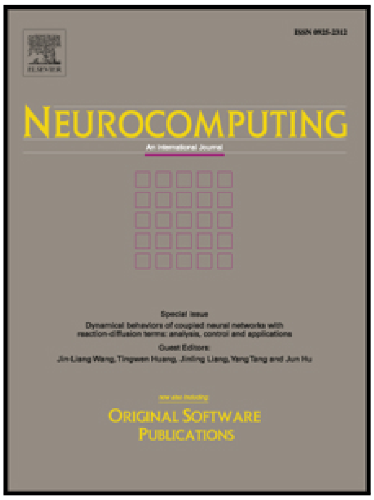

Finite time boundedness of neutral high-order Hopfield neural networks with time delay in the leakage term and mixed time delays

Chaouki Aouiti, Patrick Coirault, Foued Miaadi, Emmanuel Moulay

PII: S0925-2312(17)30799-3
DOI: 10.1016/j.neucom.2017.04.048
Reference: NEUCOM 18397

To appear in: *Neurocomputing*

Received date: 12 August 2016
Revised date: 23 April 2017
Accepted date: 29 April 2017

Please cite this article as: Chaouki Aouiti, Patrick Coirault, Foued Miaadi, Emmanuel Moulay, Finite time boundedness of neutral high-order Hopfield neural networks with time delay in the leakage term and mixed time delays, *Neurocomputing* (2017), doi: 10.1016/j.neucom.2017.04.048

Finite time boundedness of neutral high-order Hopfield neural networks with time delay in the leakage term and mixed time delays

Chaouki Aouiti[a], Patrick Coirault[b], Foued Miaadi[a], Emmanuel Moulay[c]

[a] University of Carthage, Faculty of Sciences of Bizerta, Department of Mathematics, Research Units of Mathematics and Applications UR13ES47, 7021 Zarzouna, Bizerta, Tunisia

[b] LIAS (EA 6315), University of Poitiers, 2 rue Pierre Brousse, 86073 Poitiers Cedex 9, France

[c] XLIM (UMR CNRS 7252), University of Poitiers, 11 bd Marie et Pierre Curie, 86962 Futuroscope Chasseneuil Cedex, France

Abstract

This article deals with the finite time boundedness (FTB) and FTB-stabilization problem for a general class of neutral high-order Hopfield neural networks (NHOHNNs) with time delay in the leakage term and mixed time delays. The mixed time delays consist of both discrete time-varying delays and infinite distributed delays. By using the topological degree theory, sufficient conditions are established to prove the existence of equilibrium points. Then, the Lyapunov-Krasovskii functional (LKF) method is used to prove sufficient conditions for the FTB. These conditions are in the form of linear matrix inequalities (LMIs) and can be numerically checked. Furthermore, a state feedback control is constructed to solve the FTB-stabilization problem. Finally, some numerical examples are presented to show the effectiveness of our main results.

Keywords: High-order neural networks, finite time boundedness, topological degree, stabilization, Lyapunov-Krasovskii functional, LMI, neutral systems, leakage delay .

1. Introduction

Neural Networks (NNs) have been widely studied due to their practical applications in lots of areas such as model identification, signal processing, image processing, pattern recognition, optimization problems, associative memories [1, 2, 3, 4]. The majority of these applications requires the stability of the designed NNs. It should be pointed out that the delay has a great effect on the system performances. Therefore, the stability analysis of delayed NNs has attracted the attention of many researchers and a lot of results have been obtained (see for instance [5, 6, 7, 8, 9, 10, 11]). In [10, 12], the authors discussed the case of constant delays and in [6, 9, 11, 13] the authors analyzed the stability of NNs with continuously distributed delays.

Recently, another kind of delay, variously known as leakage delay, is investigated in [14, 15, 16, 17]. It has been proved that this kind of delay tends to render the systems of NNs unstable. The effect of the leakage delay on stability is one of the important research topics in the field of the stability of NNs [18]. Many researchers analyzed the effect of the leakage delay on the Lyapunov stability of various kinds of NNs such that bidirectional associative memory NNs [19, 20] or impulsive NNs [21, 22]. However, it should be pointed out that manipulating this kind of delay is not easy. In addition, a kind of time delay systems, appointed neutral-type delay systems, is used by many authors due to their practical applications [23]. There are several results discussing the stability of neutral-type NNs, see for instance [24, 25, 26] and references therein.

In order to render the stability criteria less conservative with respect to the delays, several methods are developed in the literature [27, 28, 29, 30, 31, 32, 33, 34]. Most of these methods are based on Lyapunov functionals and associated LMIs because these inequalities can be numerically checked. However, it is well known that when a novel Lyapunov functional is designed for reducing the conservatism with respect to the delays a greater complexity in terms of inequalities and variables to be calculated can appear. Therefore, the question of reducing simultaneously the number of decision variables and the conservatism with respect to the delays arises.

Most of the previous works on stability were mainly based on the classical Lyapunov stability which is associated with an infinite time interval. However, only a finite time interval is considered in practical applications [35]. In 1953, Kamenkov has introduced in [36] the concept of finite time boundedness (FTB). Dorato reported in [37] that FTB and Lyapunov stability are two independent concepts. Many studies have addressed the FTB problem of NNs, see for instance [38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49]. For neutral-type NNs, the FTB was studied in [42, 47]. In [43, 49] and [41], the class of uncertain NNs with Markovian jumps and the complex-valued NNs are studied respectively. Also the impulsive NNs is investigated in [39] and the author's of [40, 38] deals with the problem of FTB for Memristive NNs and TS-fuzzy system with time-varying delay respectively. Moreover, all the previous results on FTB

*Corresponding author

Email address: patrick.coirault@univ-poitiers.fr (Patrick Coirault)

URL: chaouki.aouiti@fsb.rnu.tn (Chaouki Aouiti), foued.miaadi@yahoo.com (Foued Miaadi), emmanuel.moulay@univ-poitiers.fr (Emmanuel Moulay)