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Power Flow Control in Power System with UPFC

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Abstract: **UPFC is one of the most widely used FACTS devices. To control (Kw) and (Kvar) in power system FACTS devices are commonly used. In this paper case study of 9 bus system is studied under the symmetrical fault i.e. three phase fault in MATLAB Simulink. Active power, reactive power and rotor angle, angular speed during the fault is studied. Also compared power in nine bus system using PI and Fuzzy controller. Using Fuzzy controller power oscillations damp out.**

Keywords: **MATLAB-Simulink, UPFC, Transient stability.**

I. INTRODUCTION

In recent year the technology is advances so that transmission network reliable and easy to design. There are many technologies in interconnected power system such as, HVDC and EHVAC. On other side as power system network grow, the interconnected network become increasingly more composite to operate and system can be less protected for riding through the major outages. The power system interconnected network of today is large and complex. There is widely use of microelectronic, computers and high speed communication for control and protection of present interconnected system.

The main purpose of FACTS is to improve system controllability and to increase power system bound by using power automated devices. Generally, FACTS devices are more expensive than HVDC devices.

In case study consists of 3 generators nine bus system having three load and three transformer. The single line diagram of nine bus system as shown in fig. 1.It is simple diagram of power system to analyzed dynamic behavior and also power oscillation damping. In this system three phase fault is occurs at bus 8.Duration of fault time is 4 to 4.1 sec. After 4.1 sec. the fault is remove system try to maintained stability, also active power, reactive power and bus voltage of different buses is calculated.

II. ASSUMPTION IN TRANSIENT STABILITY

I) Mechanical input is given to the synchronous generator will be constant.

II) Effect of damper winding can be neglected.

III) The voltage at generator and at the bus are assumed to be constant.

IV) Angular velocity of synchronous machine will be assumed as constant.

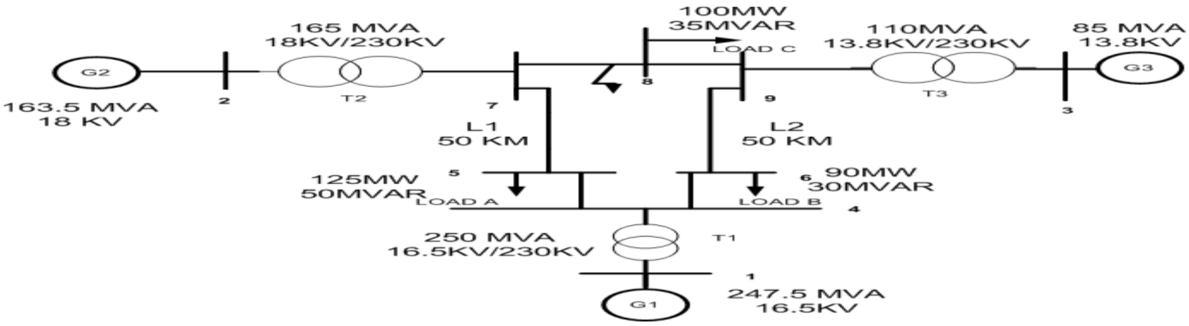

Fig.1 Single Line Diagram of 9 Bus Systems

Single line diagram consist of 9 bus power system having generator, load, transformer and transmission line having length 50km. UPFC is connected between buses 7 and 5. Duration of fault is 0.1 sec. After 4.1 sec. the fault is removed.

The main constraint in a power system i.e. line impedance (XL), terminal voltage (Vt) and rotor angle (δ). The performance of system is studied and damping of the oscillation in rotor angle (δ) and angular speed (dw) is investigated in the three machine of nine bus system.

III. UNIFIED POWER FLOW CONTROLLER (UPFC)

The UPFC consist of two converter one is series converter i.e. SSSC which inserts a voltage in series through a transformer also the series branch of the UPFC can inject a voltage with adjustable magnitude and phase angle it can interchange kw power through the transmission line and further shunt converter i.e. STATCOM , it is the most adaptable of the device. It is to control the flow of Kw and Kvar by inoculation of a voltage in series with the transmission line. Magnitude of voltage and the phase angle of the voltage can be diverse independently.

