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Role of Unified Power Flow Control in Voltage Power Transfer : A Critical Study

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Abstract-The unified power flow controller (UNIFIED POWER FLOW CONTROL) is being used as a compensating and power control device in the power systems due to its easy build, high robustness and efficiency. Simulation results reveal that as far as voltage sag and swell are concerned both the two-level and five level inverter based UNIFIED POWER FLOW CONTROL exhibit the similar performance.As the five level inverter based UNIFIED POWER FLOW CONTROL generates nearly sinusoidal load voltage, its THD is observed to be 3.15%. It is 15.65% in the case of its two level counterparts. It may be noted that for power of good quality the THD must be less than or equal to 5% as per standards. Hence, with respect to power quality, the five level UNIFIED POWER FLOW CONTROL scheme has an edge over two level UNIFIED POWER FLOW CONTROL scheme.

Introduction

Fewer natural resources and ever increasing demand has set the stage for unprecedented changes and new regulations. In this restructured and deregulated power system environment, added problem is restriction building new transmission lines and generating plants. Therefore the thrust has shifted to

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maximize available transmission facilities. Unregulated active and reactive power flows
may result in loss of power system stability, high transmission losses, voltage collapse etc. Power flow generally in the low impedance path, there by overloading that line and restricting UPFC with minimum losses and low storage capacity at unity or higher voltage transfer ratio. This research work proposes a unique converter structure using Z Source Impedance coupled to Bridge Configured Matrix Converter based unified power flow controller not dealt with so far

The UPFC is capable of integrating all conventional transmission control concepts i.e. series compensation, phase shifting, and voltage regulation into a generalized power flow controller. As a dynamic real and reactive power flow controller with operations under power system oscillations and transmission line faults it is competent of enhance the transfer capability of the transmission line beyond imagination.

Extensive researches continue to contribute on different structures and converter configurations of

UPFC. The conventional VSC based unified power flow controller, has the internal loss of extensive direct current network capacitor striking further destruction and the model proponent placed unified power flow controller has the disadvantage of less current(volt.) variation proportion. The controllable parameters of unified power flow controller and the system state variables are certainly adjusted to obtain a UPFC. Voltage collapse normally occurs in heavily loaded and faulted lines. Detailed investigations on steady state voltage stability analysis like PV curve, Stability Indices, VQ curve and Modal analysis are made on different IEEE test bus systems to identify critical nodes and voltage control areas before the placement of UPFC. A comparison of results obtained with and without PIM- UPFC in voltage stability analysis is discussed. Thus optimal reactive power compensation becomes a necessity with minimum transmission losses, best location for the reactive compensation device in addition to its rating, enhanced voltage at all nodes level and improved voltage stability margin. Therefore this problem can be designated as highly nonlinear, multimodal, and discontinuous i.e. a combinatorial optimization problem. Evolutionary based Genetic Algorithm is adopted to provide an optimal power flow solution.

LITERATURE REVIEW

In all electric power transmission system, whether overhead lines or underground cables, there will be a drop of voltage along the system when current flows in it. This drop will vary with the current and power factor.

The variations in voltage are permissible, but with favorable zones, for example the rise or drop in voltage should not exceed a prescribed tolerance of ± 10% of the nominal voltage.

Yanfang Wei et al., (2011)[15]uses the MATLAB Voltage StabilityToolbox to study power flow, singularity based analysis, eigenvalue analysis, static and dynamic bifurcation analysis and time domain simulation.

(Sharadet. al. 2010)[5](Yan Zhang and Jovica V. Milanovic 2010) presents an approach to optimally select and allocate flexible ac transmission (FACTS) devices in a distribution network in order to minimize the number of voltage sags at network buses. Three types of FACTS devices are implemented in this study, namely, static var compensator, static compensator, and dynamic voltage restorer.

Naidu and Fernandes (2009[14])decribed the closed loop control of a four leg VSC based DVR. The three phase input variables are resolved into positive, negative and zero sequence components using a weighted, recursive, least square estimator. A laboratory model of the restorer has been constructed and its performance has been tested by simulation using MATLAB and experiments.

Sasitharan and Mahesh K. Mishra (2009)[4] proposed a filter structure for improving the performance of switching band controller based DVR. The control method of the VSI inherits merits, Such as fast dynamic response, robustness, zero magnitude/phase errors and ease of implementation. The proposed filter structure and the adaptive band controller for the DVR are presented by carrying out PSCAD simulation studies.

