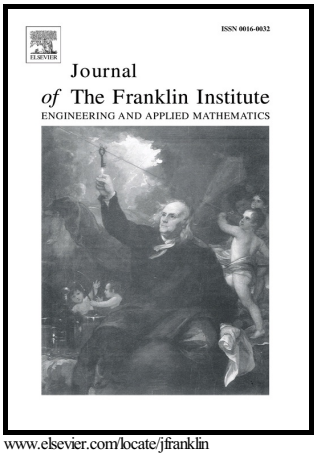

www.elsevier.com/locate/jfranklin

Improved delay-dependent stability analysis of discrete-time neural networks with time-varying delay

Li Jin, Yong He, Min Wu

PII: S0016-0032(16)30498-7
DOI: http://dx.doi.org/10.1016/j.jfranklin.2016.12.027
Reference: FI2852

To appear in: *Journal of the Franklin Institute*

Received date: 20 April 2016
Revised date: 22 October 2016
Accepted date: 25 December 2016

Cite this article as: Li Jin, Yong He and Min Wu, Improved delay-dependen stability analysis of discrete-time neural networks with time-varying delay *Journal of the Franklin Institute* http://dx.doi.org/10.1016/j.jfranklin.2016.12.027

Improved Delay-Dependent Stability Analysis of Discrete-Time Neural Networks with Time-Varying Delay

Li Jin, Yong He, Min Wu

School of Automation,China University of Geosciences,Wuhan 430074,China

Abstract

This paper presents two improved delay-dependent stability criteria for discrete-time neural networks with time-varying delay. First, a Lyapunov-Krasovskii functional (LKF) with several augmented terms is constructed. Then an improved summation inequality, together with Wirtinger-based inequality, is employed to give tight estimations for sum terms in the forward difference of the LKF. Moreover, two methods for handling the time-varying delay information are applied. As a result, two stability criteria in terms of linear matrix inequality are established. Finally, two numerical examples are given to demonstrate the effectiveness and benefits of the developed stability criteria.

Keywords: Discrete-time neural networks, Time-varying delay, Stability, Lyapunov-Krasovskii functional, Linear matrix inequality.

1. Introduction

Neural networks have been applied to many fields, such as signal processing, image recognition, predictive memory, error diagnosis, optimization problem, etc. [1, 2, 3, 4, 5]. In the actual applications, the limited signal transmission and conversion rate of the processors in the neural networks introduce time delay, which leads to oscillation , instability and poor performance of dynamic systems. Hence, it is essential to investigate the stability of the neural networks with time delay [6, 7, 8, 9, 10]. Moreover, since most systems use a digital processor such as microprocessors and microcontrollers to acquire information from computers by discrete steps, the stability analysis for the discrete-time neural networks with time delay has received increasing attention [11, 12, 13, 14, 15, 16].

The stability criteria for the discrete-time neural networks with time-varying delay can be classified into two types, i.e., delay-independent stability criteria and delay-dependent ones [13, 14]. As is well known, the latter is less conservative especially when the time delay is small since it makes use of information on the length of time delay. Many delay-dependent stability criteria are presented through the LKF method in the last few decades [15, 16, 17, 18], while they are still conservative. The main research direction on this topic is to obtain less conservative delay-dependent criteria [17, 18]. In general, there are two approaches to obtain conservatism-reducing conditions: constructing a suitable LKF and estimating sum terms in the forward difference of the LKF tightly [16, 17, 18].

During the construction of the LKFs for analysing the discrete-time neural networks with time-varying delay, the simple LKFs with the single and/or double sum terms were constructed in which the effects of time delay were taken into account in early work [13, 14, 15]. However, simple LKFs lead to the criteria with high conservatism. Then, considering that more general LKFs may contribute to conservatism-reducing criteria, the delay-partitioning

*Corresponding author: Yong He, Email: heyong08@cug.edu.cn