Preface

The past few decades have witnessed the successful application of neural networks in many areas such as image processing, pattern recognition, associative memory, and optimization problems.

For neural networks dynamics, the state variables of the model are the output signals of the neurons, and a steady output is needed in the dynamical evolution of neural networks. So the stability research of neural networks is of utmost importance. In general, there are two kinds of stability, asymptotic stability and exponential stability.

On the other hand, the response of the neurons to the information is completed jointly by neurons cluster, rather than a single neuron function. The response of the neurons to information is discharge behavior. This discharge behavior should be consistent or synchronization by some control method. Therefore, the synchronization control of neural networks is also an important research topic. Similar to the kinds of stability, there is asymptotic synchronization and exponential synchronization.

In the models of neural networks dynamics, there exist the following phenomenon.

First, as an existence in real neural networks, time-delay, which may cause oscillation and instability behavior, has gained considerable research attention.

Second, sometimes there are uncertain parameters in neural networks. Therefore, it is important to investigate the robust stability of neural networks with parameter uncertainties.

Third, it has been shown that many neural networks may experience abrupt changes in their structure and parameters due to phenomena such as component failures or repairs, changing subsystem interconnections, and abrupt environmental disturbances. In this situation, neural networks may be treated as systems that have finite modes that may switch from one to another at different times, and can be described by finite-state Markov chain. The stability analysis problem for neural networks with Markovian switching has therefore received much research attention and obtained a series of results about it.

Fourth, when the states of a system are decided not only by states of the current time and past time but by the derivative of the past states; the system can be called a neutral-type system. Indeed, some physical systems in the real world can be described by neutral-type models.

Finally, as we know, the synaptic transmission in real nervous systems can be viewed as a noisy process brought on by random fluctuations from the release of neurotransmitters and other probabilistic causes. In general, Gaussian noise has been regarded as the disturbance arising in neural networks. The chief characteristic of Gaussian noise is its continuous property.

However, in actual neural networks, the neuron's membrane potential is not only affected by the Gaussian noise, but also possesses instantaneous disturbance changes which lead to Poisson spikes from other neurons. This requires that the neuron system must possess a large number of impinging synapses and that the synapses have small membrane effects due to small coupling coefficient. These impinging synapses generate discontinuous disturbance in the neural networks. The discontinuous disturbance cannot be modeled by Gaussian noise. In view of the stochastic process, Lévy process possesses discontinuous property, and the process can be decomposed into a continuous part and a jump part by Lévy-Itô decomposition. So it is reasonable to model the noise of neural networks as Lévy process. Therefore, the stability and synchronization analysis problems for neural networks with Lévy noise, even also with Markovian switching parameters, become a new and severe challenge.

Focusing on the above models of neural networks dynamics, in this book we considered the problem of stability and synchronization. Especially for stochastic neural networks, we studied the almost surely asymptotic/exponential stability and synchronization and the pth moment asymptotic/exponential stability and synchronization. All of the results of the book are authors' recent researching achievements. The chapters are as follows.

Chapter 1 is devoted to relative mathematics foundation which includes some main concepts and formulas such as stochastic process, martingales, stochastic differential equation, Itôs formula, M-matrix, etc., and inequalities, such as some elementary inequalities and matrix inequalities, used in this book.

Chapter 2 is concerned with exponential stability analysis for neural networks with fuzzy logical BAM and Markovian jump and synchronization control problem of stochastically coupled neural networks.

Chapter 3 is devoted to some neural network models with uncertainty. In this chapter, the robust stability of high-order neural networks and hybrid stochastic neural networks is first investigated. The robust anti-synchronization and robust lag synchronization of chaotic neural networks are discussed in the sequel.

Chapter 4 is devoted to adaptive synchronization for some neural network models. In this chapter, we studied the problems of adaptive synchronization of BAM delayed neural networks, synchronization of stochastic T-S fuzzy neural networks with time-delay and Markovian jumping parameters, synchronization of delayed neural networks based on parameter identification and via output coupling, adaptive a.s. asymptotic synchronization for stochastic delay neural networks with

Markovian switching, and adaptive pth moment exponential synchronization for stochastic delayed Markovian jump neural networks, respectively.

Chapter 5 is devoted to the stability and synchronization of neutral-type neural networks. In this chapter, we studied the problems of robust stability, adaptive synchronization, projective synchronization, adaptive pth moment exponential synchronization, asymptotical adaptive synchronization for delayed neutral type neural networks with Gaussian noise, and Markovian switching parameters, respectively.

Chapter 6 is devoted to the stability and synchronization for neural networks with Lévy noise. In this chapter, we studied the problems of almost surely exponential stability, pth moment asymptotic stability, synchronization, and adaptive synchronization for time-delay neural networks with Lévy noise and Markovian switching parameters, respectively.

Chapter 7 is devoted to some applications to economy based on related research method. In this chapter, we studied the problems of portfolio strategy of financial market with regime switching driven by geometric Lévy process, robust H_∞ control for a generic linear rational expectations model of economy, respectively.

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