Control Design for Multi-machine Power Systems Using Continuous Sliding Mode Approach[1]

J. de León-Morales[+,2], Didier Goerges[*], Oscar Huerta-Guevara[+]

[+] *Universidad Autónoma de Nuevo León, Facultad de Ing. Mecánica y Eléctrica*
San Nicolás de los Garza, Nuevo León, MEXICO
[*] *Laboratoire d'Automatique de Grenoble CNRS/INPG UMR 5528*
ENSIEG-BP 46, 38402 Saint Martin d'Hères Cedex, FRANCE

Abstract

This paper is concerned with the control of multi-machine power systems. We propose a continuous sliding-mode control design. The designed controller is smooth: in that sense, it differs from classical sliding mode controllers subject to chattering phenomena. Two versions of the sliding-mode controller are then applied to the control of a multimachine power system. The practical implementation of these two controllers leads to a fully decentralized control schemes. Simulations results demonstrate better performances of these two controllers compared to a Hamiltonian passive controller.

Keywords: Multi-machine power systems, large-scale decentralized nonlinear control, continuous sliding mode control.

1. Introduction

The stability of an electrical power system (EPS) may be defined as the ability to remain in synchronous operation under normal operating conditions as well as after a disturbance (a default like a short-cut or a change of operating conditions for example).

Ensuring the transient stability under different operating conditions in order to maintain synchronism between generators is an important issue in power system control and we will focus our attention on this problem hereafter.

Excitation control, that is one of the possible actions to maintain transient stability of power systems under disturbed conditions, will be considered in this paper.

The use of advanced control techniques for power system control has been one of the more promising application areas of automatic control. To enhance transient stability of power systems, a great attention has been paid to the application of nonlinear control theory.

To improve the robustness of closed-loop power systems, different approaches based on nonlinear control theory have been proposed; for example, those based on variable structure, singular perturbation methods, control Lyapunov function (Bazanella, 1997), Hamiltonian function method (Masschke et al., 1998, Ortega et al., 1998) or adaptive control.

Recently, port-controlled Hamiltonian systems have been introduced in (Masschke et al., 1998, Ortega et al., 1998). For this class of systems the Hamiltonian function is considered as the total energy and play the role of Lyapunov function for the system. The key feature of this technique is to express the electrical power system dynamics under the form of a port-controlled Hamiltonian representation. This method has already been applied for improving the transient stability of a multi-machine power system by means of decentralized nonlinear excitation control (Xi, 2002).

Another technique for improving robustness under parameter uncertainties and external disturbances is sliding-mode control design which has attracted a number of researches (see De Carlo et al., 1988, Utkin, 1992). It can be viewed as a high-speed switching controller that provides a robust means of controlling nonlinear systems by forcing the trajectories to reach a sliding manifold in finite time and to stay on the manifold for all time.

[1] this work was sponsored in part by PAICYT-UANL, MEXICO

[2] corresponding author. e-mail: drjleon@hotmail.com