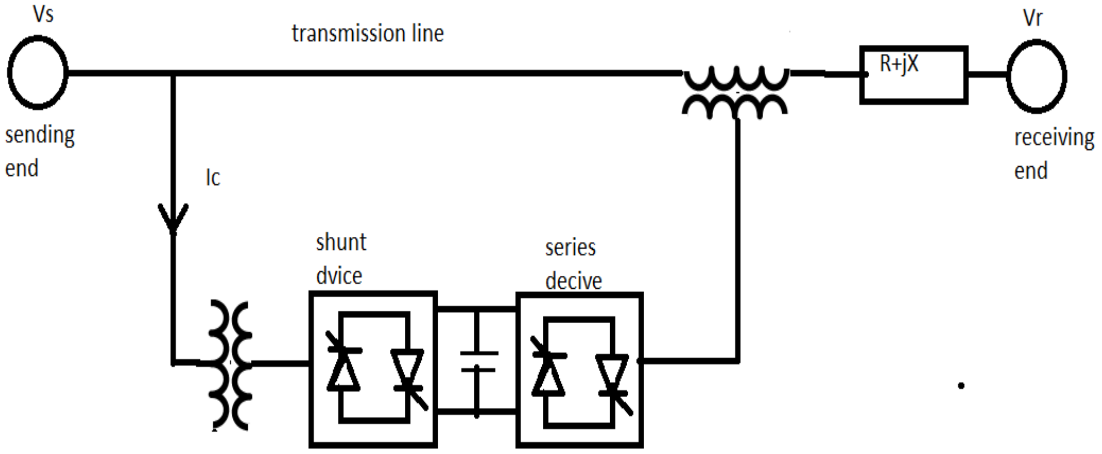

Fig.2 Schematic diagram of UPFC

Static power electronics device consist of capacitor and inductor etc. are used for compensation. So after introduction of FACT devices give a control on the compensation. FACT devices like STATCOM, SVC, SSSC etc.

IV. SIMULINK MODEL

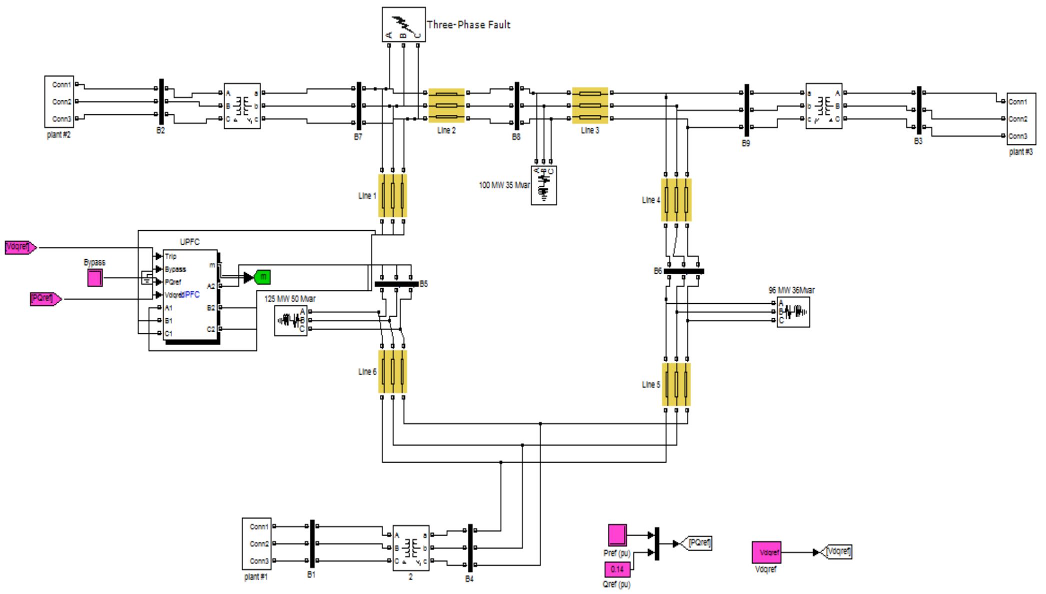

Fig.3 Simulation Diagram of 9 Bus with UPFC System

The 9 bus system contains 3 generator and 3 load . The Matlab simulation of 9 bus system is shown in the Fig.3.

