Fuzzy Logic Controlled Power System Stability for Long Power Transmission Line using UPFC

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Abstract: In this study, the research is carried on a long transmission line model which is simulated by MATLAB Simulink tool for the enhancement of power system stability with improved power factor and reduction in harmonic distortion.The UPFC(unified power flow controller) which is a shunt FACT device, were used in between the transmission line at the center of T model for compensation.UPFC is a combineendeavor of SSSCand STATCOM devices and is controlled using the implementation of FLC (fuzzy logic controller) and the results shows that power factor and other parameters were improved with less distortion.

Key words: **Long Transmission Line, UPFC, Fuzzy Logic Controller, MATLAB Simulink**

I. INTRODUCTION

In the power system, the transient stabilityis the stability of the system to maintain synchronism when subjected to a severe trouble within the power line, such as a fault on transmission line, unexpected loss of generation, or loss of uncertain loadability. The power system response to such turbulencesincludes large trips of generator rotor angles, bus voltages, power flow and other system variables or components. With the invent of Flexible Alternating Current Transmission(FACTS) devices based on power electronics, excellent operating experiences available world-wide, these devices are becoming more mature and more reliable to improve the performance of long distance AC transmission. The FACTS controllers can be categorized in two different wayssuch as first variable impedance type controllers and other voltage source converter based controllers. This article considered one of the FACTS devices Unified Power Flow Controller (UPFC). UPFC is the most useful FACT device that can be used to enhance steady state, dynamicand transient stability. The UPFC is capable of both supplying and absorbing real and reactive power [1-4]. The FACT family in form of histogram is shown in Figure 1.

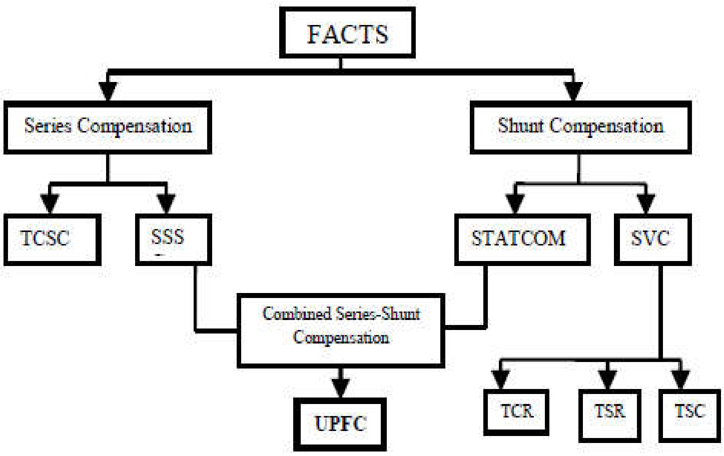

Figure 1.FACT family in form of histogram

Analysis of transient stability from with UPFC in MATLAB/SIMULINK WSCC model has been done. This paper considered three different conditions i.e. pre fault, with fault, and with UPFC (steady state, LLG fault, and after fault with UPFC).

II. CONTROL STRATEGY-UPFC

The Unified Power Flow Controller (UPFC) is the most adaptabledevice that can be employed in the power system to enhance dynamic stability and transient stability. The UPFC is capable and potential to both supplying and absorbing real and reactive power. It comprises of two ac/dc converters. The first converter is connected in series with the power transmission line through a series transformer and the other in parallel with the line through a shunt transformer. The DC link of both converters is connected through a common capacitor. It is provides DC voltage for the converter task. The power balance condition between the series converter and shunt converters is a prerequisite condition to maintain a constant voltage across the DC link. As the series branch of the UPFC is able to inject a voltage variable magnitude and phase angle. This can be interchange real power with the transmission line and thus improves the powertransmission capability of the line and its transient stability limit. Further, the shunt converter interchanges a current of controllable magnitude in order to maintain power factor angle with the power system. The UPFC is usually controlled to balance the real power absorbed or injected into the exiting power system and improve the power system stability [5-6].

III. UNIFIED POWER FLOW CONTROLLER

The circuitry of unified power flow controller (UPFC) is shown in Figure 2. To solve many of the problems facing the power delivery industry, the unified power flow controller deviseprovides multifunctional flexibility required for the real-time control and dynamic compensation of ac transmission systems.The unified power flow controllerconsists of two voltage sourced converters, using gate turn-of (GTO) thyristor valves [5].

