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EXPONENTIAL STABILITY OF DISCRETE-TIME NEURAL NETWORKS WITH MULTIPLE DELAYS

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Abstract. Discrete neural models are of great importance in numerical simulations and practical implementations. In the current paper, a discrete analogue of continuous-time neural networks with variable and distributed delays is investigated. By fixed point theorem and analytic techniques such as matrix analysis, sufficient conditions guaranteeing the existence, uniqueness and global exponential stability of an equilibrium point are obtained, without assuming the boundedness and differentiability of activation functions. The results generalize some existing ones. To show the effectiveness of our method, an illustrative example, along with numerical simulations, is presented.

Keywords. Discrete-time neural networks, variable delay, distributed delay, exponential stability, $M-$matrix.

AMS (MOS) subject classification: 34D23, 34k20, 39A11, 92B20.

1 Introduction

During the past decades, cellular neural networks, Hopfield neural networks, bidirectional associate memory model and Cohen-Grossberg model have been proposed and studied intensively, since they play important roles and have found successful applications in various fields such as pattern recognition, signal and image processing, nonlinear optimization problems, parallel computation, see, for example, Refs. [1-6]. The dynamical behaviors in neural networks, such as the existence and their asymptotic stability of equilibria, periodic solutions, bifurcations and chaos, have been the most active areas of research and been extensively explored over the past years [7-18].

Because of the finite transmission speed of signals among neurons, time delays in interactions between neurons frequently happen, and will cause complex dynamics in neural networks [19], so it is necessary to introduce time delays into the neural models. So far, discrete, time-varying and distributed delays have been respectively introduced to describe the dynamics of neural networks, and various sufficient conditions ensuring the stability have been given. Now some new novel conditions have been obtained for stability of neural models by Mou, et al [20, 21]. As well, different time-delays are simultaneously introduced to describe the models [14, 15].