Chapter 11
Load Frequency Control in Multi-Area Interconnected Power Systems Using Second Order Sliding Mode

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ABSTRACT

The chapter focuses on load frequency control (LFC) problems in multi area power systems using nonlinear second order sliding mode control (NL-SOSMC) under load disturbances and parameter uncertainties. A sudden load disturbance can causes deviation in frequency and tie line power from their schedule value. The main objective of the chapter is to give knowledge about the application of robust control technique mainly sliding mode control (SMC) for load frequency problems. The designed controller ensures finite time convergence of frequency and tie line power deviations with chattering free control signal. The proposed controller confirms better transient and steady state behavior. Furthermore, the controller is validated under matched uncertainty, random step load disturbances, parameter uncertainties, and with nonlinearities in power system like generation rate constraints (GRC) and governor dead band (GDB). The stability of the controller is theoretically proved using Lyapunov candidate function and verified using simulations in MATLAB R2015a.

INTRODUCTION

Electric power systems are an inevitable part of an industrial economy. Power systems extend over almost all developing and developed nations and represent one of the most expensive and largest man-made systems on the earth. Economic soundness of any country depends on how good and quickly its

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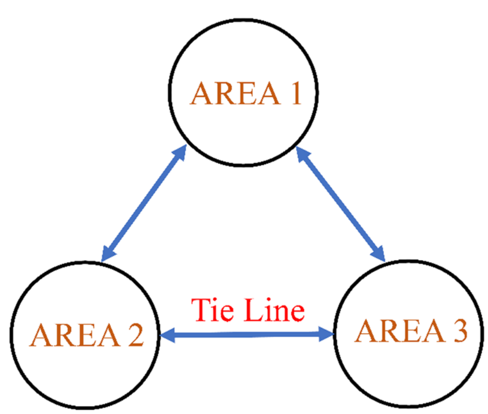
power sector responds to any transience and disturbance in the line. Discovering new sources of energy, transforming one source of energy into another, transmitting the energy from resource centric region to load centric region also constitute an integral part of power systems. Growing demand of energy in every sphere of life has resulted in increased complexity, functionality and interconnection of power systems. Thus, a special attention is required to be directed towards electric power systems of any nation. A sudden disturbance in power systems may have an indirect impact on the lives and economy of the nation. Thus, power system stability is of an utmost importance and should be dealt with modern state of art techniques.

In power systems, frequency stability is an important index of power quality. A stable frequency symbolises the balance between the generation and demand. A sudden load disturbance can cause deviations in frequency and tie line power from their schedule value. In this chapter three area interconnected non-reheated power system is considered. Interconnected power systems are more reliable and economical. A sudden increase in load in one area can be met by borrowing power from adjoining interconnected area. Interconnected power systems have many advantages like reliability, effective use of generators, reduction in the reserve generation capacity of any area etc. However, interconnection requires proper management because control operation of frequency and tie line power deviations under load disturbance can become very challenging. A sudden change of load in one area can cause deviations in frequency and tie line power in the neighboring area. A schematic diagram of a three-area interconnected power system model is illustrated in figure 1.

Load frequency control is an important aspect in an interconnected power system. In multi area power systems, frequency is dependent on active power whereas voltage is on reactive power. This combination of active power and frequency control is known as load frequency control (LFC) and is also known as power frequency control or automatic generation control (Pandey et al., 2013). LFC has made the operation and control of interconnected power systems possible. In the case of interconnected power systems, decentralized control is preferable over centralized control because it uses local area state information to reduce the frequency deviation (Mi et al., 2013). Thus, reducing the computational task and making control more practical and simpler. Decentralized control is an effective way of physically breaking complex control action into smaller and easy control task. As the size of power systems increases, it leads to increase in the complexity of the system that requires precise control technique and

Figure 1. Schematic diagram of interconnected of power systems



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