Abstract

This thesis presents two design issues to improve the performance of a PSS. The first issue considers the synthesis of a robust PSS while the second issue considers the synthesis of a model-based fuzzy PSS. The design issues are addressed using a linear matrix inequalities (LMIs) approach. Polytopes and Takagi-Sugeno (T-S) fuzzy models can capture major uncertainties in power systems. Three T-S fuzzy models are proposed to represent the uncertainties that occur due to continuous variations in operating conditions.

Robust synthesis of a PSS is addressed considering different controller forms such as state feedback, full-order output feedback, reduced order output feedback and PID controllers. Synthesizing a controller is firstly reduced to an LMI and/or BMI optimization problem. LMI optimization problems are efficiently-solved using available interior point algorithms while for BMIs which are not convex optimization problems, a set of iterative linear matrix inequalities (ILMI) algorithms are developed to find a set of suboptimal controllers. Syntheses of a multiobjective state and output feedback PSSs that guarantee robust pole-clustering and robust performance in terms of H_2 and H_∞ are presented. The structure of a PSS in industry is preserved by considering the design of reduced order output feedback PSSs. Synthesizing robust phase compensators is reduced to solving a set of BMI constraints. After selecting the pole location of a phase compensator-based PSS, the synthesis problem is reduced to a generalized static output feedback (SOF) control problem. Two ILMI algorithms are proposed to solve robust SOF control problems. Further, synthesizing robust PID-based PSS is addressed and reduced to solving SOF control problem using the proposed ILMI algorithms. Synthesizing robust decentralized state feedback, full-order output feedback, reduced order output feedback and PID-based PSSs in multimachine power systems is considered.

The second issue considers the design of model-based fuzzy PSS that guarantees robust stability and robust performance of power systems. This issue is initiated by formulating single-machine power systems as Takagi-Sugeno (T-S) fuzzy models. This issue includes the syntheses of model-based fuzzy state feedback and dynamic output feedback controllers that guarantee a mix of control objectives. Moreover, this issue considers the design of multiobjective fuzzy observer-based output feedback stabilizer that guarantees robust pole-placement in LMI regions and robust performance in terms of H_2 and H_∞. Sufficient LMI conditions for synthesizing multiobjective fuzzy state feedback and fuzzy dynamic output feedback are presented and proved. Further, sufficient LMI conditions to synthesize a pole-clustering fuzzy observer-based PSS are presented and proved. Sufficient BMIs conditions to synthesize a multiobjective fuzzy observer-based PSS are also proved and an ILMI algorithm is proposed to solve this set of BMIs constraints. The design of fuzzy static output feedback PSS that guarantees robust pole-clustering is considered where the synthesis is reduced to solving a set of LMI constraints together with an equality constraint. Furthermore, the design of fuzzy static output feedback that guarantees certain decay rate and certain H_∞ performance is reduced to solving a set of BMI constraints. Two ILMI algorithms are proposed to find a suboptimal fuzzy static output feedback PSS.

Simulation results of a single-machine and multimachine power system confirm the effectiveness of the proposed designs. In single-machine simulations, the proposed designs are compared to the CPSS while in multimachine simulation the proposed designs are compared to CPSS and to the standard IEEE-PSS4B stabilizer.

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