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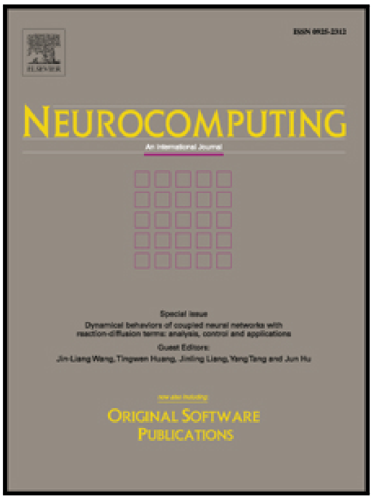

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State Estimation for Delayed Neural Networks with Stochastic Communication Protocol: The Finite-Time Case

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Abstract

This paper is concerned with the finite-time state estimation problem for a class of delayed artificial neural networks under the stochastic communication protocol. The underlying time delay is time-varying yet bounded. Compared with the common-used sigmoid-type nonlinearity, a more general type of nonlinearity is adopted to describe the neuron activation function and the nonlinearity of the measurement output, respectively. In order to avoid the communication collision, the stochastic communication protocol is introduced between the transmitter and the receiver, and the corresponding scheme is characterised with the help of a Markov chain. By introducing an auxiliary vector, a novel state estimator structure is proposed. The stochastic finite-time stability of the error dynamics is first analyzed via the stochastic analysis techniques and the Lyapunov stability theory, and then the sufficient condition for the existence of the desired state estimator is obtained. Subsequently, the estimator gain is parameterized by using a set of easy-to-check computational condition. Finally, a numerical example is provided to show the effectiveness of the proposed algorithm.

Keywords: Carrier-sense multiple access, delayed artificial neural networks, state estimation, stochastic communication protocol, stochastic finite-time stability.

1. Introduction

Over the past decades, the artificial neural networks (ANNs) have attracted considerable research interests due to its merits such as easy implementation of parallel architecture, excellent training ability on large data sets, nonlinear function approximation. A large number of results have been reported on this topic. For example, the ANN has been first used to chest pain appeared in [14]. For the purpose of electric load forecasting, an ANN-based approach has been presented in [19] to learn the relationship among past, current and future temperatures. Based upon the data of wood-glue moisture content, density of board and pressing temperature, implementation of ANNs has been studied in [5] for modeling the formaldehyde emission, where the formaldehyde emission of the particle board has been exactly predicted. It should be pointed out that, the time delay in the ANNs is always inherent yet unavoidable, which would often lead to undesired dynamic behaviors and poor performance. Therefore, base upon the analysis and synthesis approaches of time-delay systems [13], the dynamics analysis of the delayed artificial neural networks (DANNs) becomes a crucial issue in real application of ANNs, see e.g. [27, 22, 18] and the references therein.

As is well known, DANNs can be widely used in applications such as the system identification and control (vehicle control, process control [34], trajectory prediction), signal classification [20], quantum chemistry [7], game-playing and decision making, sequence recognition, etc. However, many of these applications depend largely on the dynamic behaviors of DANNs. As such, the state information of neurons becomes prerequisite in many practices. Unfortunately, the states of neurons can not always be fully available because of some physical constraint in real practices, especially for the large-scale

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