The design strategy for optimizing the total rating of an IDVR is presented (Karshenas and **Moradlou 2008)[13].** An IDVR, which is two DVRs installed in two feeders with a common DC bus, has the ability of active power exchange between two DVRs, and thus the energy storage device is not an issue. Therefore, the design criteria for the selection of the rating of an individual DVR is not applicable to the IDVR obtained.

Bingsen Wang et. al. (2006)[1] described the detailed design of a closer loop regulator to maintain the load voltage within acceptable levels in a DVR using a transformer coupled H bridge converters. A laboratory scale experimental prototype was developed tha verifies the power circuit operation and controller performance. The experimental results indicate an excellence with the digital simulations.

MahindaVilathgamuwaet. al. (2006)[2] proposed a new topology based on the Z source inverter for the DVR, in order to enhance the voltage restoration property of.

Poh Chiang Lohet. al. (2004)[6] described a detailed analysis on Z source inverter modulation, showing how various conventional PWM strategies for controlling a conventional VSI can be modified to switch a voltage type Z source inverter either continuously or discontinuously. The theoretical and modulation concepts presented have been verified both in simulation and experimentally.

the device. It was observed that the DVR compensates the disturbance caused by a sag effectively, while utilizing the stored energy fully by the use of the buck – boost capability of the proposed Z source inverter

FUZZY LOGIC CONTROLLER BASED UNIFIED POWER FLOW CONTROL FED POWER SYSTEM

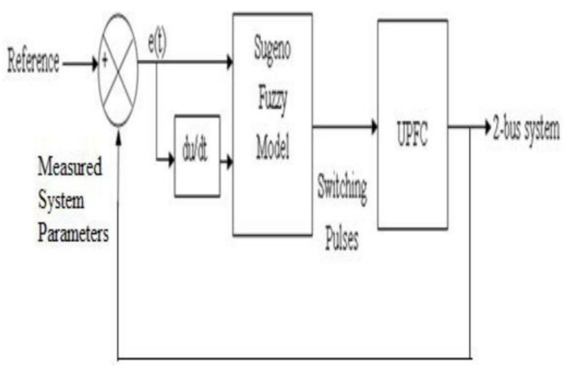

Fig1. Block Diagram of Fuzzy Based UNIFIED POWER FLOW CONTROL system

Error, E =e(t) = Vr(t) Va(t)

Change in error, CE = e(t) e(t-1)

Change in Error (CE)	Error (E)	
	L	H
L	Z	M
H	Z	H

Table 1 Linguistic Rule Table

The error between the reference voltage value and the measured voltage and the rate of change of voltage error are fed as input to the fuzzy logic controller. These values are fed as crisp inputs to the fuzzy logic controller and are converted into fuzzy sets by using min-max method. The input functions are framed from the following expressions.

Membership function values are assigned to the linguistic variable using two fuzzy subsets viz., L (low) and H (High). The partition of fuzzy subsets and the shape of the membership function adapt the shape of the appropriate system. Table 1 depicts the linguistic rule for fuzzifying the input error and change in error values.

The proposed fuzzy based UNIFIED POWER FLOW CONTROL system is simulated using Matlab/Simulink. The fuzzy editor, the corresponding fuzzy rule viewer and surface viewer are shown in Figure 5.20. The two inputs viz., error and change in error are framed using triangular membership functions. The

