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Design and Development of Self Tuning Controller for TCSC to Damp Inter Harmonic Oscillation

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Abstract

The disturbances occurring in a power system induce electromechanical oscillations of the electrical generators. These oscillations, also called power swings, must be effectively damped to maintain the system's stability. The aim is to mitigate power oscillations in power systems. There is currently interest in using Thyristor controlled series capacitors (TCSC) in transmission lines for the dual purpose of altering the steady-state power flow and enhancing system stability. Thyristor controlled series capacitors (TCSC) is one of the typical FACTS device which is used to improve the voltage profile and transient stability in power system by damping the frequency oscillation in it. This paper describes an adaptive method for control of a TCSC device for power oscillation damping. In this paper, a self-tuning PI controller for Thyristor Controlled Series Capacitor (TCSC) is proposed. Simulation results illustrate the effectiveness of the proposed self-tuning controller in simultaneously damping local-mode and inter-area oscillations. Results are compared with the fixed gain PI controller and Self-tuning PI controllers.

Keywords: Thyristor ;TCSC; ST,;FACTS

1. Introduction

There is an imbalance between the increasing generation capacity and corresponding growth of transmission

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infrastructure. India doesn't have necessary transmission infrastructure to have evacuate all the generated power existing transmission lines should be utilized to a maximum capacity by loading them closer to their limits. The existing power systems are complex highly interconnected and evolve almost on a daily basis. Some of the major issues experienced by the present transmission system include the need for reactive power compensation system, problems related to voltage stability and power system. Oscillations owing to faults and sudden load disturbances, one of the important tasks of a power system engineers is to enhance the reliability and efficiency of the existing system. In order to have operational reliability and financial profitability the power system infrastructure needs proper utilization and control. FACTS devices through their advanced technology can provide effective utilization of the existing power systems and enhance their stability and performance. One of the major concerns, then, is secure operation of the system because of the presence of low-frequency electromechanical oscillations typically in the range of 0.1–0.8 Hz. One primary way of tackling the problem is to improve the dynamic behaviour of the system and thereby allowing system operation closer to the capacity, without compromising security. Traditional ways of tackling the problem is getting increasingly complex because of variety of reasons including the lack of accurate information for all the components required to model the entire power system. It is increasingly difficult to get accurate information about overall performance of the system as there are different independent power producers, different utilities and increased interconnection between systems. One typical issue that is inherent to the interconnected synchronous generators is the phenomenon of electromechanical oscillations. Stabilization of these electromechanical oscillations is a very important necessity to have stable and secure operation. Those oscillations that are association with single generator or a single plant are referred to as local mode oscillations or plant mode oscillations. The characteristics of local mode oscillations are well understood and have typical frequencies in the range of 0.7HZ - 2.0HZ [1].Those oscillations that are attributed to a group of generators or group of plants are referred to as inter-area mode oscillations. The characteristic of inter area mode oscillations are not fully understood and the factors influencing them are not completely identified. These inter area mode oscillations typically have frequency in the range of 0.1HZ - 0.8HZ [1].Electro-mechanical oscillations are usually studied through model analysis of linearised system model. Considering the criticality of the problem alternate analysis techniques have to be developed the multiple number of studies have shown. The successful use of supplementary control signals, the use of governor systems can improve the dynamic performance of a system this dynamic performance is brought about by providing extra damping through supplementary control signals. Power systems are highly non-linear and typically operate over wide range. Regularly the power systems are subjected to random changes in load which can result in a white noise disturbance. In order to have satisfactory control over the performance it's preferable to have a stabilizer that can adjust its own parameters and adapt its structure online. Power system stabilizers (PSS) which are usually installed at generator locations or localized stabilizers are typically suited only for damping local mode of oscillations. On the other hand inter area mode oscillations are associated with inter connected power systems and hence suitable damping control methodologies should be evolved. The issues related to voltage stability and reactive power compensation can be typically dealt by conventional PI controllers. On the other hand it is difficult to damp the inter harmonic oscillations with the help of conventional controllers. Apart from their inability to damp these oscillations these PI controllers can also reduce and increase these oscillations in some system. Different modes of oscillations exist in power systems due to interaction among various components mostly these oscillations are resultant of synchronous generators rotors swinging relative to each other .when a system is stressed it is known to exhibit non-linear behaviour. Abrupt changes in load and occurrence of faults are the primary reasons for power oscillations. if these oscillations are not properly contained they can result in total or partial outage of the system, if the oscillations are not done properly they may sustained and grow eventually caucusing the system fail [3].There are different methods reported in literature for damping these oscillations and one of the most common methods is to install power system stabilizer(PSS) on generators [4-8].Even though power system stabilizer can enhance stability and damp oscillations there are limitations in determining the optimum value of PSS parameters. Improper selection of values can result in inadequate damping resulting power system instability. It is imperative to have proper selection of values and since 1981 several approaches have been identified and presented for determining the PSS control parameters. These methods include artificial neural networks, pole placement, adaptive control and variable structure control based on model control theory [9-15]. Over the years PSS have been widely utilized by power utilities to enhance system stabilities and to reduce inter- harmonics oscillations, however years of operation result in problems and also PSS have limited ability to damp only local oscillations and not inter harmonic oscillations. The proposed self-tuning (ST) controller in this paper differs from the ANN and Fuzzy Logic control approaches. Unlike ANNs, it does not require offline training nor is dependent on inference rules, which are