V. FUZZY LOGIC CONTROLLER

The main components of a fuzzy logic controller. The three main actions performed by a fuzzy logic controller are:

•Fuzzification
•Fuzzyprocessing
• Defuzzification

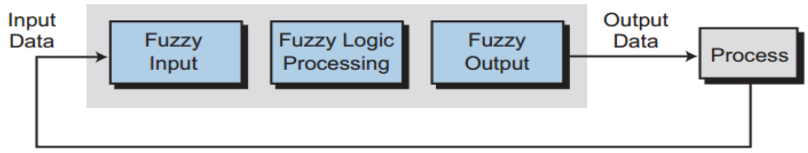

Fig.4 Fuzzy logic control system

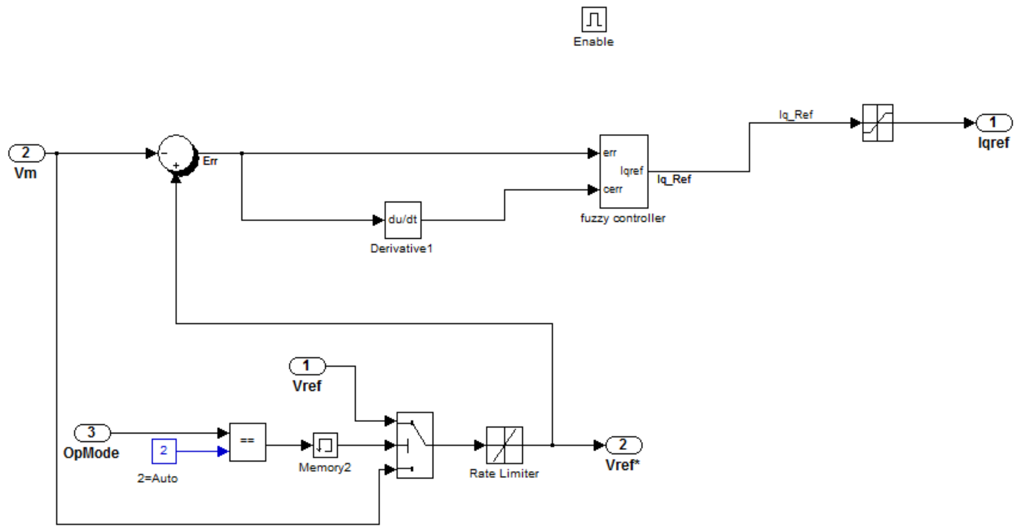

Fig.5 Fuzzy Logic Controller

In fuzzy logic controller there is one two input and one output having triangular membership function .

