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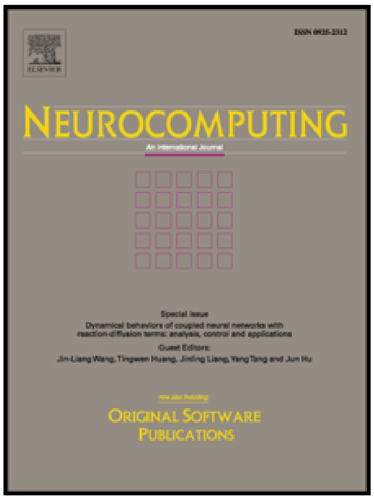

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Delay-dependent dissipativity of neural networks with *mixed non-differentiable interval delays*☆

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Abstract

This paper investigates the global dissipativity and globally exponential dissipativity for neural networks with both interval time-varying delays and interval distributed time-varying delays. By constructing a set of appropriated Lyapunov-Krasovskii functionals and employing Newton-Leibniz formulation and free weighting matrix method, some dissipativity criteria that are dependent on the upper and lower bounds of the time-varying delays are derived in terms of linear matrix inequalities (LMIs), which can be easily verified via the LMI toolbox. Moreover, a positive invariant and globally attractive set is derived via the established LMIs. Finally, two numerical examples and their simulations are provided to demonstrate the effectiveness of the proposed criteria.

Keywords: Neural networks; Dissipativity; Linear matrix inequality; Interval time-varying delay; Distributed time-varying delay.

1. Introduction

During the past decades, neural networks have received considerable attentions owing to their fruitful applications in a variety of areas such as signal processing, automatic control engineering, associative memories, parallel computation, combinatorial optimization and pattern recognition and so on [1–3]. In the process of investigating neural networks, time delays are frequently encountered as a result of the inherent communication time between neurons and the finite switching speed of amplifiers [4–6]. Beside, in hardware implementation, time delays usually causes oscillation, instability, divergence, chaos, or other bad performances of neural networks [7, 8]. Therefore the study of dynamic behaviors for delayed neural networks have received considerable attention in recent years [9–11]. For the delay conditions, both delay-independent and delay-dependent conditions have been developed. The delay-dependent conditions are usually less conservative than delay-independent ones, especially for systems with small delays, since the former takes advantage of the additional information of the time delays. Therefore, in recent years, much attention has been paid on delay-dependent conditions such as stability, dissipativity, synchronization control, periodic attractor of neural networks, and many interesting results have been proposed, especially based on Lyapunov-Razumikhin method and Lyapunov-Krasovskii functional and linear matrix inequality (LMI) approach, see [12–17] for instances.

The theory of dissipativity in dynamical systems, have drawn many researchers' attention since it was introduced in 1970s by Willems in terms of an inequality involving the storage function and supply rate [18], and it has found applications in many areas such as stability theory, chaos and synchronization theory, system norm estimation, and robust control [19–21]. In fact, the notion of dissipativity is a generalization of Lyapunov stability which only focuses on the stability of equilibrium points. Nevertheless, it does not always hold that the orbits of neural network approach to a single equilibrium point. In addition, the equilibrium point does not exist in some situations. Basically, the aim of dissipativity analysis is to find globally attractive sets. Once the attractive set is found, we only need to focus on its dynamics properties inside the attractive set, since there is no equilibrium, periodic solution, or chaos attractor outside the attractive set [22]. Dissipativity theory provides a fundamental framework for the analysis and design problem of control systems using input-output description based on system energy related considerations, and it has much good performance on neural networks. Moreover, dissipativity theory provides some important connections between physics, system theory and control engineering [23]. In recent years, various interesting results have been obtained for the dissipativity of delayed neural networks [24–27]. Especially, the dissipativity for neural networks with constant delays were studied in [27], and derived some sufficient conditions for the global dissipativity of neural networks with constant delays. By introducing a triple-summable term in the Lyapunov functional and applying stochastic analy-

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