ABSTRACT

The aim of this work is to elaborate robust control algorithms to power systems. The mathematical model employed to describe the multimachine power system is that used in small signal studies, and the main goal is to increase the damping of the critical eigenvalues of the system, guaranteeing its stability and performance in various operating conditions. To do this, we apply the Linear Matrix Inequalities (or simply LMI's), suitable to deal with robust control problems due to its flexibility and possibility to group many performance requisites. We propose three robust control algorithms: two of them are related to decentralized control with controllers of pre-defined structure, which are commonly used in the power industry, and the other one is related to the hierarchized control, which consists on the integration of various controllers layers using remote signals. The decentralized robust control algorithms proposed are novel, because both methods make possible the development of controllers of pre-defined structure, and the hierarchized control algorithm suggests a novel control structure that uses Padé approximations of different orders to represent the communication delays in the system. During the design, we can choose the communication delay, as well as the order of the Padé approximation desired. The decentralized robust control algorithms solve minimization problems over the controller gain matrix norm, which guarantees that the final values of the controller's parameters will not be much high and impracticable. The technique employed for the three types of controllers proposed is the pole placement, which ensures that the eigenvalues of the closed loop power system will be in a certain region of the complex plane, related to the minimum damping required for the system. Tests and simulations are done in MATLAB to validate the robust control algorithms, and we apply these algorithms to various power systems: 39-bus 9-machine New England power system, 69-bus 16-machine New England power systems and 39-bus New England power system with thermo machine models. The tests suggest that the proposed techniques work well, once all of them guarantee good damping rates to the power systems considered. To complete the tests round, nonlinear simulations proof the efficiency of the controllers designed for the 39-bus New England power system.

Keywords: Robust Control. Power System Stabilizers. Linear Matrix Inequalities. Pole Placement. Hierarchized Control. Power Systems Control.