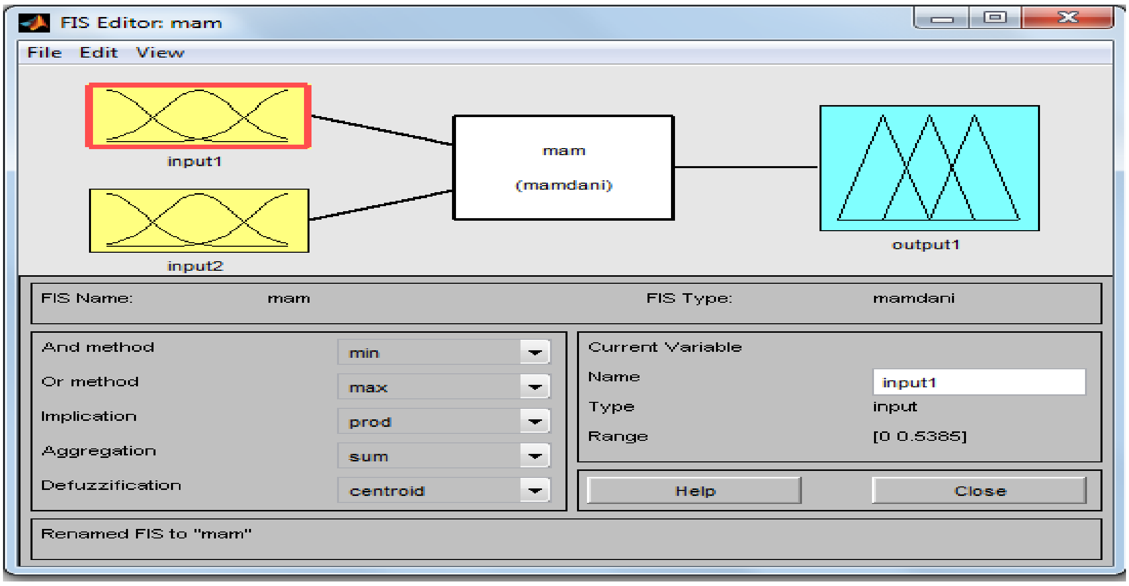

Fig. 6 FIS Fuzzy editor with 2 inputs & 1 output

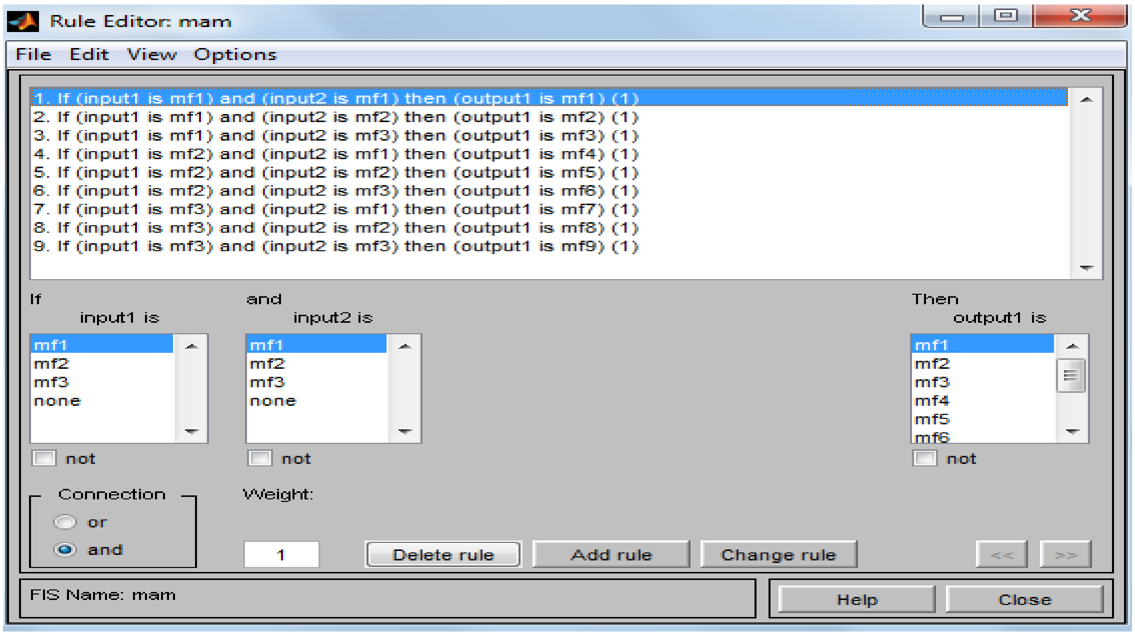

Fig.7 Fuzzy rules used in the development of the fuzzy logic coordination scheme

VI. SIMULATION RESULT

The MATLAB simulation result of the power system