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Model Reference Adaptive Approach for Power System Stabilizer for Damping of Power Oscillations

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Abstract : In recent years, electricity trade between neighboring countries has become increasingly intense. Increasing power transmission over long distances has resulted in an increase in the oscillations of the transmitted power. The damping of the oscillations can be carried out with the reconfiguration of the network or the replacement of generators, but such solution is not economically reasonable. The only cost-effective solution to improve the damping of power oscillations is to use power system stabilizers. Power system stabilizer represents a part of synchronous generator control system. It utilizes semiconductor’s excitation system connected to the rotor field excitation winding to increase the damping of the power system. The majority of the synchronous generators are equipped with the conventional power system stabilizers with fixed parameters. The control structure of the conventional power system stabilizers and the tuning procedure are based on the linear control theory. Conventional power system stabilizers are simple to realize, but they show non-sufficient damping improvement in the entire operating conditions. This is the reason that advanced control theories are used for development of better power system stabilizers. In this paper, the adaptive control theory for power system stabilizers design and synthesis is studied. The presented work is focused on the use of model reference adaptive control approach. Control signal, which assures that the controlled plant output will follow the reference model output, is generated by the adaptive algorithm. Adaptive gains are obtained as a combination of the "proportional" term and with the σ-term extended "integral" term. The σ-term is introduced to avoid divergence of the integral gains. The necessary condition for asymptotic tracking is derived by means of hyperstability theory. The benefits of the proposed model reference adaptive power system stabilizer were evaluated as objectively as possible by means of a theoretical analysis, numerical simulations and laboratory realizations. Damping of the synchronous generator oscillations in the entire operating range was investigated. Obtained results show the improved damping in the entire operating area and the increase of the power system stability. The results of the presented work will help by the development of the model reference power system stabilizer which should be able to replace the conventional stabilizers in power systems.

Keywords : power system, stability, oscillations, power system stabilizer, model reference adaptive control
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