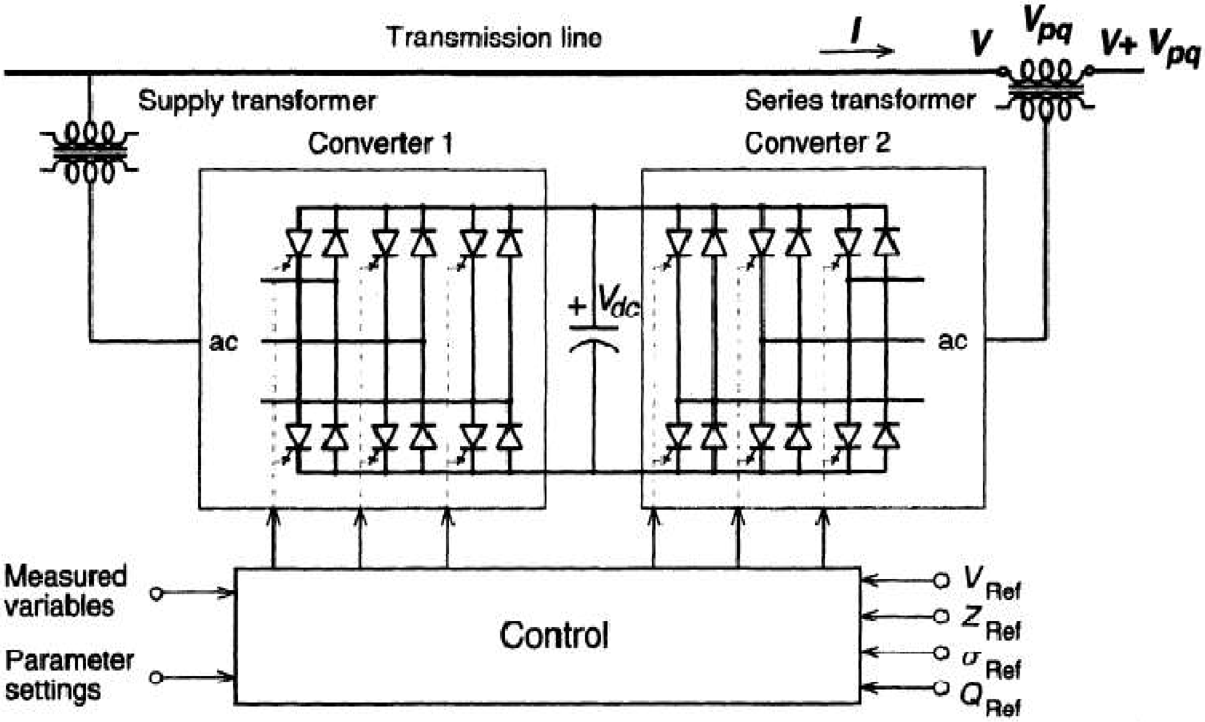

Figure 2. Unified power flow controller

Basic operating principle of UPFC

The basic terminology of UPFC is shown in Figure 3. The unified power flow controller is a unidirectional controlled device for the real-time control and dynamic compensation of ac transmission systems. This device provides multi-functional flexibility required to solve many of the problems facing the power delivery industry [5].

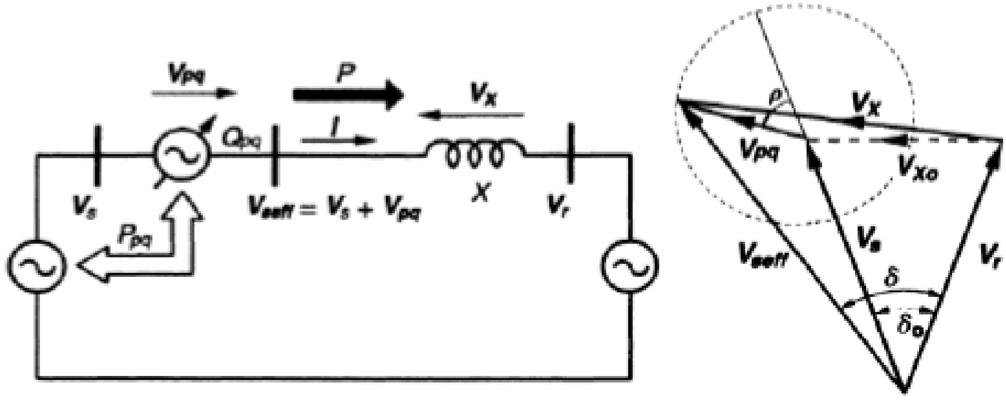

Figure 3.Conceptual representation of Unified Power flow Controller

IV. MATLAB SIMULATION MODEL

The developed Matlab Simulink model is shown in Figure 4.