is shown in the figure given below. The fault takes in between 4 to 4.1 sec. After 4.1 sec the line is removed. Also Active Power, Reactive Power and Bus Voltage is analyzed.

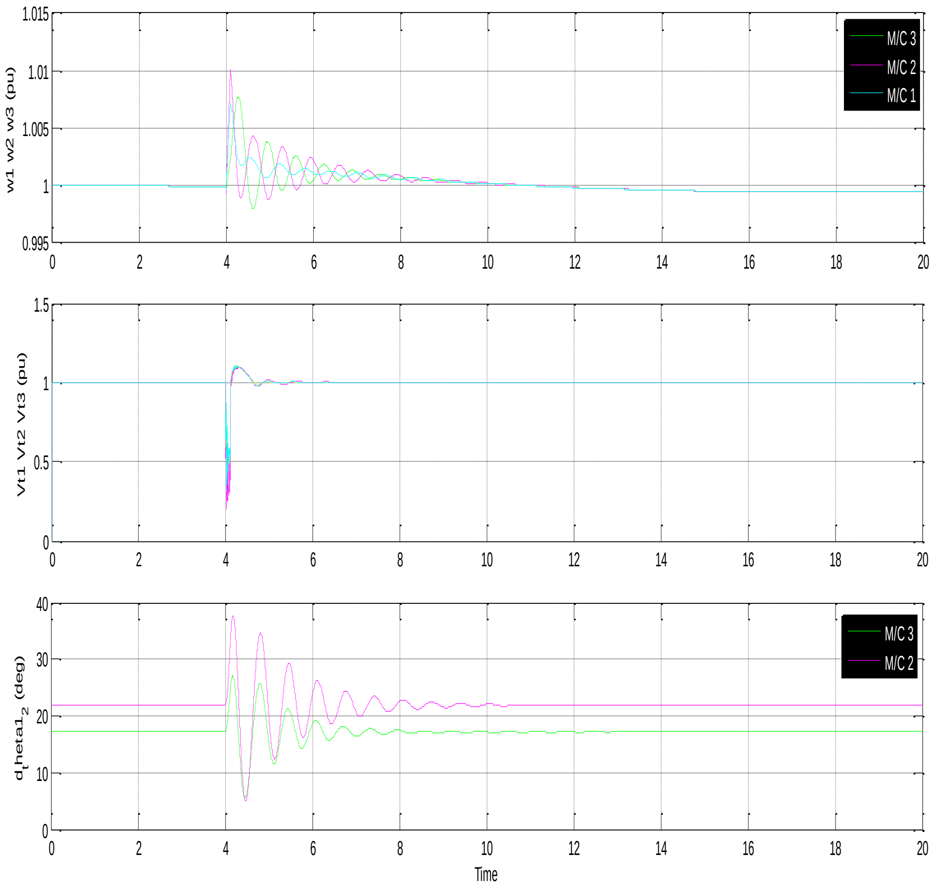

Fig.8 Angular Speed, Generator voltage and Rotor Angle without UPFC.

