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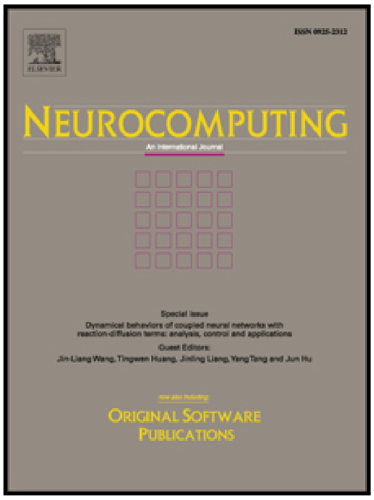

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Multiple Mittag-Leffler stability and locally asymptotical ω-periodicity for fractional-order neural networks

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Abstract

Fractional calculus is a generalization of the conventional calculus. To describe the characteristic of the neural activity more veritably, fractional calculus is applied increasingly widely in the engineering fields. This paper presents theoretical results on the multiple Mittag-Leffler stability and locally S-asymptotical ω-periodicity for a general class of fractional-order neural networks. Several conditions are obtained to guarantee the invariance and boundedness of the solutions for this class of neural networks. By constructing appropriate Lyapunov functions, the multiple Mittag-Leffler stability is addressed. Furthermore, locally S-asymptotical ω-periodicity is discussed by reduction to absurdity and the final-value theorem. Some numerical examples with simulations are elaborated to showcase the effectiveness and validity of the obtained criteria.

Keywords: Fractional-order neural networks; Mittag-Leffler stability; Multistability; Locally S-asymptotical ω-periodicity

1. Introduction

Neural networks have been attracting the attention of many researchers in recent years for the potential applications in various fields [1–3]. Due to the demand of practical applications, fractional-order neural networks have become a research hotspot over the years. As a generalization, fractional-order neural networks expand the application domains of neural networks for the potential capabilities in practical applications. In addition, a great many of literatures have revealed that the fractional-order models are the essential description of the real word. And a number of literatures concerning the fractional-order neural networks have emerged [4–6]. True, fractional-order neural networks, which are built on the basis of fractional-order calculus, deserve deep investigation. Whereas, the investigation on fractional-order neural networks are still at the early age on account of the absence of powerful tools. Furthermore, the properties derived in classical integer-order neural networks cannot be generalized straightforward into the fractional-order neural networks [7–9].

Mittag-Leffler functions are frequently employed in the fractional calculus. Totally different from the exponential stability, Mittag-Leffler stability, which is usually represented by Mittag-Leffler functions, possesses the feature of power-law convergence. And is employed extensively in analyzing the stability for solutions of the fractional-order neural networks, which is similar to the exponent functions frequently used in the stability of the solutions for classical integer-order neural networks.

There are many intriguing results regarding Mittag-Leffler stability [10–13]. It is discussed in [10] that

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