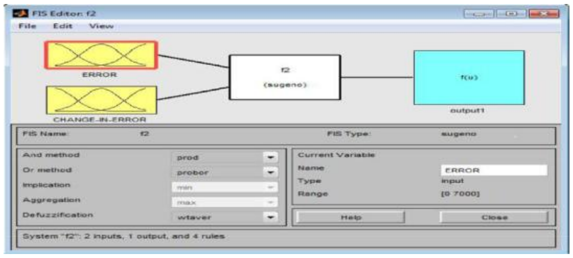

Figure 2. fuzzy editor

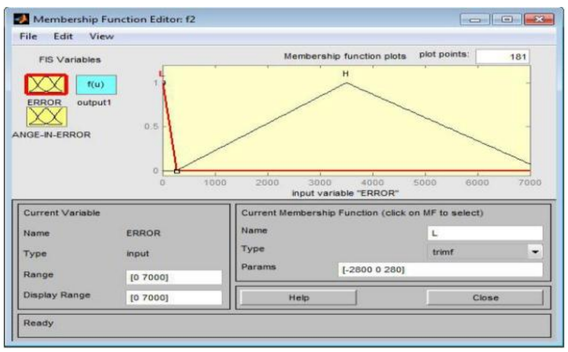

Figure3.Error Membership Function

PI CONTROLLER BASED UNIFIED POWER FLOW CONTROL FED POWER SYSTEM:-

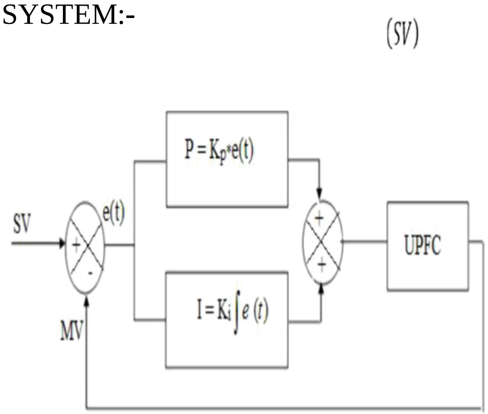

Figure 4 Basic block of PI controller

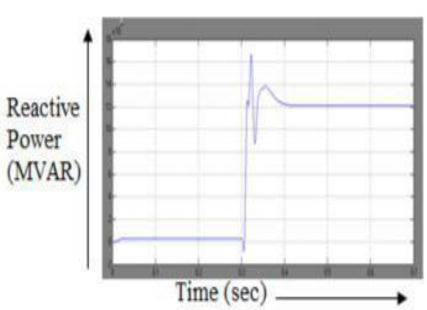

Figure 5(a) Real power

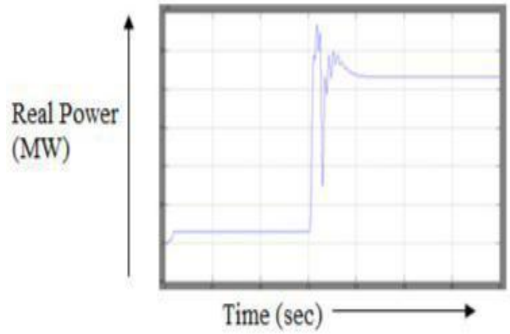

Figure 5 (b) Reactive Power

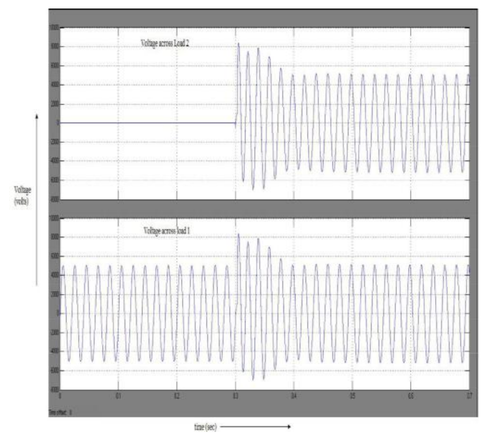

Figure 5(c) Voltage across Load 2 and Load 1

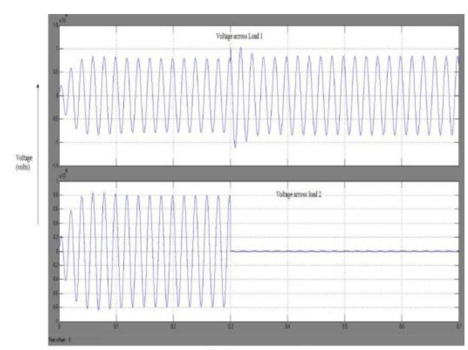

Figure 5(d)Voltage profile during swell condition

CONCLUSION

From the comparative analysis shown in Figure 5.30 it is clear that there is a drastic change in the peak overshoot occurred during the switching ON of the UNIFIED POWER FLOW CONTROL. The UNIFIED POWER FLOW CONTROL System with fuzzy logic controller scheme has less peak overshoot compared to its counterparts AWPI, PI and Open loop controller based UNIFIED POWER FLOW CONTROL systems. Also the response time for the clearance of the fault is less in fuzzy logic controller scheme compared to the other schemes.

The fuzzy logic controller based UNIFIED POWER FLOW CONTROL fed power system has an edge over the other schemes of interest on the aspects of peak overshoot, duration of sag and swell and real and reactive power flow.The control strategies suggested so far were developed to mitigate the power quality issues viz. voltage sag and swell using unified power flow controller. The voltage mitigation is achieved by determining the voltage and current injected by the UNIFIED POWER FLOW CONTROL at each step. The simulation results evaluate the aforesaid inte

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