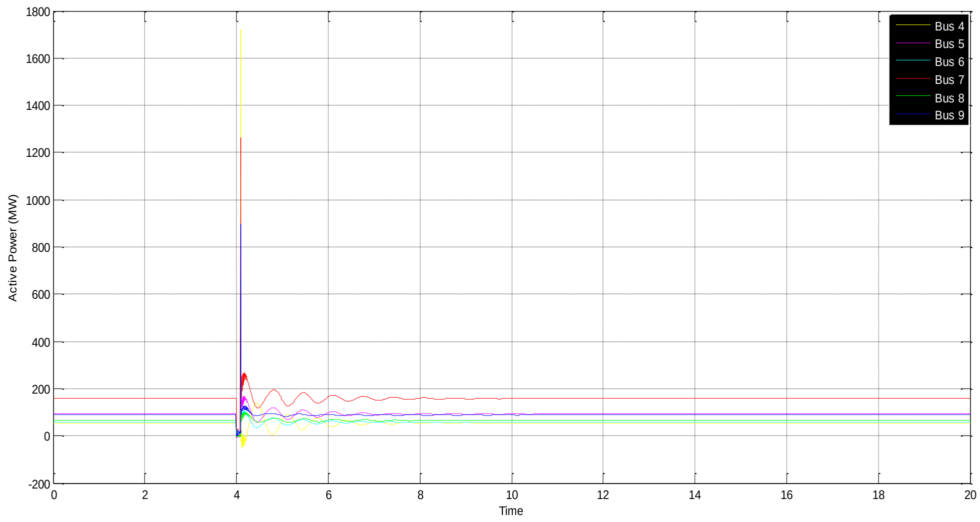

Fig.9 Active Power without UPFC

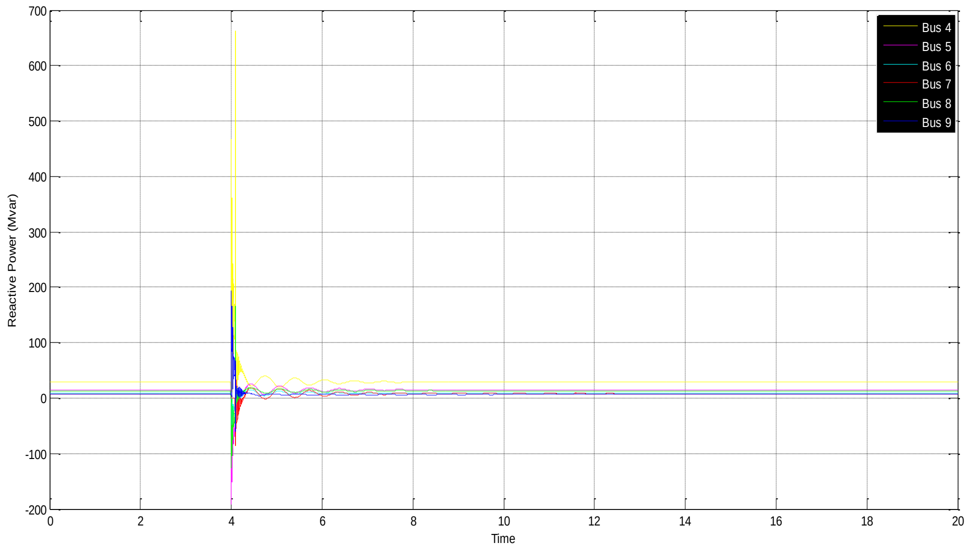

Fig.10 Reactive Power without UPFC

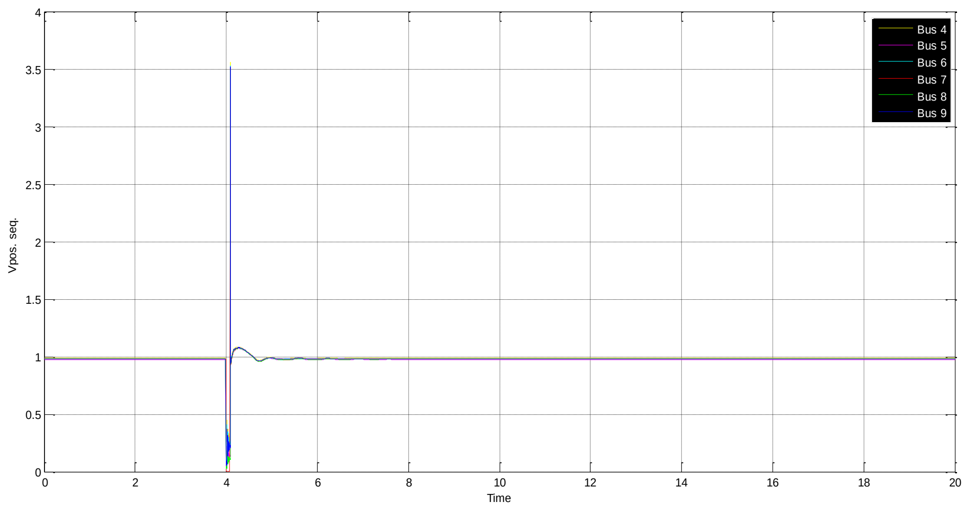

Fig. 11 Bus Voltage without UPFC

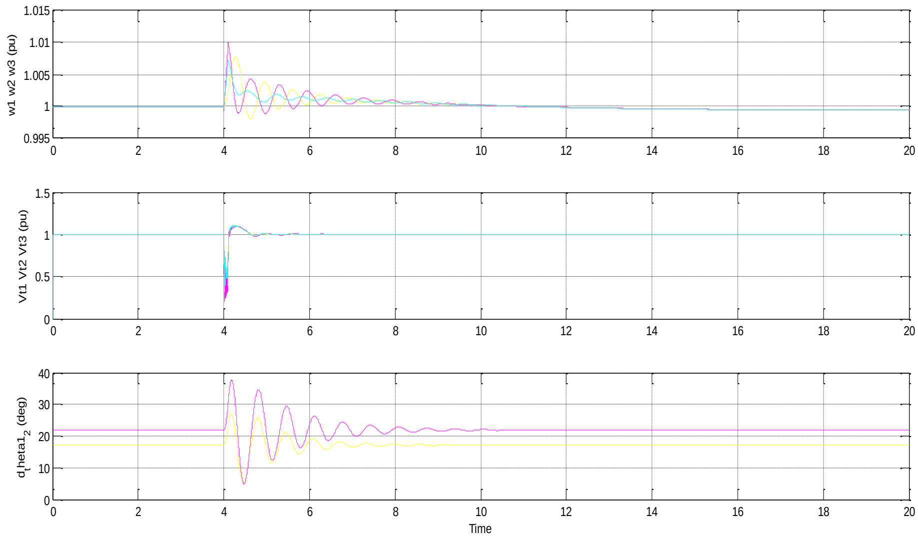

Fig.12 Angular Speed, Generator voltage and Rotor Angle with UPFC Using PI controller.

