INTRODUCTION

It is widely believed that chaos synchronization has played a more and more significant role in nonlinear science (Chen & Dong, 1998; Pecora & Carroll, 1990; Tang & Fang, 2008; Tang et al, 2008; Tang et al, 2009a; Tang et al, 2009b; Tang et al, 2009c; Ojalvo & Roy, 2001; Yang & Chua, 1997; Boccaletti et al, 2002; Shahverdiev et al, 2002). Since Pecora and Carroll (Pecora & Carroll, 1990) synchronized two identical systems with different initial conditions, chaos synchronization has drawn much attention.
due to its potential applications in many fields, such as secure communication, pattern recognition, biological systems, and so on. So far, a wide variety of synchronization phenomena have been discovered such as complete synchronization, lag synchronization (Shahverdiev et al, 2002). Lag synchronization (LS) occurs as a coincidence of shifted-in-time states of two systems $y(t) \rightarrow x(t-\delta)$, $t \rightarrow \infty$, where $\delta$ is a propagation delay. It is worth mentioning that, in many practical situations, a propagation delay will appear in the electronic implementation of dynamical systems. Therefore, it is very important and necessary to investigate the lag synchronization from the view of applications.

The past two decades have witnessed significant progress on the study of dynamical characteristics of neural networks because of their wide applications in many areas. There exist many works which are devoted to achieve the synchronization problems of neural networks. With respect to some recent representative works on this topic, we refer the reader to (Tang et al, 2009a; Tang et al, 2008; Tang et al, 2009b; Lu & Cao, 2007; Yu & Cao, 2007; Cao et al, 2006; He et al, 2008; Lou & Cui, 2008; Lu & Chen, 2004; Li & Chen, 2006; Li et al, 2007; Chen et al, 2004; Cheng et al, 2005) and references therein.

On the other hand, in the past few years, there has been an increasing interest in the research of neural networks with stochastic perturbations in the neural network community (Wang et al, 2007; Wang et al, 2006; Wan & Sun, 2005; Sun & Cao, 2007). It has been shown that, in real nervous systems, the transmission is a noisy process brought on by random fluctuations from the release of neurotransmitters and other probabilistic causes. Therefore, the synchronization and stability analysis problem for stochastic neural networks has been an important research issue. Recently, there have been some initial studies on the synchronization of neural networks (Yu & Cao, 2007; Sun & Cao, 2007). Very recently, in Ref. (Sun & Cao, 2007), the adaptive synchronization scheme has been developed to synchronize the stochastic neural networks with constant delay.

Recently, the distributed delay in neural networks has been an active subject nowadays. The reason for this is that the neural signal propagation is often distributed due to the presence of a multitude of parallel pathways with a variety of axon sizes and lengths. To be noted that distributed delay should be taken into consideration for modeling a realistic neural network (Ruan & Filfil, 2004). A number of works have been devoted to stability analysis issue for neural networks with distributed delay (Wang et al, 2007; Wang et al, 2006; Wang et al, 2008; Liu, 2006) based on linear matrix inequality (LMI) approach. However, there are few works about the synchronization of neural networks with time-varying delay and distributed delay. In Ref. (Wang et al, 2008), the sufficient conditions on the complete synchronization for two neural networks without noise perturbation which the parameters are known beforehand. But in real-life applications, this assumption is not realistic due to the stochastic perturbation widely existing in practical situations. Moreover, some systems’ parameters cannot be exactly known in prior. The effect of these uncertainties will destroy the synchronization and even break it.

With the above motivations, our intention in this chapter is to study the synchronization for a class of stochastic chaotic neural networks with mixed time-delays and unknown parameters and consider more general coupling conditions, including states and outputs which result in different theoretical synchronization criteria. The mixed time-delays comprise the time-varying delay and distributed delay and the neural networks are subjected to stochastic disturbances described in terms of a Brownian motion. Via adaptive feedback approach (Huang, 2004; Huang, 2005; Huang, 2006), several simple criteria are developed to synchronize unknown neural networks with mixed time-delays and stochastic perturbations. The corresponding numerical simulations illustrate the feasibility of the presented method.
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