & Local Joint Engineering Laboratory of Intelligent Transmission and Control Technology, College of Electronic and Information Engineering, Southwest University, Chongqing 400715, PR China

Abstract

In this paper, we investigate the asymptotic stability of fractional-order fuzzy neural networks with fixed-time impulse and time delay. According to the fractional Barbalat's lemma, Riemann-Liouville operator and Lyapunov stability theorem, some sufficient conditions are obtained to ensure the asymptotic stability of the fractional-order fuzzy neural networks. Two numerical examples are also given to illustrate the feasibility and effectiveness of the obtained results.

Keywords: Asymptotic stability; Fractional order; Fuzzy neural networks; Impulse effects; Time delay

1. Introduction

About 300 years ago, Leibniz and L'Hospital proposed fractional calculus through correspondence [1,2]. As the result of the lack of useful comparison of fractional calculus in practical applications, it was limited and developed slowly. However, compared with integer-order models, many practical systems need to be illustrated by fractional-order models. Recently, fractional calculus have been investigated and applied in many fields by some researchers, such as diffusion, electrochemistry, viscoelastic materials, control and biological systems, see [3-7] and the references therein.

In the reality, the fractional calculus incorporated into the neural network model can better present the dynamical characteristics. Therefore, fractional-order neural networks have been considered by many researchers [8-10]. Meanwhile, time delay [11-12] exists in practical dynamical systems, including neural networks, because of limited signaling rate between neurons. Furthermore, time delay influences even changes the dynamical behavior of fractional-order neural networks. So it is necessary to consider the time delay in the analysis of fractional-order neural networks. Besides, many practical systems exist sudden external disturbance, which makes the system trajectory deviate from the original direction in a moment, this disturbance is regarded as impulse [13-17]. The experiments show that the short time disturbance can make the neural network produce marvellous dynamic phenomena. Hence, the dynamic characteristics of fractional-order neural networks might be described more accurately by considering the impulse and time delay.

It is well known that stability is the primary condition of the various systems [18-20]. Hence, a lot of researchers have been begun to study the stability of fractional-order neural networks, see [21-25] and the references therein. In [21,22], Mittag-Leffler stability of variable impulsive and fixed impulsive fractional-order neural networks have been investigated, respectively. B-equivalent method was applied to guarantee the Mittag-Leffler stability of variable impulsive fractional-order neural networks. Based-on S-procedure and impulsive differential equations, general quadratic Lyapunov function and some sufficient criteria were established to ensure the Mittag-Leffler stability of fixed impulsive fractional-order neural networks. In [23], finite-time stability of delayed fractional-order neural networks have been discussed. Inequality techniques and some sufficient conditions were applied to guarantee the finite-time stability for the addressed model. In [24], authors investigated the projective synchronization of fractional-order neural networks. Based on the fractional adaptive control and a new fractional differential inequality, some novel conditions were obtained to achieve projective synchronization for the addressed model. In [25], authors studied the stability and synchronization of impulsive fractional neural networks, comparison principle and the Lyapunov function method were utilized to ensure the stability and synchronization of impulsive fractional neural networks. However, there are few if any studies on stability of the fractional-order fuzzy neural networks with both impulse and delay, so it is necessary to study the dynamic behavior of delayed fractional-order impulsive fuzzy neural networks.

Owing to the contribution of Zadeh in the establishment of fuzzy logic [26], the fuzzy logic has been paid more and more attention, furthermore, it has been successfully and effectively applied in fuzzy analysis of many models

*Corresponding author

Email addresses: jiyangchen@163.com (Jiyang Chen), cdli@swu.edu.cn (Chuandong Li), xujunyangcquc@163.com (Xujun Yang)