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Stochastic stability of discrete-time uncertain recurrent neural networks with Markovian jumping and time-varying delays☆

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ABSTRACT

In this paper, the problem of robust exponential stability analysis of uncertain discrete-time recurrent neural networks with Markovian jumping and time-varying delays is studied. By employing the Lyapunov functional and linear matrix inequality (LMI) approach, a new sufficient criterion is proposed for the global robust exponential stability of discrete-time recurrent neural networks which contain uncertain parameters and Markovian jumping parameters. The obtained stability criterion is characterized in terms of linear matrix inequalities (LMIs) and can be easily checked by utilizing the efficient LMI toolbox. Two numerical examples are presented to show the effectiveness and conservativeness of the proposed method.

1. Introduction

Recurrent neural networks (RNNs) such as Hopfield neural networks and cellular neural networks have been successfully applied to solve some previously unsolvable problems and improve system performance in many fields [1]. In hardware implementation of recurrent neural networks, however, time delays occur due to finite switching speed of the amplifiers and communication time [2]. On the other hand, it has also been shown that the processing of moving images requires the introduction of a delay in the signal transmitted through the networks [3]. Recurrent neural networks with delays have found many applications in some fields such as signal processing, image processing, pattern recognition, associative memory and optimization problems [4,5]. In the application of recurrent neural networks with delays, it is often required that the network model has a unique equilibrium point which is globally exponentially stable. In recent years, considerable efforts have been devoted to the stability analysis of delayed recurrent neural networks, and via the Lyapunov functional method, many sufficient conditions have been presented for global stability of equilibrium point, periodic attractor and synchronization of recurrent neural networks with delays, see for example, [6–17].

In addition, parameter uncertainties can be often encountered in real systems as well as neural networks, due to the modeling inaccuracies and/or changes in the environment of the model. In the past few years, to solve the problem brought by parameter uncertainty, robustness analysis for different uncertain systems has received considerable attention, see for example, [18,15,19–21].

It is worth noting that, up to now, most recurrent neural networks have been analyzed by using a continuous-time model. However, when the continuous-time recurrent neural networks are implemented to simulate, experimentalize or compute

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