Advanced Simulation Modeling For Control Damping Oscillations in SMIB System With UPFC based On Hybrid Fuzzy Logic and PID Controller

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Abstract— In this paper we are describing about the recently transmission network reason the power system to be complex and stressed out. Due to the stress in the power system there is a chance of down the stability during the fault. Power system over the globally become complex every day. we have continues requirement of secured, stable, economic, controlled and better quality of power. When the fault occurs in the power system the whole system goes to severe transients. By using FACTS device like UPFC we can easily stabilize the system, suppress the power system oscillations and control active and reactive power also of the system. UPFC is mount in a single-machine infinite bus system to suppress low frequency oscillations. In it we analysis the behavior of power system with hybrid fuzzy logic –PID based UPFC. And simulate the model of UPFC based hybrid PID-FUZZY logic controller and UPFC connected SMIB system. This is very much useful to control power flow as well as damping out the swing of the system during fault.

Keywords—SMIB, UPFC(FACTS), fuzzy logic controller, PID controller

Introduction

Presently power system to be complex and stressed out. power systems over the global becoming complex day by day and constant necessities are coming for steady, secured, controlled, cost-effective and better excellence power.Power transfer capability in transmission system is inadequate due to different factors like steady state stability limit, thermal limit, transient stability limit and system damping. one of the main criteria, deciding the power system operation is its stability. stability of the power system is the capability to sustain the machines connected to the system in synchronism. However trouble always happen either due to the rapid addition or removal of load, short circuit of lines, lightning etc.

Flexible AC transmission system and distributed flexible ac transmission system presents possible and cost-effective result to these troubles and so these devices are necessary to use global for improving presentation of power system. development in semi-conductor electronics have helped in the growth of new control technologys for stability improvement, which contains the use of facts controllers [1].

Facts controllers are high power electronic controllers, which can be useful individually or collectively in power system, to manage the line parameters like series and shunt impedances efficiently.facts devices improve the stability of the power system with its rapid control characteristics and constant compensating ability[5].

The manage of power flow and raise in the transmission capacity of the presented transmission lines are the two main purpose of facts technology [3]. Unified power flow controller is one such facts device, able of improving the dynamic control of real and reactive power flow. UPFC is the component of facts family that has emerged for the controlling and the optimization of power flow in the transmission systems. all the constraints of the power transmission line (impedance, voltage and phase angle) can be controlled at the same time by upfc [1]. in accumulation, it can execute the control function of the transmission line real/reactive power flow, upfc bus voltage and the shunt-reactive-power flow control [2].

Both the series and shunt converters use a voltage-sourced converter (vsc) linked on the secondary side of a coupling transformer. both the converters equally contribute a wide range of control of both the real & reactive power in the transmission lines,

As a result, upfc is to control the active and reactive power flow during the transmission line. it is widely traditional that the UPFC is not able of damping the oscillations with its normal controller.A well-designed upfc controller can not only raise the transmission capability but also improve the power system stability. In it we simulate the model of upfc based hybrid fuzzy logic and PID contoller and compare the performance of upfc based damping controllers with and without fuzzy logic and pid controller technique.

II. Single Machine Infinite Bus System (SMIB system)

This coordination consists of a synchronous generator which is connected infinite bus system through a transmission line. It is seen that the single machine connected to the infinite bus always disturbed with the frequent load change and it may leads to be serious stability problem

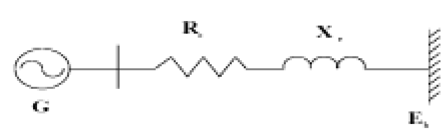

Fig. 1. SMIB SYSTEM

III. UNIFIED POWER FLOW CONTROLLER (UPFC)

Unified power flow controller (UPFC) is a combination of static synchronous compensator (STATCOM) and a static synchronous series compensator (SSSC) which allow bi-directional flow of real power between the series output terminals of SSSC and the shunt output terminals of the STATCOM via a common dc link and are controlled to provide concurrent real and reactive series line compensation without an external electrical energy source [6].

