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A NOVEL CONTROL SCHEME OF STATIC SYNCHRONOUS SERIES COMPENSATOR FOR FREQUENCY OSCILLATION CONTROL

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ABSTRACT

Here in this paper Low frequency oscillations (LFO) are a common opposing phenomenon which raise the risk of insecurity for the power system and consequently decrease the total and existing transfer capability. In this paper a clear examines the damping presentation of the static synchronous series compensator (SSSC) prepared with an auxiliary fuzzy logic controller (FLC). Here in this paper at the outset an improved Heffron-Phillips design model of a single machine infinite bus (SMIB) system integrated with SSSC is recognized. In this paper examined the following an auxiliary Fuzzy Logic Controller for SSSC is well calculated to improve the transient stability of the power system. So that estimate the operating performance of the recommended Fuzzy Logic Controller in damping LFO the SMIB power system is exposed to a disruption such as deviations in mechanical power. The whole digital simulations are implemented in the MATLAB and Simulink platform to deliver complete accepting of the issue. The achieved Simulation responses are demonstrated that the established Fuzzy Logic Controller would be more operative in damping electromechanical fluctuations in comparison with the traditional proportional integral (PI) controller.

INDEX TERMS: Low Frequency Oscillations, Static Synchronous Series Compensator (SSSC), Single Machine Infinate Bus (SMIB) Power System, Heffron-Phillips Design, Fuzzy Logic Controller.

I.INTRODUCTION

The existed interconnecting the huge power systems utilities have accomplished more continuity and economic sustainability. Though, low frequency fluctuations with the frequencies in the limit of 0.2 to 2 Hz are one of the straight outcomes of the huge intersected power systems. The power fluctuations may come up to complete rating of a transmission line like they are covered on steady state line flow. Hereafter, these alternations would control the entire and available transfer capability by demanding higher safety limitations. Here these electromechanical approaches of fluctuations are generally poorly damped which may rise the risk of instability of power system. Consequently in order to sustain the stability of the complete system it is critical to damp the electromechanical alternations as soon as conceivable.

Various kinds of approaches also suggested alleviating the deviations in the power system. Since many years the power system stabilizer is one of the conventional equipment’s utilized to damp out the fluctuations. It is clear that during some different operational situations. The power system preservative may not remove the fluctuations effectively. Therefore the other effective alternatives are desired in extra to power system stabilizer. The advent of Flexible AC Transmission System (FACTS) equipment's has led to a modern and more adaptable strategy to maintain the power system in a required way. FACTS controllers deliver a set of remarkable abilities such as power flow control, reactive power balance, voltage profile guidelines, damping of fluctuations, and so onward. The static synchronous series compensator (SSSC) is one of the series FACTS devices based on a solid state voltage source inverter which produces a manageable ac voltage in quadrature with the line current. Like this way the SSSC matches as an inductive or capacitive reactance and hence maintains the power flow transfer in the transmission lines. In authors have established the damping function for the SSSC. It is a familiar fact that by appropriately designing an auxiliary power fluctuation damping controller the SSSC would be capable of destroying the instabilities as an ancillary duty.

Here in this collected works various kinds of approaches are also suggested to design a POD controller for SSSC. For example authors have utilized the phase balance technique to improve a additional damping controller for SSSC. Here the important difficulty associated with these approaches is that the control procedure is based on the linear zed machine design. The other regularly utilized method is the proportional Integral (PI) controller. Even though the PI controllers proposal simplicity and ease of constructional design their operating characteristics depreciates when the system operating points vary extensively or large instabilities happens. Now in this operating situation some novel steadying control explanations for power system have been explained. Newly the fuzzy logic controllers (FLCs) have appeared as an capable tool to circumvent these disadvantages.

A novel Fuzzy Logic Controller incorporates qualitative and quantitative knowledge about the system operating characteristics through some grading. So as to advance more accurate fuzzy logic affords a general concept for description and quantity of systems. The entire fuzzy logic systems encode human reasoning into a program in order to attain at conclusions or to regulate a system. The effective Fuzzy logic contains fuzzy sets which are a way of demonstrating non statistical improbability along with estimated reasoning and in fact consist of the operating conditions utilized to make suggestions. There are some documents which have authenticated the successful application of Fuzzy Logic Controller for transient permanence improvement of a power system. The Limying charone have utilized fuzzy supplementary controller with the purpose of accomplishing low frequency fluctuations damping.

