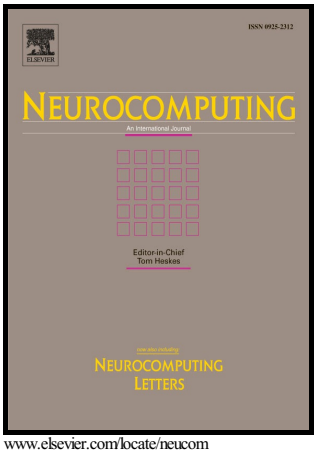

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New robust stability condition for discrete-time recurrent neural networks with time-varying delays and nonlinear perturbations

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Abstract. In this paper, the robust delay-dependent stability problem is investigated for discrete-time recurrent neural networks (DRNNs) with time-varying delays and nonlinear perturbations. A novel summation inequality is proposed, which takes information on the double summation of system state into consideration and further extends the discrete Wirtinger-based inequality. By utilizing technique of the novel inequality and Lyapunov-Krasovskii functionals, a sufficient condition on robust stability of DRNNs with time-varying delays and nonlinear perturbations is obtained in terms of linear matrix inequality. The numerical example is included to show that the proposed method is effective and provides less conservative results.

Keywords: Recurrent neural networks; Time-varying delay; Nonlinear perturbation; Summation inequality

1. Introduction

Recurrent neural networks (RNNs) as nonlinear dynamic systems, are usually regarded as a kind of simplified models of biological neural networks (the central nervous systems of animals, in particular the brain). By imitating the way interconnected neurons exchange messages between each other, RNNs can process information more quickly and efficiently than many traditional approaches. In recent years, RNNs have been developed and successfully applied in many fields, such as signal processing, image processing, associative memories, pattern recognition, robotics and control as well as other engineering or scientific areas [1-3].

It is well known that stability of recurrent neural networks is a prerequisite for above-mentioned engineering applications. However, on account of the limited switching speed of amplifiers and the inherent communication time of neurons, time delay frequently presents in neural networks in electronic implementations. Since time delay can affect the dynamic behaviors of neural networks evidently and even deteriorate system performance, the stability analysis of RNNs with delays has been widely studied and various stability conditions have been obtained. In this regard, the stability criteria are classified into two categories, delay independent [4, 5] and delay dependent ones [6-12]. Generally speaking, delay-dependent criteria are less conservative, especially when time delay is small or it varies within an interval.

However, it is worth noting that most systems contain digital computers (usually microprocessors or microcontrollers) with the necessary input/output hardwares to implement the systems. Thus discrete-time system model with time delay plays a significant role in fields of engineering applications. As a result, discrete-time recurrent neural networks (DRNNs) seem to be much more effective in our digital life than continuous-time ones. Many researches and results are dedicated to the development of DRNNs with time-delay systems over the years, see [13-18] and reference therein. Since delay-dependent criteria tend to be less conservative, various methods have been applied to the delay-dependent category, such as augmented Lyapunov-Krasovskii functional method [15,

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