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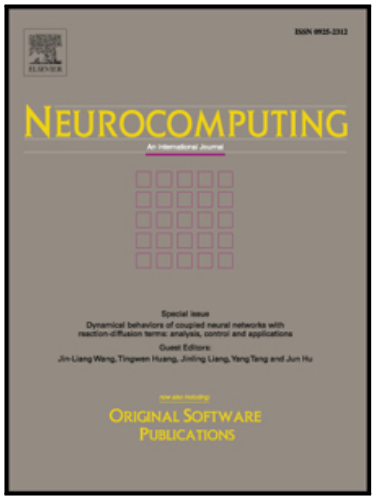

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Yuqiang Luo, Baoye Song, Jinling Liang, Abdullah M. Dobaie

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Finite-Time State Estimation for Jumping Recurrent Neural Networks with Deficient Transition Probabilities and Linear Fractional Uncertainties

Yuqiang Luo[a], Baoye Song[b,*], Jinling Liang[c], Abdullah M. Dobaie[d]

[a]*Shanghai Key Lab of Modern Optical System, Department of Control Science and Engineering, University of Shanghai for Science and Technology, Shanghai 200093, China.*
[b]*College of Electrical Engineering and Automation, Shandong University of Science and Technology, Qingdao 266590, China.*
[c]*School of Mathematics, Southeast University, Nanjing 210096, China.*
[d]*Department of Electrical and Computer Engineering, Faculty of Engineering, King Abdulaziz University, Jeddah 21589, Saudi Arabia.*

Abstract

This paper is concerned with the finite-time stability and the finite-time boundedness issues on the estimation problem for a class of continuous-time uncertain recurrent neural networks with Markovian jumping parameters. The uncertain parameters are described by the linear fractional uncertainties and the jumping parameters obey the homogeneous Markov process with possibly deficient probability transition matrix. A full-order state estimator is constructed to estimate the neuron state, in presence of the uncertain and jumping parameters, such that the resulting error dynamics of the state estimation is i) finite-time stable in the disturbance-free case; and ii) finite-time bounded in case of exogenous disturbances on the measurements. By employing the Lyapunov stability theory and stochastic analysis techniques, sufficient conditions are established that ensure the existence of the desired finite-time state estimator, and then the explicit expression of such state estimators is characterized in terms of the feasibility to a convex optimization problem that can be easily solved by using the semi-definite programme method. Validity and effectiveness of the developed design method are demonstrated by a numerical example.

Keywords: Recurrent neural networks, State estimation, Markovian jumping parameters, Linear fractional uncertainties, Finite-time stability, Finite-time boundedness.

1. Introduction

As is well known, for a few decades, the recurrent neural networks (RNNs) have been successfully applied in various areas such as parallel computation, pattern recognition, data mining, image processing, machine learning, pattern classification, and intelligence control, etc. The excellent abilities of RNNs in classification, clustering, approximating and learning are largely dependent on their dynamical behaviors. As such, the mathematical properties (e.g. observability, attractivity, stability and oscillation) of different RNNs have received considerable research interest from a variety of communities, and a rich body of literature has been available on the analysis problems of dynamical behaviors including global/asymptotic stability, existence of periodic solutions as well as equilibrium points, see e.g. [29]. Driven by real-world applications, the structure, scale and complexity of RNNs continue to evolve and new features/attributes keep emerging, thereby posing more challenges on the analysis and synthesis issues of the RNNs. For instance, by using M-matrix theory and LaSalle invariant principle, the exponential dissipativity of a class of memristor-based RNNs with time-varying delays has been analyzed in [8]. In [31], a new design approach of passivity and passification has been studied for a class of memristor-based recurrent neural networks (MRNNs), where the passivity condition can be presented in the form of linear matrix inequality (LMI) by utilizing the characteristic function method. With help from the static or dynamic coupling method, the globally exponential synchronization has been investigated in [9] for two MRNNs with time delays.

Information latching (IL) is a frequently occurred phenomenon in the implementation of a typical RNN due to its limited capability of catching long-term dependencies in the input stream. The IL phenomenon

*Corresponding author
Email addresses: songbaoye@gmail.com (Baoye Song), jinlliang@seu.edu.cn (Jinling Liang)