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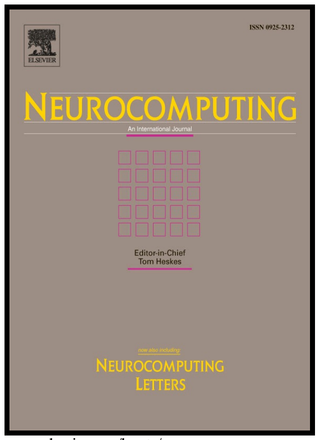

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Delay-range-dependent passivity analysis for uncertain stochastic neural networks with discrete and distributed time-varying delays*

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Abstract

The purpose of this paper is to investigate the problem of passivity analysis for delayed uncertain stochastic neural networks (DUSNNs) with discrete and distributed time-varying delays. The novelty of this paper lies in the consideration of a new integral inequality proved to be celebrated Jensen's inequality and takes fully the relationship between the terms in the Leibniz-Newton formula within the framework of linear matrix inequalities (LMIs). By constructing a suitable Lyapunov-Krasovskii functional with triple integral terms and using Jensen's inequality, integral inequality technique and linear matrix inequality frame work, which guarantees stability for the passivity of addressed neural networks. This LMI can be easily solved via convex optimization techniques. Using several examples from the literature, it is shown that the proposed stabilization theorem is less conservative than previous results. Finally, the technique is applied to benchmark problem, showing how to derive efficient stability criteria for realistic problems, using the proposed technique.

Keywords: *Passivity analysis; Uncertainty; Stochastic neural networks; Discrete and distributed delays.*

1 Introduction

Since neural networks have come to play an important role in many branches of science and engineering applications such as signal processing, pattern recognition, static image processing, associative memory, combinatorial optimization and so on. However, in many physical and biological phenomena the rate of variation in the system state depends on the past states. This characteristic is called a delay (or a time delay) and therefore a system with a time delay is called a time-delay system. Time delay phenomena were first discovered in biological systems and were later found in many engineering systems, such as mechanical transmissions, fluid transmissions, metallurgical processes and networked control systems. They are often a source of instability, periodic oscillatory, chaos and poor control performance. Time-delay systems have attracted the attention of many researchers [1, 2, 3] because of their importance and widespread occurrence. These applications are largely dependent upon the stability of the equilibrium of neural networks, that is, stability is of much importance in dynamical properties about neural networks when neural networks are designed. As we know, the stability criteria for delayed neural networks can be classified into two types namely delay-independent [4, 5] and delay-dependent [6, 7, 8]. Therefore delay-dependent stability criteria are usually less conservative than delay independent ones especially when the size of the delay is small. This implies delay-dependent stability criteria gives both theoretical and practical importance. It is worth noting that although the signal propagation is sometimes instantaneous and can be modeled with discrete delays, it may also be distributed during a certain time period so that distributed delays are incorporated into the models [7, 8, 28, 30, 33], and references therein.

We are familiar about that passivity is a property of many physical systems which may be generally defined as energy dissipation. Therefore it is related to the property of stability is intimately linked to Lyapunov stability theory see for example [9] - [12], [23], meanwhile passivity theory originated from circuite theory and

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