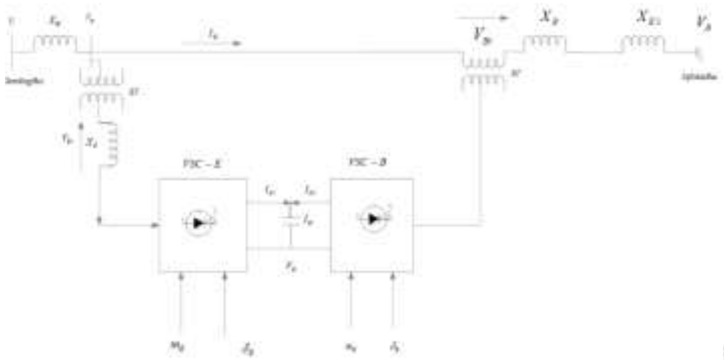

Fig.2 UPFC installed in SMIB system

IV. FUZZY LOGIC CONTROLLER (FLC)

To maintain the stability, the output of obtained model reference of power system is compared with output of real power system and the error signal is fed to a fuzzy controller to damp out system oscillations [7].

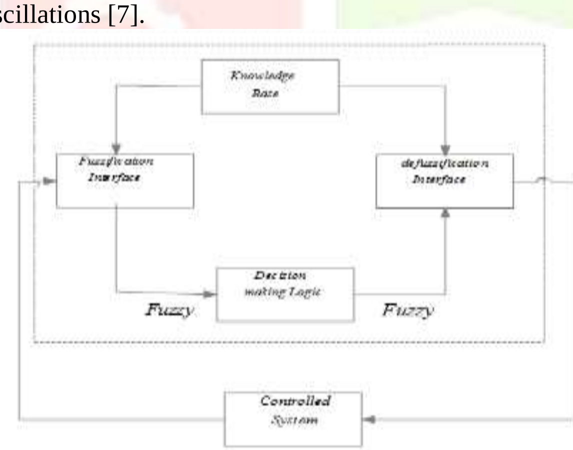

Fig.3.Basic structure of fuzzy controller

The Fuzzy controller provide stabilizer signal in order to damping system oscillations. FLC work on the principle of simple understanding of the system behavior of a person and simple rule based "If x and y then z", this rule base again defined by some membership function of FLC with proper argument to improve the system performance [8] [9] [10].

The UPFC with Fuzzy controller is shown in the figure. imprecise, noisy, or lost input information FLC work on the principle of simple understanding of the system behavior of a person and simple rule based "If x and y then z", this rule base again defined by some membership function of FLC with proper argument to enhance the system performance [8] [9] [10]. The UPFC with Fuzzy controller is shown in the figure.

