Available online at www.sciencedirect.com
ScienceDirect
Journal of the Franklin Institute 347 (2010) 559–566
Journal of The Franklin Institute
www.elsevier.com/locate/jfranklin

Existence of periodic solution for discrete-time cellular neural networks with complex deviating arguments and impulses ☆

Xinsong Yang[a,*], Fen Li[b,c], Yao Long[a], Xiangzhao Cui[a]

[a] *Department of Mathematics, Honghe University, Mengzi, Yunnan 661100, China*
[b] *Department of Electrical Engineering, Yunnan Vocational College of Mechanical and Electrical Technology, Kunming 650203, China*
[c] *Economics and Management School, Beijing University of Post and Telecommunication, Beijing 100876, China*

Received 14 January 2008; received in revised form 20 May 2009; accepted 13 December 2009

Abstract

A class of discrete-time cellular neural networks with complex deviating arguments and impulses are considered. Sufficient conditions for the existence of periodic solution are obtained by using contraction theorem and inequality techniques. The results of this paper are new. An example is employed to illustrate our results.
© 2009 The Franklin Institute. Published by Elsevier Ltd. All rights reserved.

Keywords: Cellular neural networks; Impulse; Periodic solution; Complex deviating arguments

1. Introduction and preliminaries

In recent years, cellular neural networks (CNNs) have been extensively studied and found many important applications in different areas, such as psychophysics, perception, robotics, adaptive pattern recognition, image processing and associate memory [1,2]. Hence, they have been the object of intensive analysis by numerous authors and some

☆This work was jointly supported by the Scientific Research Fund of Yunnan Provincial Education Department under Grant no. 07Y10085, the Scientific Research Fund of Yunnan Province under Grant no. 2008CD186, and Scientific Research Fund of Honghe University under Grant no. XJ1Y0510.
*Corresponding author.
E-mail address: xinsongyang@163.com (X. Yang).

0016-0032/$32.00 © 2009 The Franklin Institute. Published by Elsevier Ltd. All rights reserved.
doi:10.1016/j.jfranklin.2009.12.004

interesting results on continuous-time CNNs have been obtained. In particular, there have been some results on the existence and global exponential stability of periodic solutions or almost periodic solutions for continuous-time CNNs with delays and impulses [3–12]. We note that many of the previous works concerning periodic solutions only considered the case of time delays, including constant delays, time-varying delays and distributed delays. However, since the complexity of problems in reality, models describing these problems should reflect effects of such fluctuation factors. Hence, it is significant important in theory and application to study equation with deviating arguments, which has a wider meaning than equation with delays. Recently, authors of [13] considered continuous-time CNNs with complex deviating arguments and obtained sufficient conditions for the existence of periodic solutions by using the coincidence degree theorem [14].

In numerical simulation and practical implementation of the neural networks, it is essential to formulate a discrete-time system that is an analogue of the continuous-time system. Very recently, some results on the stability of CNNs difference equation with delays or with delays and impulses have been obtained [15–18]. It is well known that the research of neural networks involves not only the stability analysis of equilibrium points but also that of periodic solution. However, to the best of our knowledge, the existence of periodic solution are seldom considered for discrete-time CNNs with complex deviating arguments and impulses.

Motivated by the above discussions, in this paper, we investigate the existence of periodic solution for discrete-time CNNs with complex deviating arguments and impulses of the following form:

$$\begin{cases} x_i(n+1) - x_i(n) = -a_i(n)x_i(n) + \sum_{j=1}^{m} b_{ij}(n) f_j(x_j(x_j(n))) + I_i(n), \\ n = 0,1,2,\ldots, n \neq n_k, \ \ i = 1,2,\ldots,m, \ \ x_i(n_k+1) - x_i(n_k) = b_{ik} x_i(n_k), \\ i = 1,2,\ldots,m, \ \ k = 1,2,\ldots, \end{cases} \tag{1}$$

where $m \in N$, n_k is impulsive point, $x_i(n)$ is the state vector of the i th unit at time n, $a_i(n)$ represents the rate with which the i th unit will reset its potential to the resting state in isolation when disconnected from the network and external inputs at time n. $b_{ij}(n)$ are connection weights at time n, $I_i(n)$ denotes the external bias on the i th unit at the time n, f_j is the activation function of signal transmission.

For convenience, we use the following notations $a_i^+(n) = \max\{|1 - a_i(n)|, 1\}$, $b_{ij}^+ = \max_{n \neq n_k, 0 \leq n < \omega} |b_{ij}(n)|$, $I_i^+ = \max_{n \neq n_k, 0 \leq n < \omega} |I_i(n)|$, $b_{ik}^+ = \max\{0, b_{ik}\}$.

We denote the product of $1 + b_{ik}$ when $n_k \in [a,b)$ by $\prod_{a \leq n_k < b}(1 + b_{ik})$ with the understanding that $\prod_{a \leq n_k < b}(1 + b_{ik}) = 1$ for all $a \geq b$.

Throughout this paper, we assume that

- (H_1) $a_i(n), b_{ij}(n), I_i(n)$ are ω-*periodic* functions, where ω is an positive integer with $\omega \geq 1$, $i,j = 1,2,\ldots,m$.
- (H_2) $\{b_{ik}\}$ and $\{n_k\}$ are real ω-*periodic* sequences, i.e., there exists a $q \in N$ such that $n_{k+q} = n_k + \omega$, $\quad b_{i(k+q)} = b_{ik}$, $\quad b_{ik} > -1$, $\quad 0 < n_1 < n_2 < \cdots < n_k < n_{k+1} < \cdots$, $k = 1,2,\ldots,$ $i = 1,2,\ldots,m$.

Download English Version:

https://daneshyari.com/en/article/4976470

Download Persian Version:

https://daneshyari.com/article/4976470

Daneshyari.com