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Title of Thesis : AGC Strategies in Power System Based on Model Order Reduction Techniques

For effective design, operation and control of a system, creating an accurate system model is the first step. As system grows larger, its complexity increases. To analyze such systems, a full order of the system is used. The systems like power system higher order models pose numerous design problems which are of great concern from the simulation point of view, storage of data describing such systems and the implementations of these design strategies. The computational effort required to deal such higher order models needs extra expertise and may result in unwieldy portions leading to high investments with no substantial advantages.

Out of various power system operation and control problems, Automatic Generation Control is the most important problem which should be dealt in most effective manner especially in interconnected power systems. Most of the AGC strategies reported so far are concerned with the design of different types of controllers and their validity have been demonstrated with their implementation in the wake of load disturbance in the system. The preliminary design and optimization of AGC system can often be accomplished with greater ease, if low order linear model is derived for large order system with a good degree of approximation to the system.

In the present work an exhaustive study is carried out to design reduced order models for AGC of interconnected power systems. New methods are also proposed to overcome the shortcomings of the existing methods.

Model order reduction techniques concerns the transformation of higher order model into a low order model through computations and certain relationship between these two

models are preserved, with similar characteristics. Methods are utilized for alleviating computational complexity simplifying system analysis which leads to minimization of time and cost. Different reduced order model strategies have been reported in literature to achieve simpler simulation of the process and reduce the computational effort. Comprehensive overview of existing model order reduction techniques is presented in the introductory Chapter of the thesis.

Aggregation methods for model order reduction of linear time-invariant systems are studied in detail and applied to SISO systems and MIMO systems. In modal aggregation approach, a modal matrix is required which increases the additional computational efforts. A method is proposed based on controllability matrix of original system. The proposed method ensures that certain important properties of original model are retained in reduced model.

Frequency domain methods are also applied to AGC of various power system models. In frequency domain, Routh approximation technique and mixed method is applied and various parameters like stability, accuracy and dynamic characteristics are investigated. Time response plots and pattern of integral square error are observed in line for both reduced and higher order models.

Following model order reduction, techniques based on time domain are also applied to AGC models; Balanced truncation technique, Singular perturbation technique, Hankel norm approximation technique.

From the analysis of the results achieved in the study, it is inferred that singular perturbation technique offers better results than truncation and HNA technique. It is also observed that reduced model takes lesser time as compared to original higher order model when simulated on the same platform. To demonstrate the accuracy index of the reduced order model, ISE values of difference of step responses of original and reduced order models are determined for each output.