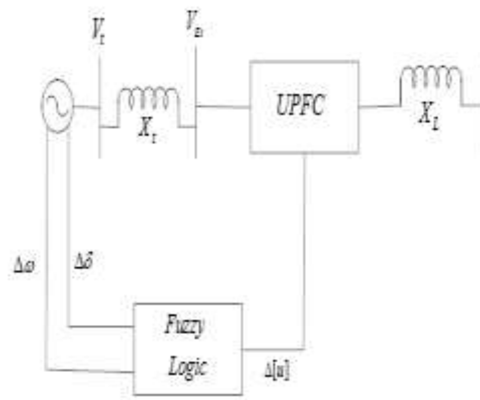

Fig.4: UPFC with Fuzzy logic controller

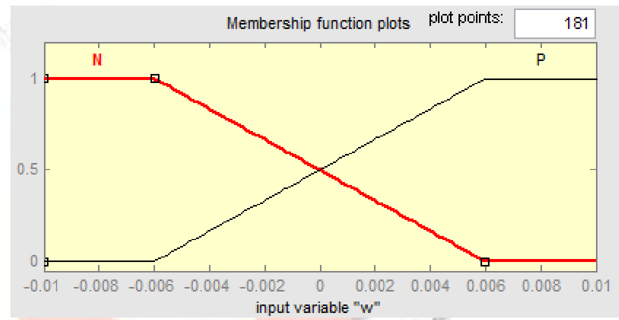

Fig. 4(a): Membership function of Error signal

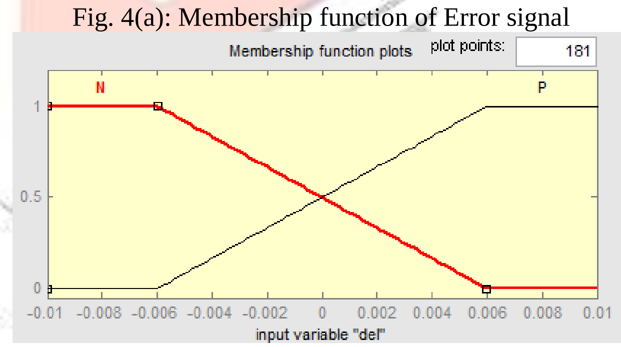

Fig. 4(b): Member function of Derivative signal

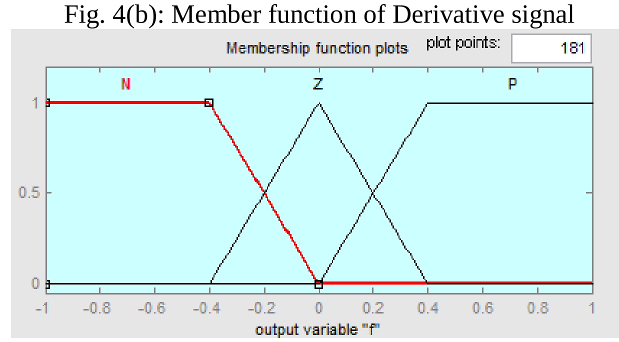

Fig. 4(c): Membership function of Output

The Rules used in this controller are chosen as follows:

If Δω is P and Δδ is P then Δ[u] is P.

If $\Delta\omega$ is P and $\Delta\delta$ is N then $\Delta[u]$ is Z.
If $\Delta\omega$ is N and $\Delta\delta$ is P then $\Delta[u]$ is Z.
If $\Delta\omega$ is N and $\Delta\delta$ is N then $\Delta[u]$ is N.

- A Fuzzyfication is a process in which we can alter the input data into linguistic variable.
- A Knowledge Base which contains the data base with the required linguistic definitions and control rule set.
- A Defuzzyfication interface which yields a non-fuzzy control action after an incidental fuzzy control action.

VI. MODELLING OF SMIB WITH UPFC

The small-signal stability of a SMIB system is seen that the Single Machine connected to the infinite bus always concerned with the frequent load change and it may leads to be serious stability problem and should be discussed. Exploration of SMIB provides physical perception of the small but Low Frequency Oscillations. The SMIB system directly involves to the study of LFO .If proper damping is not supplied to the system then the small oscillation leads to create a savior instability problem.
These paper also investigate the impact of UPFC with SMIB system under low frequency oscillations by providing suitable damping signal using PSS. By picking proper control parameter i.e. speed and angel deviation as a input function and using the knowledge base of the system performance with mamdani interface damping signal which can effectively reduce the system oscillation. And a compression study is made to see the effectiveness of these controllers [16-17].

