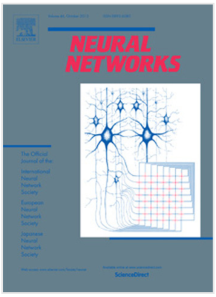

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Synchronization of stochastic reaction–diffusion neural networks with Dirichlet boundary conditions and unbounded delays

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Abstract

In this paper, synchronization of stochastic reaction–diffusion neural networks with Dirichlet boundary conditions and unbounded discrete time–varying delays is investigated. By virtue of theories of partial differential equations, inequality methods, and stochastic analysis techniques, *p*th moment exponential synchronization and almost sure exponential synchronization of the underlying neural networks are developed. The obtained results in this study enhance and generalize some earlier ones. The effectiveness and merits of the theoretical criteria are substantiated by two numerical simulations.

Keywords: Stochastic reaction–diffusion neural networks; Unbounded delay; Stochastic analysis; *p*th moment exponential synchronization; Almost sure exponential synchronization.

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1. Introduction

Over the past three decades, considerable attention has been drawn to the research of various neural networks, such as Hopfield neural networks, cellular neural networks, bidirectional associative memory neural networks, and memristive neural networks, owing to their significant implementations in combinatorial optimization problems, signal and image processing, associative memories, and pattern recognition (Cao & Wang, 2003; Zeng & Wang, 2008). These successful applications are critically dependent upon the dynamical properties of those neural networks. Therefore, the qualitative analysis of dynamical behaviors for various neural networks including stability (He, Ji, Zhang, & Wu, 2016; Liu, Zeng, & Wang, 2017), synchronization (Li, Yu, & Huang, 2014; Zhang, Sheng, & Zeng, 2017), dissipativity (Wu, Lam, Su, & Chu, 2012), and stabilization (Guo, Yang, & Wang, 2016) is imperative.

Time delays naturally exist in physical and biological systems due to the finite switching speeds of neuron amplifiers and the communication time (Sheng, Shen, & Zhu, 2016). Time–delayed phenomena generally generate complex dynamical behaviors such as oscillation or divergence (Huang, Li, Duan, & Starzyk, 2012; Sheng & Shen, 2016). It is thus important to incorporate time delays into dynamical analysis of neural networks. Meanwhile, diffusion effects cannot be neglected in neural networks and electric circuits once electrons transport in a nonuniform electromagnetic field (Liu, Zhang, & Xie, 2016). Under this situation, state variables of a neuron vary with time and space variables simultaneously. That is to say, the dynamics of such behaviors for a neuron can commonly be described by a partial differential equation through involving a reaction–diffusion term (Sheng, Zhang, & Zeng, 2017). Considering these facts, in recent years, intensive efforts have been deployed to analyze dynamical behaviors of various delayed reaction–diffusion neural networks including stability (Liang, Wang, Wang, & Wang, 2015; Lu, 2007; Lv, Lv, & Sun, 2008; Ma, Feng, & Xu, 2013; Song, Cao, & Zhao, 2006; Wang, Wu, & Guo, 2011; Wang & Zhang, 2010; Wang, Zhang, & Li, 2010; Xu, Zhang, & Zhang, 2011; Zhou, Xu, Zhang, Zou, & Shen, 2012; Zhu & Cao, 2011; Zhu, Li, & Yang, 2011) and synchronization (Chen, Luo, & Zheng, 2016; Gan, 2012a,b; Hu, Jiang, & Teng, 2010; Liu et al., 2016; Ma, Xu, Zou, & Shi, 2012; Rakkiyappan, Dharani, & Zhu, 2015; Sheng, Zhang, et al., 2017; Wang, Wu, & Huang, 2015a; Wang, Wu, Huang, & Ren, 2015b; Wang, Teng, & Jiang, 2012).

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