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Pole placement by coordinated tuning of Power System Stabilizers and FACTS-POD stabilizers

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ABSTRACT

This work presents the application of the Decentralized Modal Control method for pole placement in multimachine power systems utilizing FACTS (Flexible AC Transmission Systems), STATCOM (Static Synchronous Compensator) and UPFC (Unified Power Flow Controller) devices. For this, these devices are equipped with supplementary damping controllers, denominated POD (Power Oscillation Damping), achieving a coordinated project with local controllers (Power System Stabilizers – PSS). Comparative analysis on the function of damping of the FACTS, STATCOM and UPFC is performed using the New England System that has 10 generators, 39 buses and 46 transmission lines.

1. Introduction

Electric power systems were always regulated by market forces, but with deregulation of the electric energy market and the increase in environmental pressure, the efficient and careful use of generation, transmission and distribution systems has become imperative. Because of these factors, systems operate close to their stability limits, favoring the emergence of electromechanical oscillations, which are a limiting factor in the transport of electrical energy between large systems.

Power System Stabilizers (PSS) have been efficaciously, reliably and economically utilized for electromechanical oscillation damping over several decades [1,2]. However, it is recognized that due to their location, these devices have a great effect on local modes but may not be the best alternative to damp interarea oscillations [3,4]. PSS devices can be tuned to damp interarea modes however this may create conflicting objectives in the control of oscillations, as damping of local modes may be underestimated [5].

An alternative is the use of FACTS (Flexible Alternating Current Transmission Systems) devices, providing they are equipped with supplementary damping controllers often termed Power Oscillation Damping (POD) controllers [6]. The design of PSS and POD controllers has fundamental importance for achieving adequate damping rates to the oscillatory modes of interest and minimal influence on the remain oscillatory modes. In this context, the proposition and analysis of various design techniques for controllers gained prominence in the specialized literature. Sequential [7] or uncoordinated [8,9] techniques can be used to design multiple stabilizers; however, the prediction of interactions among different controllers is compromised, causing the eigenvalue drift problem. The eigenvalue drift can be overcome by coordination in the design of all controllers. Some authors suggest only gain tuning coordination, implementing a sequential procedure to obtain the lead/lag parameters (phase compensation blocks) in way to achieve pole placement [10,11]. However, in this case, the usage of optimization techniques is required in way to ensure efficiency, and the definition of optimal constrains depends on prior knowledge of system characteristics. Artificial intelligence techniques have recent emphasis on coordinated design and robustness of PSS and POD controllers, through application of Genetic Algorithms [12,13], Fuzzy Logic control [14,15], Artificial Neural Networks [16,17], or combinations of previous [18,19]. However, the high level of knowledge required about the system to be controlled and the numerous combinations of parameters values for its implementation are undesirable in real systems usage. Despite the advances and the diversity of emergent tuning techniques for power system controllers, the classical control theory remains with high theoretical and practical acceptance [5,20]. Various algorithms are based on classical control theory, among of them this paper uses the Decentralized Modal Control (DMC) approach

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