II.POWER SYSTEM MODELING

Here in this section is dedicated to abstract an particular linearized Heffron-Phillips design model for the inspected power system. As represented in Fig. 1 a single machine infinite bus (SMIB) system connected with SSSC is measured as the sample power system. In the following figure XT is the transformer reactance and XL resembles to the reactance of the transmission line. And also V_t and V_b denotes the generator terminal voltage and infinite bus voltage respectively. A simple SSSC comprising of a three-phase GTO based voltage source converter is combined in the transmission line. It is expected that the SSSC operating performance is based on the very familiar pulse width modulation methodology. The operating principle of SSSC is the transformer leakage reactance VINV is the series injected voltage CDC is the common DC link capacitor VDC is the voltage at DC link m is amplitude modulation index and y is the phase angle of the series inserted voltage.

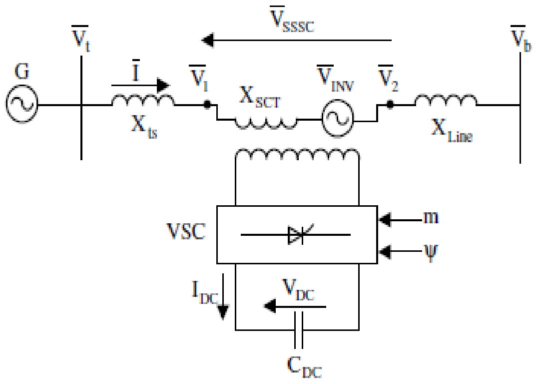


Fig. 1 A Single Machine Infinite Bus Power System with A SSSC

2.1Nonlinear Dynamic Design of the Power System with SSSC

As the initial step a nonlinear dynamic design model for the investigated system is derived by omitting the resistance of all the components along with generator, static transformer, and transmission line and series converter transformer line and series converter transformer.

III.DESIGN OF DAMPING CONTROLLERS

Targeting to damp the low frequency fluctuations two sorts of damping controllers are considered and compared with each other. In the examined system as stated earlier the SSSC series converter amplitude modulation index namely m affords a control signal to yield better damping of variations. In the consequent segments each controller is individually discoursed in detail.

3.1 Conventional Proportional-Integral (PI) Controller

The various kinds of damping controllers are designed so as make available an extra electrical torque in phase with the speed abnormality in order to improve the damping of fluctuations in Fig. 2 shows the traditional PI controller arrangement. With respect to this figure it can be observed that the first block compares the generator rotor speed with the mention speed. In the sequel the error is served to a Proportional Integral controller to generate the appropriate amplitude modulation index for the SSSC converter. There are many different approaches to design PI controllers such as try and error method pole-placement, Ziegler Nichols and so forth. In this investigation try and error method is used to fix proper values for PI controller gains.

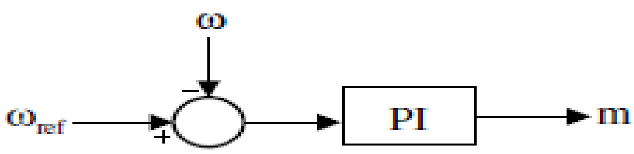


Fig.2 Traditional PI Damping Controller

3.2 Auxiliary Fuzzy Logic Damping Controller

A described in the earlier sections though the PI controller's proposal simplicity and ease of constructional design their operating performance depreciates when the system operating situations differ extensively or large instabilities occur. Accordingly to certify the operative performance of damping controller over extensive range of system processes and also to enhance the transient stability of the system a supplementary fuzzy logic controller (FLC) depend on the Mamdani's fuzzy inference technique is developed for the SSSC input. A Fuzzy

Logic Controller produces the essential small change for amplitude modulation index to control the magnitude of the inserted voltage. The centroid defuzzyfication method was used in this fuzzy controller.

Fig.3 determines the Fuzzy Logic Controller design structure. Now In this case a two input and one output Fuzzy Logic Controller is measured. The input signals are angular velocity abnormality (D_w) and load angle abnormality (D_d) and the subsequent output signal is the amplitude modulation index (Dm) for SSSC converter.

