Robust stability analysis for discrete-time uncertain neural networks with leakage time-varying delay

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A B S T R A C T

This paper is concerned with the stability problem for a class of discrete-time neural networks with time-varying delays in network coupling, parameter uncertainties and time-delay in the leakage term. By constructing triple Lyapunov-Krasovskii functional terms, based on Lyapunov method, new sufficient conditions are established to ensure the asymptotic stability of discrete-time delayed neural networks system. Convex reciprocal technique is incorporated to deal with double summation terms and the stability criteria are presented in terms of linear matrix inequalities (LMIs). Finally, numerical examples are exploited to substantiate the theoretical results. It has also shown that the derived conditions are less conservative than the existing results in the literature.

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1. Introduction

Neural networks have become an important area of research in many areas including pattern recognition, associative memory, combinatorial optimization, fixed-point computation and signal processing [7,10]. Dynamical behaviors such as stability, instability, periodic oscillatory and chaos of the neural networks are known to be crucial in applications. Stability of neural networks is a prerequisite for many engineering problems, it received much research attention in recent years and many elegant results have been reported, for details see [14,24,27,36,38]. It is worth noticing that, when implementing the continuous-time recurrent neural networks for computer simulation, for experimental or computational purposes, it is essential to formulate a discrete-time system that is an analogue of the continuous-time recurrent neural networks. Merely, the discretization cannot always preserve the dynamics of the continuous-time counterpart even for a small sampling period [29]. Therefore, there is a crucial need to study the dynamics of the discrete-time neural networks.

Since time-delay inevitably occurs in the communication and response of neurons owing to the unavoidable finite switching speed of amplifiers in the electronic implementation of analog neural networks, it is more significant to study neural networks with time-delay, see [43,44,46], and references therein. It is well known that time-delay often causes undesirable dynamic behaviors such as performance degradation, and instability of the systems. The stability analysis problem for neural networks with time-delay has attracted much attention and many sufficient conditions have been proposed to guarantee the asymptotic and exponential stability of neural networks with various types of time-delay such as constant, time-varying, random and distributed delays, see for example [3–5,12,13,15,16,21,34]. In [20], new improved delay-dependent stability criteria guaranteeing the global exponential stability have been obtained via a new augmented lyapunov-Krasovskii functional (LKF). Stability analysis problem for a new class of discrete-time neural networks with randomly discrete and distributed time-varying delays has investigated in [37]. The state estimation problem for a class of discrete-time stochastic neural networks with random delays has been studied in [2]. In [25], synchronization problem has been considered for an array of linearly coupled neural networks with simultaneous presence of both the discrete and unbounded distributed time-delays. Recently, synchronization criteria for discrete-time coupled networks have discussed in [32] and a delay-dependent stability condition has presented in [40] by using the triple lyapunov functional technique. Impulsive perturbations can also cause undesirable dynamical behaviors leading to poor performance. Moreover, impulsive neural networks model belongs to a new category of dynamical systems, which are neither purely continuous-time nor purely discrete-time ones, in recent years considerable attention has been paid to investigating the stability analysis of impulsive neural networks, see [43,45]. The problem of global exponential stability and exponential convergence