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Finite-time stabilization control for discontinuous time-delayed networks: New switching design *

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Abstract

This paper discusses the finite-time stabilization problem for time-varying delayed neural networks (DNNs) with discontinuous activation functions. By using fixed point theory and set-valued analysis, we establish the existence theorem of equilibrium point. In order to stabilize the states of this class of discontinuous DNNs in finite time, we design two different kinds of switching controllers which are described by discontinuous functions. Under the framework of Filippov solutions, several new and effective criteria are derived to realize finite-time stabilization of discontinuous DNNs based on the famous finite-time stability theory. Besides, the upper bounds of the settling time of stabilization are estimated. Numerical examples are finally provided to illustrate the correctness of the proposed design method and theoretical results.

Keywords: Time-delayed neural networks; Kakutani's fixed point theorem; Discontinuous activation; Differential inclusions; Finite-time stabilization; Switching controller.

1 Introduction

Discontinuous dynamical systems are an important class of differential equations that frequently arise in many scientific problems and engineering fields. One of the most interesting classes of discontinuous dynamical systems are the neural networks with discontinuous neuron activations. This class of discontinuous dynamical neuron systems have been proved really useful as ideal models to solve various control problems such as constrained optimization problem and programming problem [1-4]. Due to the discontinuities, the existence of a continuously differentiable solution for differential equation is not guaranteed. So many results in the classical theory of differential equation have been shown to be invalid for discontinuous dynamical neuron systems. In order to overcome this difficulty, Forti and Nistri firstly introduced the differential inclusion theory developed by Filippov to investigate the dynamical behaviors of neural networks with discontinuous activation functions in 2003 [3]. Inspired by the study of Forti and Nistri, many theoretical results for neural network models with discontinuous activations have been obtained [5-16,33]. However, most of existing results are focus on the existence and stability of periodic or almost periodic orbits or even equilibrium points. To the best of our knowledge, discontinuous neural networks may also exhibit some unstable behaviors such as chaos and oscillation. Therefore, some controller should be designed to realize the stabilization of the unstable neural networks with discontinuous activations.

The concept of stabilization arises natural in control field of neural networks, which has an important feature to control the states of neuron systems to some equilibrium values or periodic orbits. The issue

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