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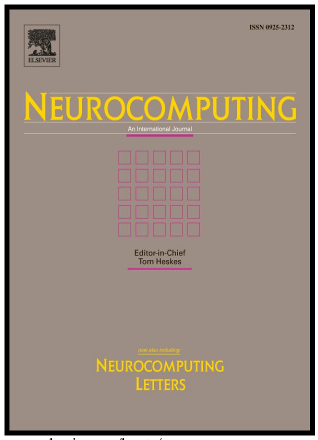

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Input-to-state stability of memristor-based complex-valued neural networks with time delays

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Abstract

This paper concentrates on the input-to-state stability problem for a class of memristor-based complex-valued neural networks with time delays. Different from the input-to-state stability criteria of real-valued neural networks, several new stability criteria of complex-valued neural networks are proposed by utilizing the Lyapunov function method, the differential inclusions theory and set-valued maps. The obtained results generalize some existing literature about real-valued neural networks as special conditions. A numerical example is presented to demonstrate the effectiveness of our theoretical results.

Keywords: Complex-valued neural networks, Memristor, Input-to-state stability, Time delays.

1. Introduction

In 1971, Chua [1] defined the fourth basic two-terminal passive circuit element by the charge q and magnetic flux φ, and named as memristor. On 1 May 2008, the Hewlett-Packard Laboratories research team proudly announced their realization of a memristor prototype, with an official publication in Nature [2-3]. Compared with ordinary resistor, the value of memristor is not unique and it hinges on the voltage applied to the corresponding state. Memristor owns a lot of characteristics, such as good scalability, a high density and low power. For the last several years, the nonlinear systems have been widely studied [4-7], as a result, many researchers introduced these peculiarities of memristor to nonlinear system and began to investigate the memristor-based neural networks (MNNs) [8-17]. In [18], the authors studied the synchronization control of neural networks with state-dependent coefficient matrices, Similarly, from [10,15], we know that the memristor-based neural networks are also state-dependent nonlinear switching systems.

As we all know, the activation functions are chosen to be bounded and smooth in real-valued neural networks. However, according to Liouville's theorem [19], every bounded and smooth activation function reduces to a constant in the complex-valued neural networks (CVNNs). Therefore, choosing an appropriate activation function is the primary challenge in CVNNs. What's more, a comparison of CVNNs with real-valued neural networks in both theoretical and practical applications shows that they possess more complicated and abundant properties, since their states, connection weights, activation functions and input vectors are complex valued. Hence, The main objective of studying CVNNs not only for exploring new dynamic performance but also for solving some problem which cannot be solved in real-valued networks. And, it is worth noting that the dynamic properties of CVNNs have been widely investigated in engineering optimization, filtering, quantum devices, pattern recognition, artificial neural networks and so on [20-26]. Recently, researchers introduced the memristor-based weights to the CVNNs to form memristor-based complex-valued neural networks (MCVNNs), which could better describe the dynamic properties of the neurodynamic systems in complex domain. Up to now, some important and interesting results about stability of MCVNNs have been obtained, see [27-30].

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