IMA Journal of Mathematical Control and Information Advance Access published October 21, 2014

IMA Journal of Mathematical Control and Information (2014) Page 1 of 17
doi:10.1093/imamci/dnu038

Synchronization for networks of coupled non-linear systems with external disturbances

QUNJIAO ZHANG*
Normandie Univ, France; ULH, LMAH, F-76600 Le Havre, France; FR CNRS 3335, ISCN, 25 Rue Philippe Lebon, 76600 Le Havre, France and College of Mathematics and Computer Science, Research Center of Nonlinear Science, Wuhan Textile University, Wuhan 430073, PR China
*Corresponding author: qunjiao99@163.com

M. A. AZIZ-ALAOUI
Normandie Univ, France; ULH, LMAH, F-76600 Le Havre, France and FR CNRS 3335, ISCN, 25 Rue Philippe Lebon, 76600 Le Havre, France

AND

CYRILLE BERTELLE
Normandie Univ, France; ULH, LITIS, F-76600 Le Havre, France and ISCN, 25 Rue Philippe Lebon, 76600 Le Havre, France

[Received on 31 March 2014; revised on 6 July 2014; accepted on 5 September 2014]

Based on the integral sliding mode control method, some theoretical criteria for the robust synchronization of multi-coupled general non-linear systems with external disturbances are presented, the ultimate error bounds are estimated simultaneously. Furthermore, as an application, the detailed analysis and conclusions are derived for a network of multi-coupled FitzHugh–Nagumo (FHN) systems with external disturbances. Finally, some numerical examples, with two or more coupled FHN systems, are given to illustrate the effectiveness of the proposed theoretical results.

Keywords: robust synchronization; integral sliding mode; disturbance; network; FitzHugh–Nagumo system.

1. Introduction

The first quantitative model of excitation in neuronscience was proposed by Hodgkin & Huxley (1952), which has been studied as a model for nerve conduction, to understand the dynamics of the interaction between the membrane potential and the restoring force, and to capture the basic properties of excitable membranes (Fitzhugh, 1961; Nagumo *et al.*, 1962). From then on, numerous simplifications of the spiking dynamics of neurons have been proposed, among them, a class of FitzHugh–Nagumo (FHN) systems (see Zhou *et al.*, 2009; Sánchez & Izús, 2010; Nguyen & Hong, 2011; Rehan & Hong, 2011; Rehan *et al.*, 2011; Ambrosio & Aziz-Alaoui, 2012; Yu *et al.*, 2012), called here FHN-type systems.

In the last few years, many theoretical results about the coupled FHN-type systems have emerged. The researchers investigated the synchronization and control of coupled reaction-diffusion FHN systems (Ambrosio & Aziz-Alaoui, 2012). Based on adaptive backstepping sliding mode control method,