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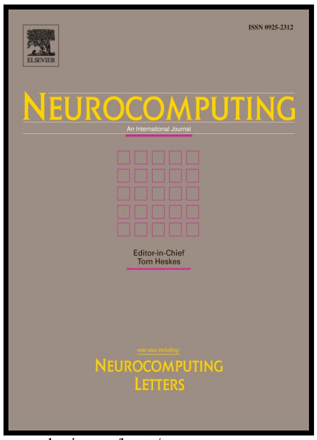

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Quasi-uniform synchronization of fractional-order memristor-based neural networks with delay

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Abstract

Quasi-uniform synchronization of delayed fractional-order memristor-based neural networks (FMNNs) is discussed in this paper. On the basis of the theory of fractional differential equations and the theory of differential inclusion, the synchronization error system between the concerned drive system and the associated response system is formulated, and then, by employing Hölder inequality, C_p inequality and Gronwall-Bellman inequality, several sufficient criteria are proposed to ensure the quasi-uniform synchronization for the considered delayed FMNNs. Three simulation examples are also presented to illustrate the availability and correctness of the theoretical results.

Keywords: fractional-order neural networks; quasi-uniform synchronization; memristor; delay

1. Introduction

Nowadays, fractional calculus, which is mainly dispose of derivative and integral of arbitrary non-integer order, has been widely applied to physics, biology, economics and engineering. For more details on the theory of fractional calculus, one can see the monographs of Podlubny [1], Kilbas [2], and Diethelm [3]. It is found that the generalization of dynamics systems in interdisciplinary fields described by fractional derivative has been proved to be more accurate both in theory and applications. As knows, the vital features of fractional derivative are nonlocal and have weakly singular kernels, which lead to the two main advantages of fractional derivative, that is, more degrees of freedom and infinite memory [4]. In view of this, fractional derivative has been acted as an excellent instrument for the depiction of memory and hereditary properties of various material and processes. For this reason, the dynamical analysis of fractional-order systems has been witnessed as a heated research topic for many researchers and a considerable number of results have been reported in the literature, see [5]-[9].

In the past few years, fractional derivative has been introduced to the dynamic analysis of nonlinear systems, where methods of dynamic analysis for integer-order systems were extended to the case of fractional order. Specifically, the fractional-order neural networks have been a burgeoning research topic of which the memory terms are incorporated into. In recent years, the dynamic behaviors of fractional-order neural networks have been paid a considerable attention, and numerous results on stability [10], stabilization [11], synchronization [12], dissipativity [13] and periodic solution [14] have been reported in droves, among which the synchronization of fractional-order neural networks has been a hotpot. It is recognized that the synchronization of chaotic neural networks has been emerged praiseworthy applications in combinational optimization, secure communication, pattern recognitions and ecological systems. Up to now, projective synchronization [15], global Mittag-Leffler synchronization [16], finite-time synchronization [17], adaptive synchronization [18] and hybrid synchronization [19] of fractional-order neural networks have been investigated by all kinds of control strategies such as feedback control, sliding mode control, adaptive control and impulsive control.

On the other hand, the dynamics of memristor-based neural networks has also been attracted extensive interests over the last few years due to their viability to achieve large connectivity and highly parallel processing power for biological systems [20]. As is known to all, memristor, the fourth basic two-terminal passive circuit element in the circuit theory, was originally proposed theoretically by Chua [21], and was primordially realized as the prototype by Hewlett-Packard laboratory [22]-[23]. When compared with the other circuit elements such as capacitors, resistors and inductors in the circuit theory, the memristors could exhibit distinct properties. This mainly due to the fact that the major merit of memristor is the value of its resistance would rely both on the magnitude and polarity of the voltage

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