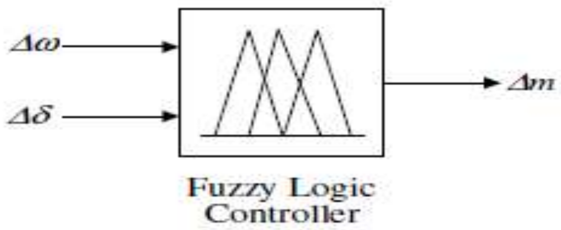


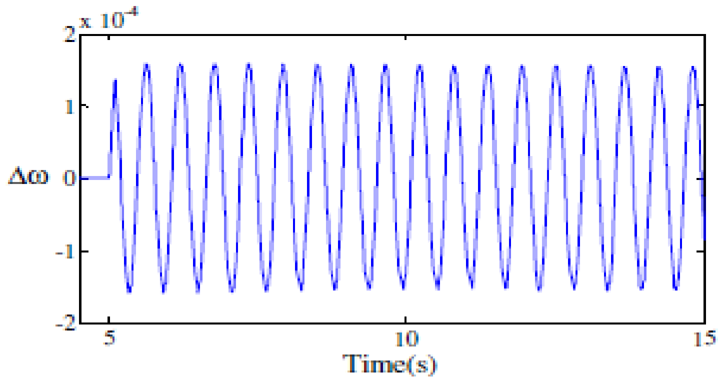
Fig. 3 Fuzzy Logic Damping Controller Structure

The accessible FLC has a very simple in constructional design structure. Here we can measure the membership functions of the input and output signals are presented in following. There are two various kinds of linguistic variable for each input variable comprising ‘Positive’ (P) and ‘Negative’ (N). And also the output variable there are three linguistic variables specifically ‘Positive’ (P), ‘Zero’ (Z), and ‘Negative’ (N).

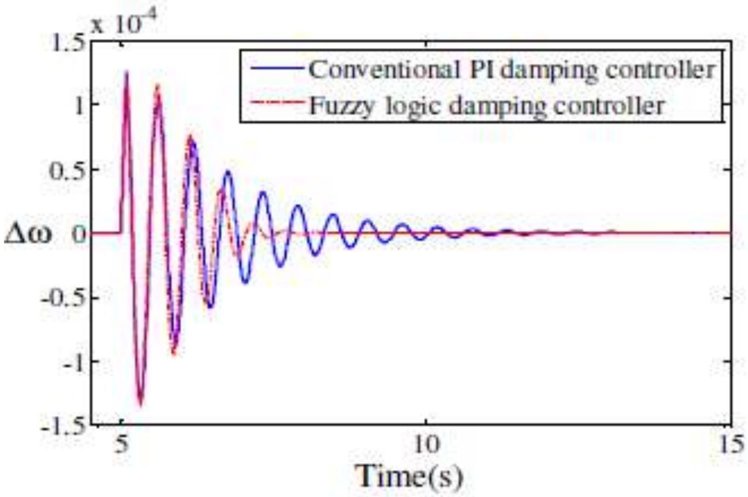
IV.SIMULATION RESULTS AND DISCUSSION

For the purpose to compare the suggested fuzzy logic damping controller performance with the traditional PI damping controller some beneficial simulations are conveyed. The eventuality simulated is a step change in mechanical power ($DPm = 0.01$) which ensues at t=5sec and lasts for certain time as 0.1 sec.

In the start the SSSC has no damping controller. For this case the angular velocity abnormality and also the load angle abnormality responses are displayed in Fig.4. This figure exposes that when there is no damping controller the Low Frequency Oscillation damping is very poorlater an auxiliary damping controller is basicallymandatory to increase the transient stability of the system.



In the second case simulations are executed with the same contingency in mechanical power but the SSSC has been prepared with a damping controller. The Simulation results are presented in following Fig. With respect to this figure it is expected that the fuzzy logic controller displays improved damping than the traditional PI controller. Similarly the power system transient stability is improved when the SSSC is prepared with the fuzzy logic damping controller. The Simulation results authenticate the efficiency of the recommended fuzzy logic damping controller and its enhanced performance is highlighted.



V. CONCLUSION

This paper functions an exact exploration to achieve a whole linearized Heffron-Phillips prototype for a single machine infinite bus power system prepared with an SSSC to study Low Frequency Oscillations damping with an auxiliary Fuzzy Logic Controller. It was exposed that a contingency in power system will cause to initiate power instabilities. Here in this sequel two various kinds of controllers specifically the traditional PI and the Fuzzy Logic Controller were calculated to damp the system fluctuations. The proportional study between the Fuzzy Logic Controller and PI controller demonstrations that the recommended Fuzzy Logic Controller has greater operating performance and effect in transient stability improvement and alternations damping. The Simulation results authenticate the efficiency of the recommended fuzzy logic damping controller and its improved operating performance is highlighted. Subsequently the fuzzy logic controller would be a enhanced opportunity in the design of damping controllers.

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