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Exponential stability of Markovian jumping Cohen–Grossberg neural networks with mixed mode-dependent time-delays

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ABSTRACT

In this paper, the exponential stability problem is investigated for a class of Cohen–Grossberg neural networks with Markovian jumping parameter and mixed time-delays. The mixed time-delays under consideration consist of both the mode-dependent discrete time-delays and the mode-dependent distributed time-delays. By constructing a new Lyapunov–Krasovskii functional and employing the stochastic analysis techniques, sufficient conditions are proposed to guarantee that the addressed neural networks are exponentially stable in the mean square sense. It is shown that the developed stability criteria can be easily verified by using the standard numerical software. Finally, an illustrative example is provided to show the feasibility and usefulness of the developed results.

1. Introduction

The past few decades have witnessed the recent developments of the neural networks that have been successfully applied in a variety of areas such as system identification and control, pattern recognition, game-playing and decision making, sequence recognition, data mining, quantum chemistry, medical diagnosis and visualization [1,2]. Accordingly, a great number of results have been published concerning several neural networks, such as biological neural networks, bidirectional associative neural networks, artificial neural networks, Hopfield neural networks, and Cohen–Grossberg neural networks [3,4]. It is worth mentioning that the Cohen–Grossberg neural network has received special research interest due to the fact that it can encompass several neural networks as special cases [5–9]. Therefore, a rich body of research results concerning various stability criteria has been reported for Cohen–Grossberg-type neural networks. For example, in [10,11], the exponential stability problems have been discussed for delayed Cohen–Grossberg neural networks. The globally exponential stability problem has been discussed in [12] for inertial Cohen–Grossberg-type neural networks with time delays. In [13], the problems of the exponential stability and the almost sure exponential stability have been studied for a class of fuzzy stochastic Cohen–Grossberg neural networks with time-invariant delays. In addition, the input-to-state stability problem has been addressed in [14] for a class of stochastic impulsive Cohen–Grossberg neural networks with mixed delays.

As is well known, the time-delays are frequently encountered in the neural processing and signal transmissions [15–18]. Therefore, considerable research effort has been made to investigate the dynamics behaviour analysis problem for neural networks subject to discrete time-delays. For example, the problems of exponential stability in mean square sense have been studied in [11,19] for fuzzy Cohen–Grossberg neural networks with time delays and some sufficient conditions have been given based on the linear matrix inequality technique. In parallel to the discrete time-delays, another class of time-delays, i.e., distributed time-delays, has begun to receive some research attention due to the fact that there commonly exists an amount of parallel pathways in a neural network with a variety of axon sizes and lengths and the neural network often exhibits the phenomenon of the distributed time-delays [20,21]. In [20], the global asymptotic stability problem has been studied for a class of stochastic Cohen–Grossberg neural networks with discrete time-delays and distributed time-delays. Recently, the problems of the existence and global exponential stability of periodic solution have been conducted in [21] for a general class of fuzzy Cohen–Grossberg bidirectional associative memory neural networks with variable coefficients and mixed time-delays.

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