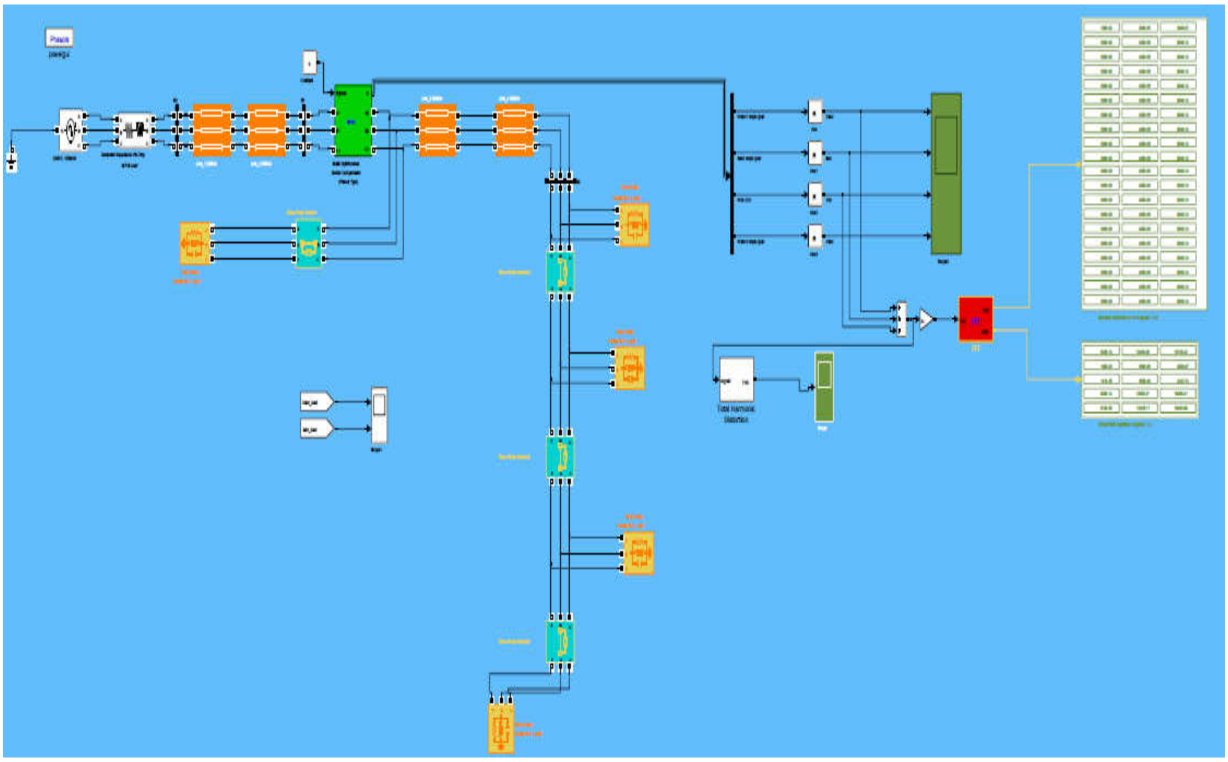

Figure 4. Simulation model used for analysis

The UPFC is introduced in the middle of the line in the atdeveloped Matlab Simulink model as the most nominal place in the T model of installation strategy. A 230 kV ,100 MVA source is taken for a long transmission line of 800 km. the line resistance per unit length is considered as [0.01273 0.3864] ohms/km [N*N matrix] or [R1 R0 R0m] in per unit, the line inductance per unit length is [0.9337e-3 4.1264e-3] H/km [N*N matrix] or [L1 L0 L0m] and the line capacitance per unit length is [12.74e-9 7.751e-9] F/km [N*N matrix] or [C1 C0 C0m] for each 200 km length. In this long transmission line parallel R-L-C load is connected which is introduced in different steps as no load, half load and full load.

V. RESULT ANALYSIS

The matlab simulated model and their results with PI controller and fuzzy log controller based are shown in Figure 5 and Figure 6 respectively.

