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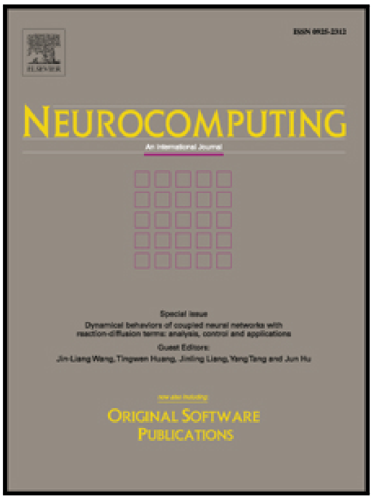

Exponential synchronization of memristor-based neural networks with time-varying delay and stochastic perturbation

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Exponential synchronization of memristor-based neural networks with time-varying delay and stochastic perturbation

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***Abstract*—This paper deals with the stochastic exponential synchronization problem of memristor-based neural networks with time-varying delay. Firstly, considering the state-dependent properties of the memristor, less conservative of model is constructed to analyze the complicated memristor-based neural networks. Then, by applying the stochastic differential inclusions theory and Lyapunov functional approach, sufficient verifiable conditions that depend on the time-varying delay and stochastic perturbation are obtained. It is shown that synchronization can be realized by linear feedback control and adaptive feedback control. The obtained results complement and improve the previously known results. Finally, a numerical example is given to illustrate the effectiveness of the theoretical results.**

***Index Terms*—Exponential synchronization, Memristor-based neural networks, Time-varying delay, Stochastic system**

I. INTRODUCTION

THE originally theoretical concept of memristor was derived from [1], it is well known that there are three basic circuit elements: 1) resistance; 2) capacitance; and 3) inductance. These elements are used to describe the relations between fundamental electrical quantities: 1) voltage; 2) current; 3) charge; 4) flux. Resistance relates voltage and current ($R = d\vartheta/di$), capacitance relates charge and current $C = dq/d\vartheta$, and inductance relates flux and current ($L = d\varphi/di$), respectively. However, Chua [1] realized that there was a missing link between flux φ and charge q, as shown in Fig.1, which he called memristance; it could describe the nonlinear relation between flux and charge ($M = d\varphi/dq$). Almost 40 years later, the practical memristor was realized by scientists at Hewlett-Packard Laboratories and was published in [2]. It is shown in [2] that the relation between current and voltage exhibits the so-called pinched hysteresis loops as the signature of memristor (see Fig.2). In recent years, increasing research attention from different branches of science and application fields has been paid to memristor, since it can be used to neural networks to mimic the memory and forgetting effect in the human memory [3-9].

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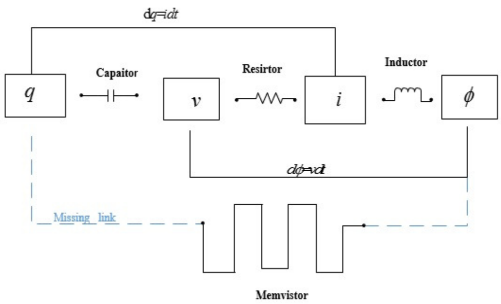

Fig.1 Relations between four fundamental circuit elements (Chua, 1971).

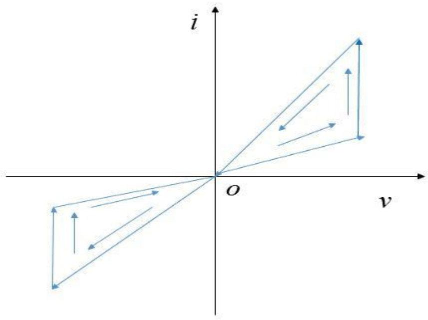

Fig.2 Current-voltage characteristics of the memristor (Strukov et al., 2008).

In addition, synchronization in coupled networks is one of the most important collective dynamical behaviors [10-11]. Some works dealing with the synchronization phenomena of the memristor-based neural networks have also appeared [12-26]. In [12], based on the drive-response concept, fuzzy theory, and Lyapunov functional method, some new criteria are established to guarantee the exponential synchronization of coupled memristor-based neural networks. Li et al. [13] considered the lag synchronization problem of memristor-based coupled neural networks with or without parameter mismatch using two different algorithms. Chandrasekar et al. [14] extended the notion of synchronization of the memristor-based neural networks with two delay components based on second-order reciprocally convex approach. Moreover, the synchronization's