Electrical Power and Energy Systems 33 (2011) 1750–1759

Contents lists available at SciVerse ScienceDirect

Electrical Power and Energy Systems

journal homepage: www.elsevier.com/locate/ijepes

Real time implementation of H_∞ loop shaping robust PSS for multimachine power system using dSPACE

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ARTICLE INFO

Article history:
Received 9 December 2010
Received in revised form 15 June 2011
Accepted 12 August 2011
Available online 17 October 2011

Keywords:
dSPACE
H_∞ loop shaping
Linearized mode
Multimachine
Power system stabilizer
Robust control

ABSTRACT

This paper presents the simulation and the experimental validation of the designed robust power system stabilizer (RPSS) to stabilize a linearized uncertain power system using Glover–McFarlane's H_∞ loop shaping design procedure. Guidance for setting the feedback configuration for loop shaping, weighing functions selection and synthesis are also presented. The efficiency of the designed controller is simulated using Matlab/Simulink and tested by implementing on real time environment using dSPACE work stations DS1005 and DS1104. The real time experimental results of RPSS are compared with that of the conventional power system stabilizer (CPSS) for a three phase fault. Also, the real time simulation results of RPSS are compared with the off-line simulation results of RPSS, thus validating the simulation results with the experimental results. Justification of robustness is also presented by considering three different operating points. The proposed method presented in this paper shows the effectiveness of the RPSS in damping the power system oscillations.

1. Introduction

The main objective of installing a power system stabilizer (PSS) is to achieve desired stability and security at a reasonable cost by modulating the generator excitation to provide additional damping to electromechanical oscillations of synchronous machine rotors. They also enhance the power transfer capability of the power system [1]. FACTS is more required for switching purposes and isolating the grid from faults [2], whereas the PSS is used as a controller for dynamic performance of the grid. Therefore, both can be complementary and can improve the performance of the system more effectively. In recent years there has been an increasing interest on applying advanced control designs in power systems like adaptive control, H_∞ control, μ synthesis [3], non-linear control, feedback linearization [4], periodic output feedback, sliding mode control [5]. The goal of these studies is to achieve power system stability and performance robustness upon the occurrence of faults. Conventional stabilizers are not designed in a way to guarantee the desired level of robustness. Such designs are specific for a given operating point and they do not guarantee robustness for a wide range of operating conditions [6].

To include the model uncertainties at the controller design stage, modern robust control methodologies have been used in recent years to design PSS [3,4]. The resulting PSS ensures the stability for a set of perturbed operating points with respect to the nominal system and has good oscillation damping ability. The proposed RPSS [7] is free from common deficiencies of normal power system nonlinear controllers which are network dependent and equilibrium dependent. The H_∞ optimal controller design is relatively simpler in terms of the computational burden. Glover–McFarlane's H_∞ shaping technique is applied to design RPSS with respect to model uncertainties of the power system for Single Machine connected to Infinite Bus (SMIB) systems [8,9] only. RPSS using Glover–McFarlane's H_∞ loop shaping technique are developed for SMIB systems with synchronous machine models based on Model 1.1 [10] and for a series compensated line based on Model 2.2 [11]. Dual-input PSS using Glover–McFarlane H_∞ loop-shaping technique was designed to mitigate the Sub Synchronous Resonance [8]. Only Zhu et al. [3] have designed a PSS using Glover–McFarlane H_∞ loop-shaping technique for multimachine system based on sequential tuning. This paper uses the Glover–McFarlane H_∞ loop shaping design procedure [12] with the normalized coprime factor robust stabilization technique for multimachine system based on decentralized scheme with simultaneous tuning to design the RPSS to effectively damp the power system oscillations.

Various researchers across the globe have implemented different types of PSS with different real time methodologies by conducting experiments using hardware and software. The works done by the various researchers [13–21] was implemented only

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doi:10.1016/j.ijepes.2011.08.018