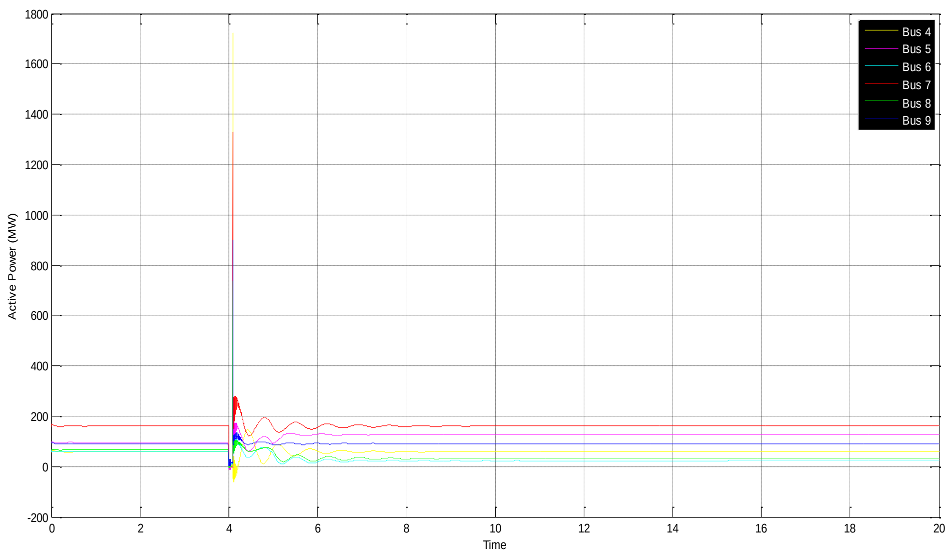

Fig.13 Active Power With UPFC Using PI controller

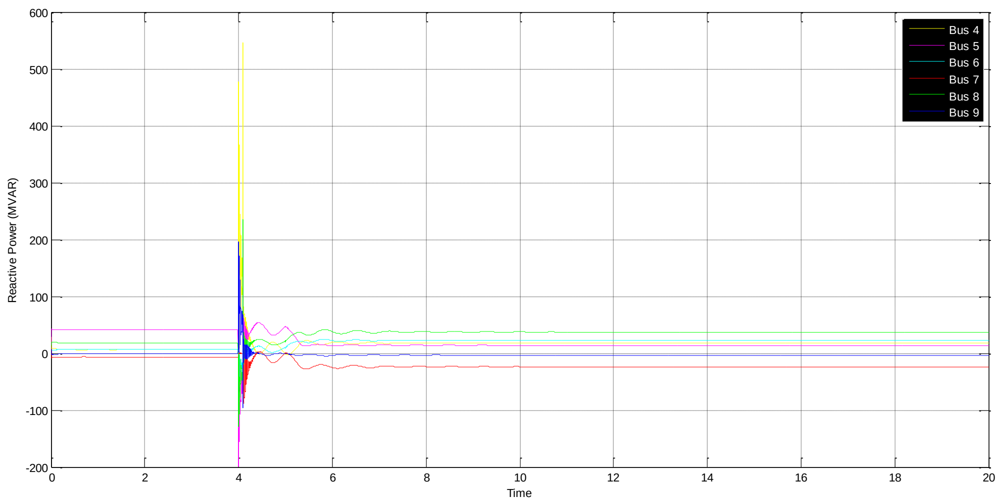

Fig. 14 Reactive Power with UPFC Using PI controller

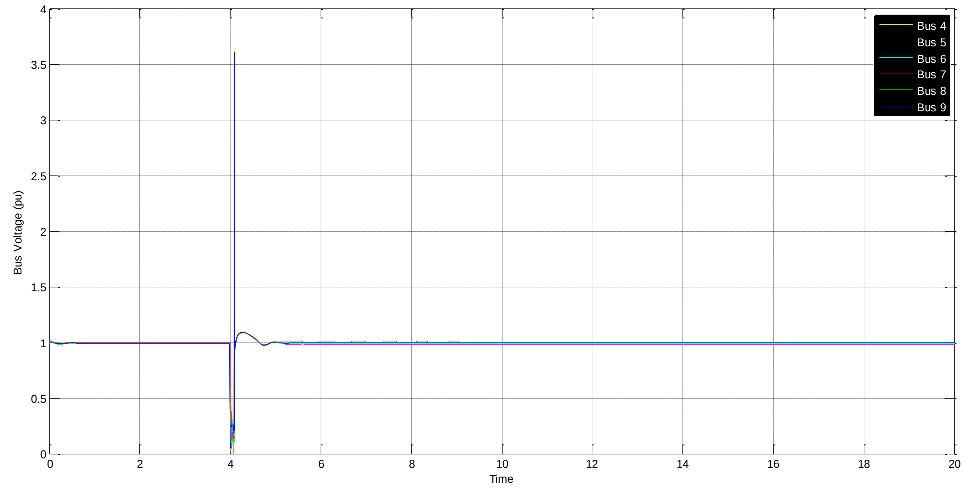

Fig.15 Bus Voltage with UPFC Using PI controller

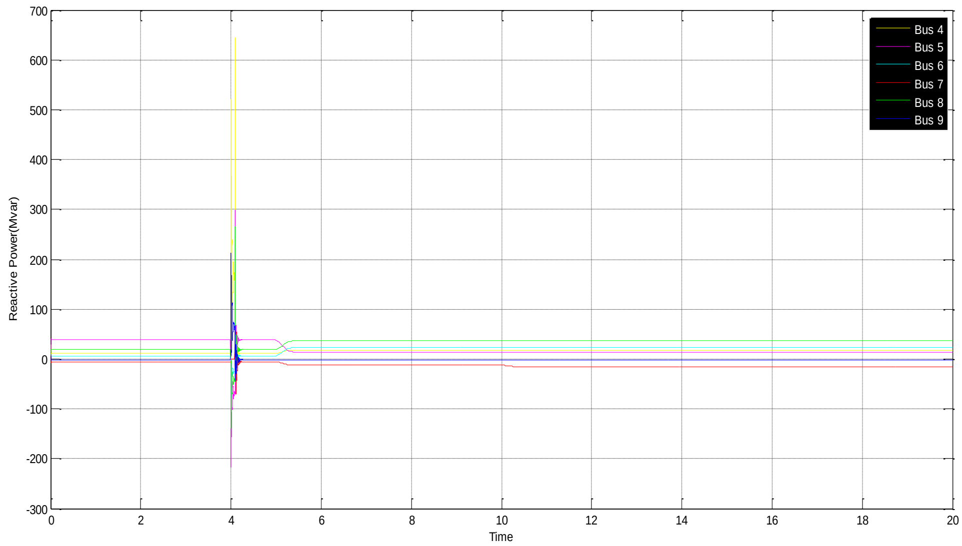

Fig. 16 Reactive Power with UPFC using Fuzzy Controller

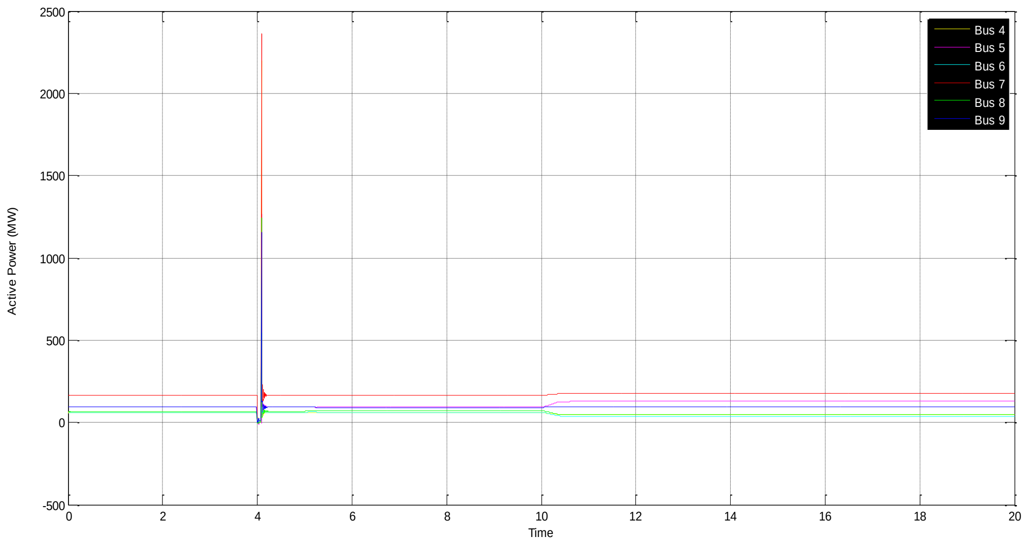

Fig.17 Active Power with UPFC using Fuzzy Controller

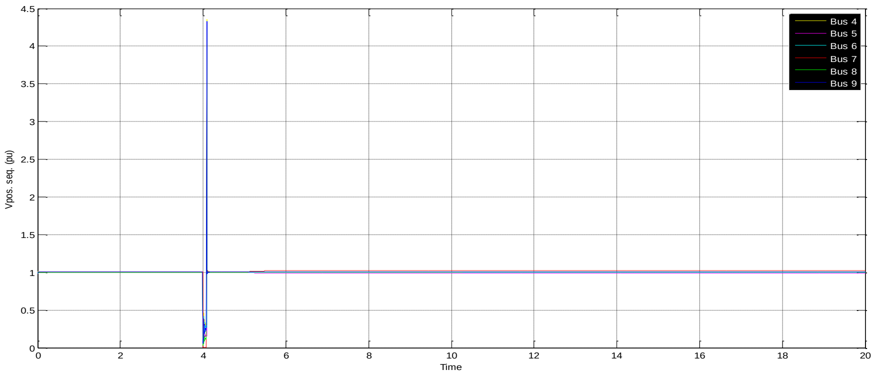

Fig.18 Bus Voltage with UPFC using Fuzzy Controller

VII. CONCLUSION

From comparative study of the relative variation in rotor angle and angular speed of the three machines nine-bus system is analysed. Also active power and reactive power and bus voltage of different buses is done. By using a UPFC we obtain better transient stability performance than the case without a UPFC. Using Fuzzy controller oscillation of system is improved as compared to PI controller. Settling time is improved.

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