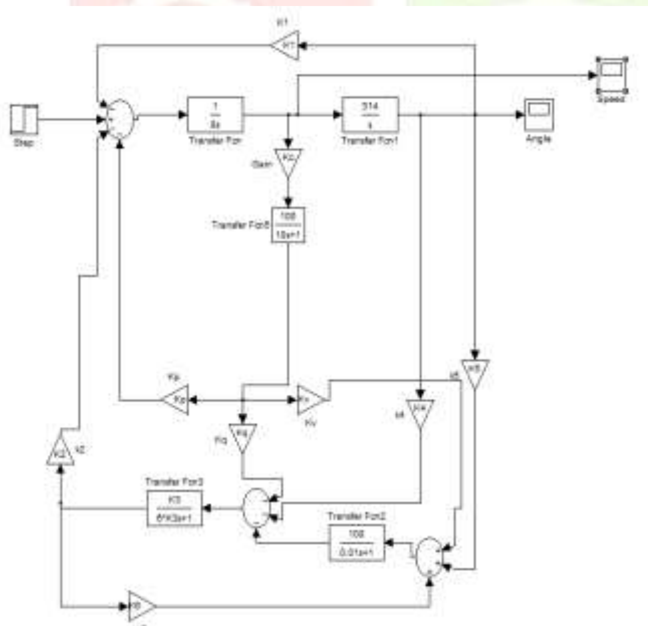

Fig.5: Simulink Model for SMIB power system with UPFC

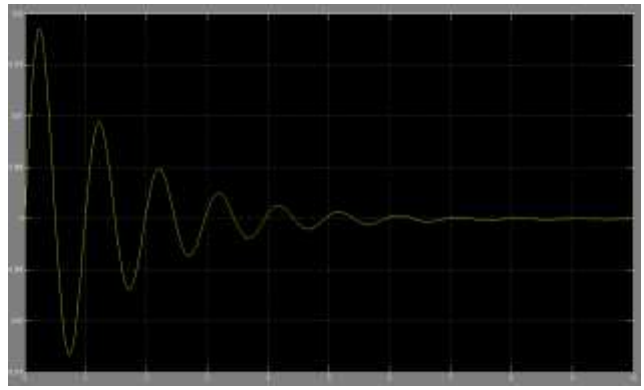

Fig.6: Speed Deviation for SMIB power system with UPFC

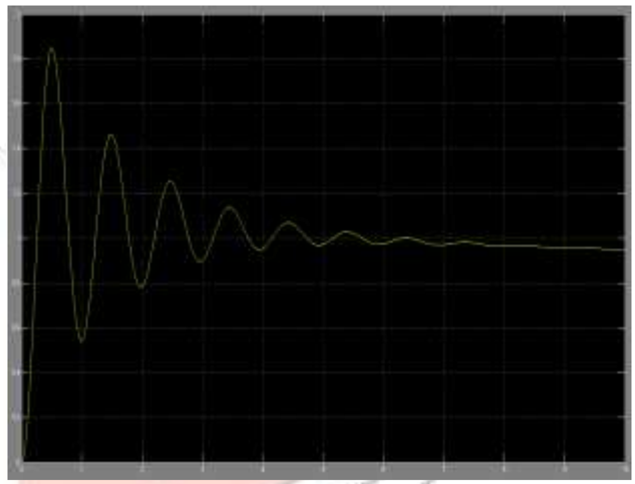

Fig. 7: Angle Deviation for SMIB power system with UPFC

7. MODELLING OF SMIB USING UPFC BASED HYBRID FUZZY LOGIC-PID CONTROLLER

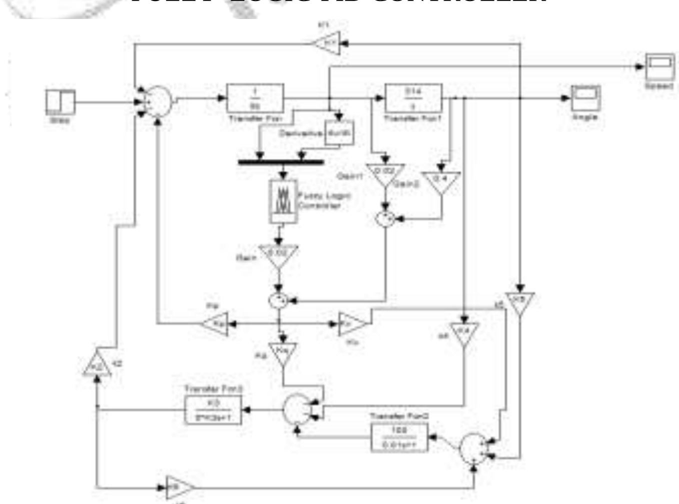

Fig.8: Simulink Model of SMIB Using UPFC Based Hybrid Fuzzy Logic-PID Controller

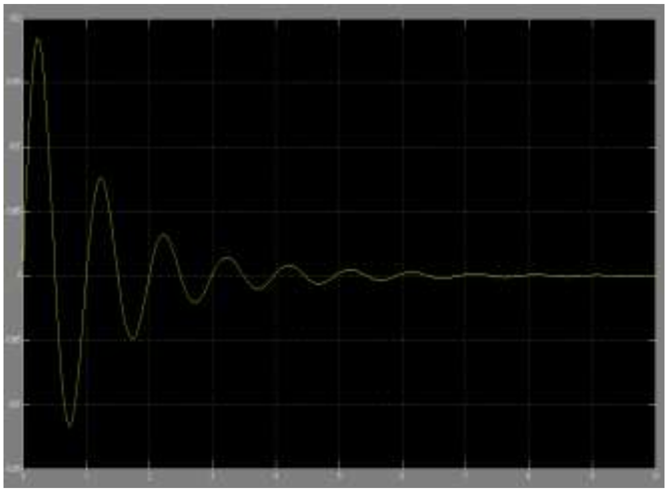

Fig. 9: Speed Deviation of SMIB Using UPFC Based Hybrid Fuzzy Logic-PID Controller

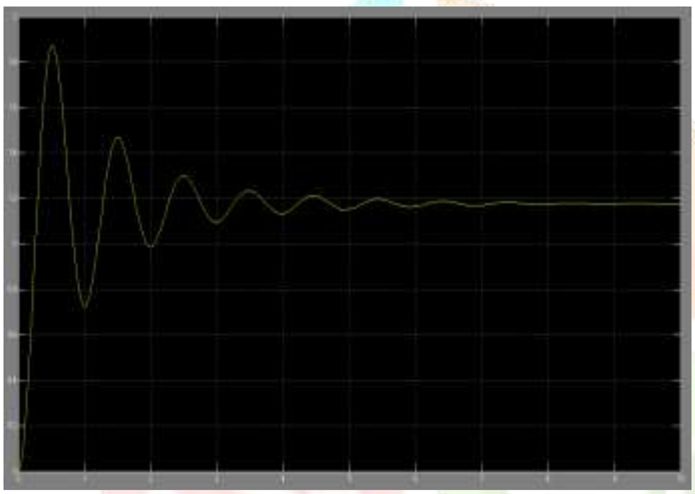

Fig.10: Angle Deviation of SMIB Using UPFC Based Hybrid Fuzzy Logic-PID Controller

VII. CONCLUSION

A systematic approach for designing UPFC based PID-fuzzy logic controllers for damping oscillations of power system shown. Response of PID- fuzzy logic based UPFC is better than UPFC based SMIB system. Which is shown by output graph in fig.[6][7][9][10]. Output coming from UPFC based PID- fuzzy is more smooth and stable than UPFC. It is observed from the output graph hybrid fuzzy logic PID based UPFC controllers significantly damp power system oscillation compared to the conventional fuzzy logic UPFC.

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10. Appendix

The nominal parameters and the operating condition of the system are given below.

Power system data:	Operating condition :
T_{do}=5.046s X_d=1.01 pu X_q=0.6 pu M=2H=8.0 MJ/MVA D=0.0 K_a=110 T_a=0.02s	V_t=1.0 pu V_b=1.0 pu f= 50 Hz