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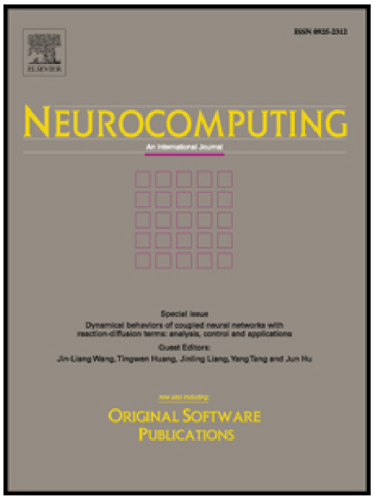

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A new method for global stability analysis of delayed reaction-diffusion neural networks

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Abstract

This paper presents improved criteria for global exponential stability of reaction-diffusion neural networks with time-varying delays. A novel diffusion-dependent Lyapunov functional, which is directly linked to the diffusion terms, is suggested to analyze the role of diffusivity of each neuron on the model dynamics. In the case of Dirichlet boundary conditions, the extended Wirtinger's inequality is employed to exploit the stabilizing effect of reaction-diffusion terms. In the framework of descriptor system approach, the augmented Lyapunov functional technique is utilized to reduce the conservatism in the values of the time delay bounds. As a result, the derived global stability criteria are more effective than the existing ones. Three numerical examples are provided to illustrate the effectiveness of the proposed methodology.

Keywords: Reaction-diffusion neural networks; Time-varying delays; Lyapunov method; Linear matrix inequality (LMI)

1. Introduction

During the past decades, neural networks have been widely applied to many areas (i.e. associative memory, signal processing, image processing, pattern recognition, and optimization problems). It is true that most of these applications heavily depend on the nonlinear dynamic behavior of neural networks. For example, in order to apply neural networks to solve the optimization problems, a globally stable dynamics where each trajectory converges to a unique equilibrium is needed. In electronic implementations of neural networks, time delays are actually unavoidable due to the finite speed of the processing and transmission of the signals. In this case, some delay parameters are introduced into the neural network model to improve the reliability of signal processing capabilities. It is known that time-delays can induce complex dynamic behaviors, such as instability and nonlinear oscillations. Therefore, it is of importance to understand how to assure the stability and good performance in the presence of time-delays. Considerable attention has been contributed to the global stability analysis of time-delay neural networks, see, for example, [1–7], and the references therein.

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