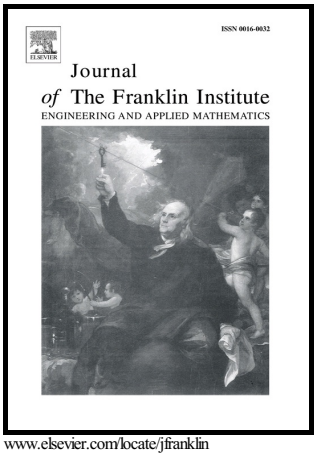

www.elsevier.com/locate/jfranklin

Stability analysis of neural networks with periodic coefficients and piecewise constant arguments

Tianhu Yu, Dengqing Cao, Shengqiang Liu, Huatao Chen

PII: S0016-0032(15)00426-3
DOI: http://dx.doi.org/10.1016/j.jfranklin.2015.11.010
Reference: FI2491

To appear in: *Journal of the Franklin Institute*

Received date: 22 November 2014
Revised date: 31 May 2015
Accepted date: 10 November 2015

Cite this article as: Tianhu Yu, Dengqing Cao, Shengqiang Liu and Huatao Chen, Stability analysis of neural networks with periodic coefficients and piecewise constant arguments, *Journal of the Franklin Institute* http://dx.doi.org/10.1016/j.jfranklin.2015.11.010

Stability analysis of neural networks with periodic coefficients and piecewise constant arguments

Tianhu Yu[1], Dengqing Cao[1*], Shengqiang Liu[2*], Huatao Chen[1*]

[1]*School of Astronautics, Harbin Institute of Technology, P. O. Box 137, Harbin 150001, P. R. China.*

[2]*Academy of Fundamental and Interdisciplinary Science, Harbin Institute of Technology, 3041#, 2 Yi-Kuang Street, Harbin 150080, P.R. China.*

Abstract

Global exponential stability of a class of neural networks with periodic coefficients and piecewise constant arguments is investigated in this paper. A new definition of exponential stability and a novel differential inequality with piecewise constant arguments are introduced to obtain sufficient conditions for the globally exponential stability of the periodic solution of neural networks. The stability criteria are independent on the upper bound of the adjacent element difference of the discontinuous switching moments. According to the new definition of exponential stability and the novel differential inequality, not only it is not necessary to establish any relationship between the norms of the states with/without piecewise constant arguments, but also the stability criteria for the neural networks can be obtained just in terms of the original differential equation, rather than the equivalent integral equation which is widely used in the early works. Typical numerical examples are utilized to illustrate the validity and improvement in less conservatism of the theoretical results.

Keywords: Globally exponential stability; Neural networks; Piecewise constant arguments; Periodic solution.

1. Introduction

Since the Hopfield-type artificial neural networks[1, 2] has been introduced in 1980s, various of neural networks including cellular neural networks(CNNs), recurrent neural networks and Cohen-Grossberg neural networks(CGNNs) have obtained many attentions from increasing number of researchers because there are many applications depending on the dynamical behaviors of these systems, such as image processing, pattern recognition, signal processing, associative memory[3, 4]. For instance, if we apply the neural networks to associative memory models, it is highly desired to ask whether the neural networks have a stable state which indicates that the information been sent back and forth does not change after a few iterances, and such networks are well known as the bidirectional associative memory(BAM) neural networks.

It is well known that time delays are widely employed in the interaction and connection between the neurons and in the numerical simulations of neural networks. Time delays in neural networks can be seen as the 'memorize' effects of the state variables at certain time to use the values during the process till the next moments. Therefore, the dynamical behaviors of the neural networks with discrete time delays and distributed time delays have obtained many attentions from several scholars[5–12]. For instance, the globally exponential stability of reaction-diffusion recurrent neural networks with continuous distribute delays is studied in [5] for the exponential stability of both equilibriums and periodic solutions. Using the Lyapunov-Krasovskii approach, the stability criteria in terms of linear

[0]This work was supported in part by "the Fundamental Research Funds for the Central Universities" (Grant No. HIT. IBRSEM. A. 201401) and in part by National Natural Science Foundation under Grant 11471089.

[*]Corresponding author

Email address: dqcao@hit.edu.cn. Fax: +86 (0)451 86414479. (Dengqing Cao[1])