Enhancement of Small Signal Stability in Power Systems: Novel Approaches

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ABSTRACT

The modern power system is a highly nonlinear system that operates in a constantly changing environment. Power system, need to maintain more or less flat voltage profile across the grid and maintain stability for small and large disturbances. Traditionally, automatic voltage regulators (AVR) are used for voltage regulation and power system stabilizers (PSS) are used as auxiliary controllers in AVR to enhance the small signal stability of power system.

The conventional PSS design techniques require considerable expertise, full system information and extensive eigenvalue calculations, which increase the computational complexity with the increase in system size. The thesis proposes a novel approach to design a fixed parameter PSS utilizing only the local system information applicable for a wide range of operating and system conditions. The phase compensation requirements for a fixed parameter PSS significantly change with the generator loading and topology which degrades the PSS performance. The thesis proposes to augment a nonlinear gain to the existing static AVR structure so that the impact of the loading conditions is completely eliminated. It is shown that this modification produces a single phase-compensation curve for all loading levels which simplifies the PSS design and eliminates the PSS tuning requirements.

If the coupling between the voltage loop and the rotor angle loop is removed then the conflicting nature between them can be eliminated. This thesis shows that the rotor dynamics and voltage dynamics can be decoupled in a synchronous machine using a partial feedback linearization based nonlinear AVR. However, in such cases the damping is only dependent on the natural damping in the system. So, PSS is needed even in the case of a nonlinear AVR if the natural damping is insufficient. Consequently, a PSS design for a single machine infinite bus (SMIB) power system with the nonlinear AVR is proposed. The PSS design using local information is also extended to the nonlinear AVR scenario in a multi machine environment.