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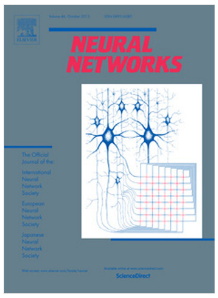

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PII: S0893-6080(18)30095-9
DOI: https://doi.org/10.1016/j.neunet.2018.03.010
Reference: NN 3918

To appear in: *Neural Networks*

Received date : 26 August 2017
Revised date : 16 January 2018
Accepted date : 14 March 2018

Please cite this article as: Sheng, Y., Zeng, Z., Impulsive synchronization of stochastic reaction diffusion neural networks with mixed time delays. *Neural Networks* (2018), https://doi.org/10.1016/j.neunet.2018.03.010

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Impulsive synchronization of stochastic reaction diffusion neural networks with mixed time delays

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Abstract

This paper discusses impulsive synchronization of stochastic reaction diffusion neural networks with Dirichlet boundary conditions and hybrid time delays. By virtue of inequality techniques, theories of stochastic analysis, linear matrix inequalities, and the contradiction method, sufficient criteria are proposed to ensure exponential synchronization of the addressed stochastic reaction diffusion neural networks with mixed time delays via a designed impulsive controller. Compared with some recent studies, the neural network models herein are more general, some restrictions are relaxed, and the obtained conditions enhance and generalize some published ones. Finally, two numerical simulations are performed to substantiate the validity and merits of the developed theoretical analysis.

Key words: Stochastic reaction diffusion neural networks; Mixed time delays; Synchronization; Impulse; Stochastic analysis.

1. Introduction

Since the pioneering work of synchronization between two chaotic systems in Pecora & Carroll (1990), the issue of synchronization has gained much research interest owing to the wide area applications in secure communication, image processing, pattern recognition, and shortest path problem (Yang & Chua, 1997). In recent years, many efforts have been dedicated to investigating synchronization of various neural network models, please refer to Zhang, Ma, Huang, & Wang (2010); Wu, Shi, Su, & Chu (2013); Wan, Cao, Wen, & Yu (2016); Guo, Yang, & Wang (2016); Rakkiyappan, Latha, Zhu, & Yao (2017); Liu, Zhu, & Ye (2017).

Time delays do exist in neural network models because of the limited switching speeds of neuron amplifiers and the finite velocity of signal delivery, which may cause instability, bifurcation, or vibration (Zeng & Zheng, 2013; Song, Yan, Zhao, & Liu, 2016; Sheng, Shen, & Zhu, 2017; Zhang, Han, & Zeng, 2017). Actually, neural networks have spatial extensions since the existence of a large quantity of parallel pathways with plenty of axon sizes and lengths. Therefore, discrete and distributed time delays should be introduced into neural network models to exhibit the characteristics of neurons in human brains in a more realistic way (Sheng, Zhang, & Zeng, 2017b).

Diffusion phenomena cannot be ignored in physical and biological systems due to the nonuniform electromagnetic fields where electrons transport and interactions of different species, respectively. For instance, in the process of chemical reactions, different chemicals react with each other and spatially diffuse in the intermedium until a balanced–state spatially concentration pattern has been structured (Yang, Cao, & Yang, 2013). It is thus reasonable and important to consider neural networks with diffusion effects. Recently, many elegant achievements on qualitative analysis of dynamical behaviors for various reaction diffusion neural network models have been reported in Yang et al. (2013); Hu, Jiang, & Teng (2010); Sheng & Zeng (2017b); Sheng, Zhang, & Zeng (2017c); Liu, Zhang, & Xie (2017); Chen, Luo, & Zheng (2016); Song, Cao, & Zhao (2006); Sheng & Zeng (2017a); Li & Li (2009); Sheng, Zhang, & Zeng (2017a); Zhang & Luo (2012); Gan (2012); Rakkiyappan, Dharani, & Zhu (2015); Zhu & Cao (2011b), and relevant references therein.

As is known to us, stochastic perturbations frequently occur in real–world systems because of the presence of environmental noise and human disturbances (Mao, 2007; Pan & Cao, 2011; Zhu & Cao, 2011a). The research of stochastic neural networks is beneficial for us to understand how stochastic noise influences dynamical behaviors of a neural network. Currently, numerous accomplishments on dynamical analysis of stochastic neural networks have been accumulated in Huang, Li, Duan, & Starzyk (2012); Bao, Park, & Cao (2016); Zhu & Cao (2011a); Sheng & Zeng (2017b); Gan (2012); Zhu & Cao (2012); Zhu, Huang, & Yang (2011).

Generally, synchronization of coupled neural networks cannot be achieved by themselves, hence, many control strategies, including feedback control (Li & Cao, 2015), adaptive control (Zhu & Cao, 2010), intermittent control (Zhang, Li, Huang, & Xiao, 2015), and impulsive control (Zhang, Ma, Huang, & Wang, 2010), are designed for the synchronization scheme. Among them, feedback control and adaptive control are continuous time ones, which require the

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