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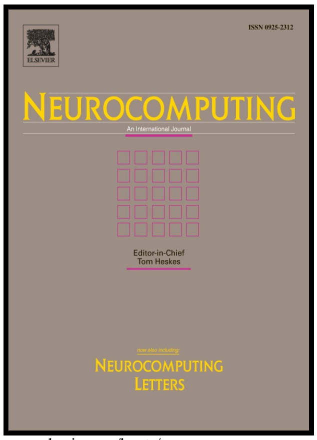

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Abstract—**This paper investigates the synchronization problem for chaotic memristor-based neural networks with time-varying delays. First, a novel lemma is proposed to deal with the switching jump parameters. Then, a novel inequality is established which is a multiple integral form of the Wirtinger-based integral inequality. Next, by applying the reciprocally convex combination approach, linear convex combination technique, auxiliary function-based integral inequalities and a free-matrix-based inequality, several novel delay-dependent conditions are established to achieve the globally asymptotical synchronization for the chaotic memristor-based neural networks. Finally, a numerical example is provided to demonstrate the effectiveness of the theoretical results.**

Memristive neural networks; Synchronization; Wirtinger-based integral inequality; Reciprocally convex combination; Free-matrix-based inequality

I. Introduction

In 1971, Chua [11] postulated theoretically the existence of a fundamental two-terminal passive device, called memristor (as a contraction of memory and resistor) using symmetry logical reasonings. For the device a nonlinear relationship links charge and flux. The resistance of a current-controlled (voltage-controlled) memristor is uniquely determined by the time history of current through it (voltage across it) and is indefinitely storable by the device once the controlling source is turned off. In 2008 credit for the first conscious experimental observation of memristor behavior in nature was given to researchers at HP Labs, that showed how the properties of a memristor (theoretically devised by Chua) are embodied in a metal-oxide film-metal nanoscale device [37]. From then on the memristor behavior is more and more noticeable as new technology process nodes are introduced in integrated circuit design, where the memristor may be used as a nonvolatile memory switch. We know that a Hopfield neural network model can be implemented in a circuit where the connection weights are implemented by resistors, motivated by these facts, recently, by using memristors instead of resistors, many scholar have studied a new model, where the connection weights change according to its state, i.e., a state-dependent switching recurrent neural networks, which is said to be the memristor-based recurrent neural networks (MNNs) [36].

In the last two decades, synchronization of chaos has been extensively studied. In the seminal paper [33], Pecora and Carroll first found that two chaotic trajectories with different initial conditions can be synchronized. Since then researchers around the world have been actively engaged in discovering different possible synchronization scenario of chaos and many types of synchronization approaches have been presented due to their potential applications in secure communication, biological networks, chemical reactions, biological neural networks, information processing, etc [24], [49], [50]. Recently, some achievements about synchronization control of MNNs have been obtained. For instance, based on the differential inclusions theory, Wu et al [42] derived a feedback controller to achieve the synchronization of MNNs by use of linear matrix inequalities (LMIs), Wang et al [38] investigated to guarantee the exponential synchronization for coupled MNNs also by applying LMIs approach, Mathiyalagan et al [25] proposed feedback controller gains to guarantee the exponential synchronization for delayed impulsive memristive BAM neural networks by using a time-varying Lyapunov functional and LMIs, Wang et al [40] obtained a sufficient condition to guarantee the exponential synchronization for a class of chaotic MNNs with mixed delays and parametric uncertainties by using the comparison principle and LMIs form, Song et al [36] designed two kinds of feedback controllers to ensure the exponential synchronization in the p-th moment of the stochastic MNNs by means of the stochastic differential inclusions theory, Jiang et al [16], [17] investigated the synchronization problem for MNNs by utilizing the matrix-norm inequality and LMIs.

However, the results of [7], [16], [17], [36], [38], [40]–[43], [47], [48] on synchronization or anti-synchronization control of delayed MNNs were obtained under the following typical assumption:

$$[\underline{A},\bar{A}]f(x(t))-[\underline{A},\bar{A}]f(y(t))\subseteq[\underline{A},\bar{A}](f(x(t))-f(y(t))).$$

As was pointed out in [44], [45] that this assumption holds only when $f(x(t))$ and $f(y(t))$ have different signs or $f(x(t))f(y(t)) = 0$. Hence, these results are useless to the theory and application in engineering. To establish effective synchronization conditions remain challenging. Chen et al [10] investigated the global Mittag-Leffler stability and synchronization for fractional-order MNNs by using Lyapunov method under the assumption that the neural activation functions are Lipschitz-continuous and satisfy $f_j(\pm T_j) = 0$ $(j = 1, 2, ..., n)$; Abdurahman et al [1] introduced two different types of discontinuous state feedback controllers to ensure the finite-time synchronization for MNNs with time-varying delays, Ding and Wang [12] designed discontinuous state feedback controller and adaptive controller to realize

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