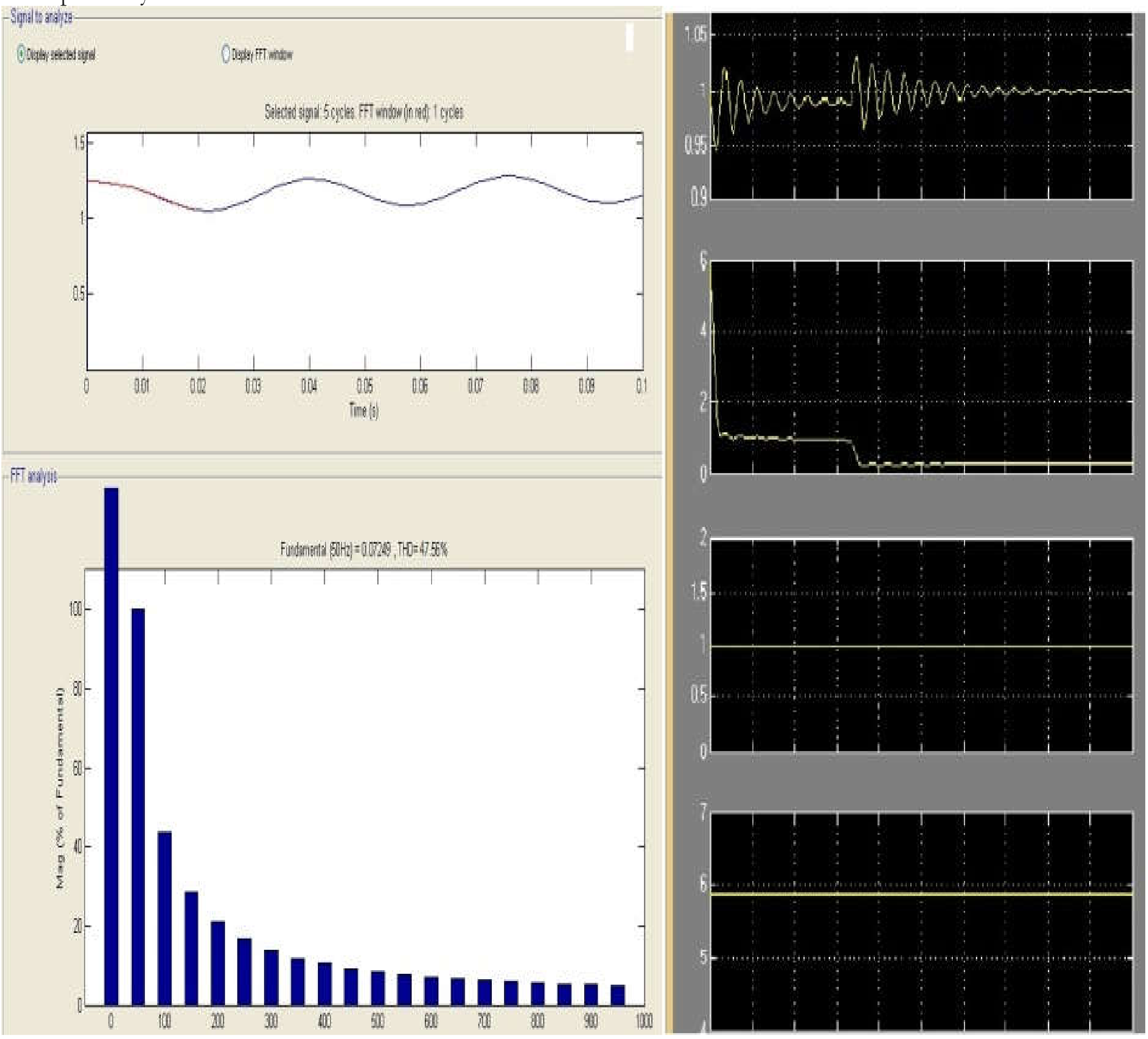

Figure 5. Results showing with UPFC PI controller

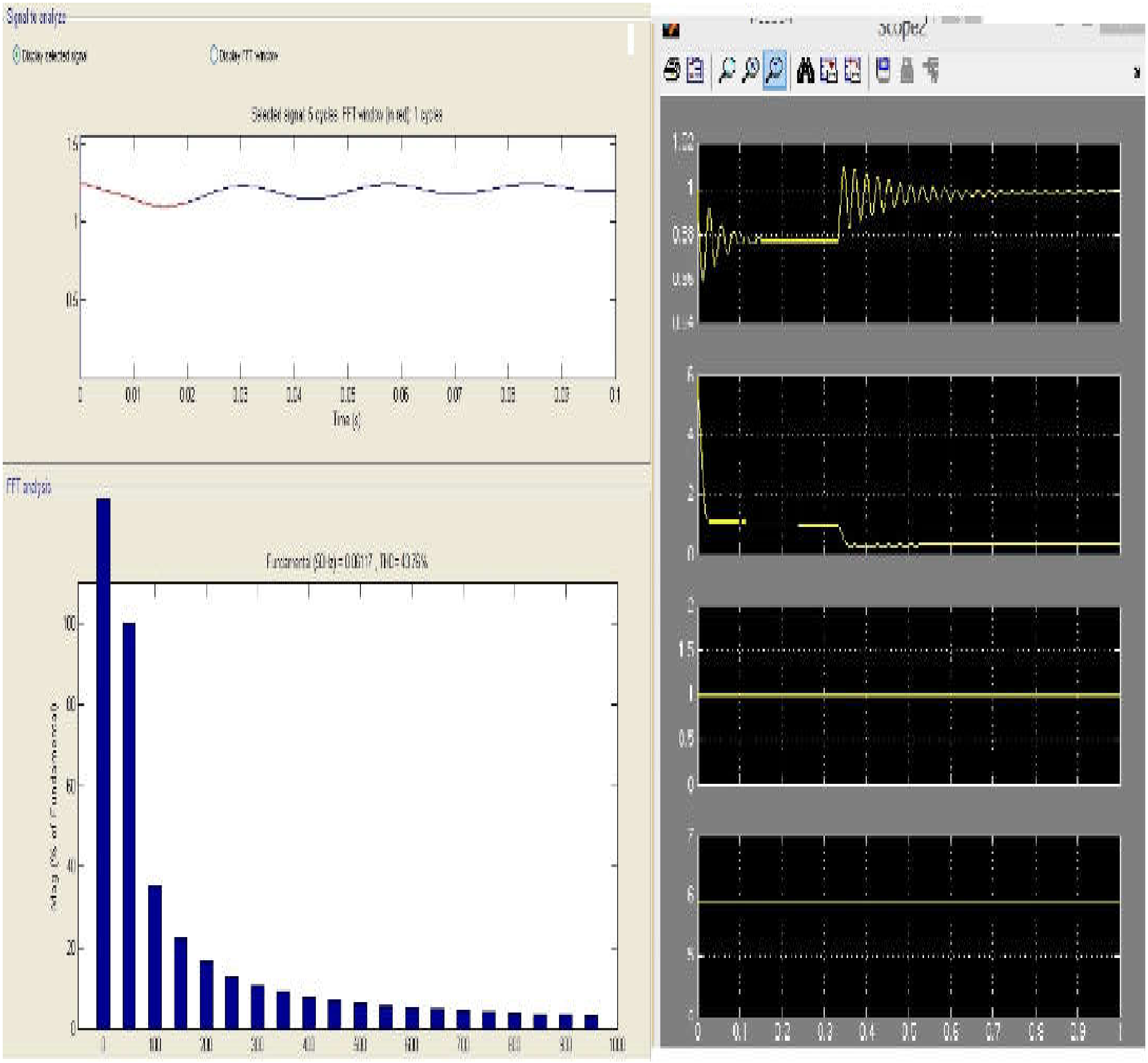

Figure 6. Results showing with UPFC fuzzy logic controller

Analysis:

1. It can be clearly seen in Figure 5 and Figure 6 that the fast settlement of system is in Figure 6 which is controlled by the approaches of fuzzy logic control. The results shows that the improvement of settling time parameter of time response as it increases damping ratio also.
2. In the total harmonic distortion window showing FFT analysis it is seen that previously the THD is reduced from 47.9 % to 43.67 %.THD is inversely proportional to power factor hence power factor is improved improving the transmission capacity of power with reduced losses.
3. steady state error is improved
4. Overshoots are reduced.
5. Fast response of the system.

VI. CONCLUSION

For the transmission of power through long distance over the line it is transmitted in high ratings and due to which due to sudden load or generator side disturbances compensation is required for maintaining the complete system in synchronism. While compensation now it is required to have fast responses and immediate controlled actions which can be done by using intelligent system of controlling .in this paper the same is done as the implementation of fuzzy logics are used in controlling the UPFC and it is seen that harmonic distortions are improved with fast settlement of the system.

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