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A NEW HOMOGENEOUS UPFC CONTROL DESIGN USING NEURAL NETWORK MODULE FOR POWER FLOW AND VOLTAGE CONTROL

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Abstract**—**Voltage control and stability are the most important factor in the daily operation of highly stressed electrical power system networks. An Unified power flow controller (UPFC) is an important power control device, which can control the voltage as well as the active and reactive power flow through the transmission line to which it's connected. The variables of the UPFC must be controlled in agreement with system load conditions for stable operation of the electrical power system. An Artificial neural network (ANN) is an important tool which gives better result in real time. In this paper a artificial neural network(ANN) is design for assessing the output variables of UPFC for different loading scenario of EHV power system.

Keywords**—**voltagecontroller,UPFC,ANN,Active &Reactive Power

1. Introduction

The todays deregulation of electrical power systems around the globe may not only provied cheaper electricity and quality service to the customers but also create new technological challenges to the power industries and researchers. In a deregulated atmosphere, the open access to the transmission networks requires adequate Available Transfer Capability (ATC) to insure economic transactions. However, in a privatized electricity market, the major traditional paths to improve ATC, such as rescheduling active power generations, controlling terminal voltage of generators and changing taps of on-load tap changer etc, may not be controlled by the transmission network authority or system operator's. Construction of new transmission lines has always been better option, but it is subject to tougher environmental restrictions and sometimes social problems too. With widely availability of the fully controlled semiconductor devices such as the Gate Turn-off Thyristor (GTO) and the Insulated Gate Bipolar Transistor (IGBT) and the invention of new topologies i.e. the combination of multiple compensators, the most powerful and versatile group of FACTS (Flexible AC Transmission System) devices, namely composite compensators has been developed. Its representatives include the Unified Power Flow Controller (UPFC) and the Interline Power Flow Controller (IPFC). The latter is the latest generation of FACTS devices. It is well known that heavily loaded lines and buses with relatively low voltages are factors that significantly limit Fuzzy systems and neural networks have attracted the interest of researchers in various scientific and engineering areas. The main idea of (Artificial Neural Network) ANN logic control is to build a model of a human control expert who capable of controlling the plant without thinking in terms of a mathematical model and expression.These control rules are translated into the framework of ANN set theory providing a calculus which can simulate the behavior of the control expert .The quality of ANN logic controller can be drastically affected by the choice of membership functions. Thus, methods for tuning ANN logic controllers are necessary.

- The power system is an interconnection of generating units to load centers through high voltage electric transmission lines and in general is mechanically controlled.

- It can be divided into three subsystems: generation, transmission and distribution subsystems. Until recently all three subsystems were under supervision of one body within a certain geographical area providing power at regulated rates
- A special arrangement of two SVSs, one connected in series with the ac system and the other one connected in shunt, with common dc terminals is called Unified Power Flow Controller (UPFC). It represents series - shunt type of controller.

A. Power Quality

Power quality' generally refers to eminence of voltage supply . To an application it means supply of adequate and reliable power. To a consumer, it means adequate, uninterrupted power which does no longer have an effect on the equipment. For a manufacturer it resources the quality and tolerance of voltage and current parameters that is written, the range of parameters for which they are artificial and tested the product.

B. Why power quality is important

Client pays for good 'quality power'. If power quality is corrupted that means it is a breach of trust. Meager quality damages consumers' equipment's and affects equipment life.

- Bad eminence power such as flicker etc. causes irrigation and health threats.
- Poor voltage and high current with harmonics cause heating and high losses.
- Reliability of energy delivered is affected due to relay operation, frequent faults and equipment botches.

C. Power system troubles

The trouble is a passing deviation from the steady state wave form produced by faults of 'brief duration' or unexpected.

- change in load'. Some of the power system troubles are Voltage dips (sag) .
- Interruptions.
- Voltage increase (swell).
- Voltage impulses.
- Transients.

II. Literature Survey

[1] Samiksha Thakare proposed "Improvement in Power Flow Control and Voltage Regulation using UPFC", 2019 Innovations in Power and Advanced Computing Technologies (i-PACT) IEEE XPLORE DOI: 10.1109/i-PACT44901.2019.8960151.

FACTS is a flexible alternating current transmission system which is used to transfer AC power. FACTS technology is a way of improving power system controllability's and power transfer. There are various FACTS devices used for various purpose. In this paper, we are using UPFC. UPFC is a combination of STATCOM and SSSC. UPFC controls the power flow and regulate the voltage. This paper represents the various modes of operation using series and shunt converters. Unified Power Flow Controller (UPFC) is IGBT based voltage source converter which shows the step change..

[2] Swati Bhasin ; Annapurna Bhargava ; Sandeep Verma ; Vandana Chaudhary, in paper titled Comparative Simulation Studies for Hybrid Power Flow Controller and UPFC based Controller for SMIB System," 2019 2nd International Conference on Power Energy, Environment and Intelligent Control (PEEIC) IEEE Xplore DOI: 10.1109/PEEIC47157.2019.8976670

Day by day increment in the necessity of the consumer side is observed so we use FACTS technology for utilising better functionality of the power system. HPFC is the useful device like UPFC that observed severally and selectively Performance characteristics over actual controllers. The main demerit of UPFC is so expensive from HPFC because of its full rating (MVA) of VSC's converter. So, the total cost of controller (HPFC) is reduces. This paper defines the study of performance improvisation in the power system by comparing the HPFC and UPFC. Here we used one topology of HPFC which is formed by two VSC's are connected in series and SVC is connected in shunt through the tie-lines. The outcomes of comparison on HPFC and UPFC are explained on SMIB system that observes the HPFC is economically better than other controllers with better performance..

[3] Hyun-Jun Lee ; Young-Doo Yoon proposed in "Single-phase UPFC Topology with Autotransformer Structure for Smart Grid 2019 10th International Conference on Power Electronics and ECCE Asia (ICPE 2019 - ECCE Asia) IEEE Xplore.
" This paper proposes a topology for UPFCs. The proposed topology consists of N:2 transformer with a center-tap, a full-bridge converter and a half-bridge converter. While the conventional UPFC topology uses two three-phase transformers, which are called as a series transformer and a parallel transformer, the proposed topology uses three singlephase transformers. By using an autotransformer structure, the voltage ratings of the transformers and the switches in the power converter module can be decreased significantly. As a result, compared to the conventional UPFC topology, it is possible to reduce installation spaces and costs. Also, by adopting a full-bridge converter and a halfbridge converter structure, the proposed topology can be easily implemented with the conventional power devices and control techniques. Simulations and experiments were performed and, the results verify the effectiveness of the proposed UPFC topology .

III. OBJECTIVE

In this study the effects of UPFC locations are investigated on voltage profile and transmission lines power flow as active and reactive power are analyzed. Following Objectives are made:.

- Power flow control to be achieved and congestion Should be less.

- Transient stability Should be improved
- Faster Steady State achievement
- Improved Voltage Profile
- To understand the design of a real power coordination controller for a UPFC.
- The interaction between the series injected voltage (Vse) and the transmission line current (Ise) leads to exchange of real power (Pse) between the series converter and the transmission line.
- The interaction between the series injected voltage and the transmission line current leads to real and reactive power exchange between the series converter and the power system

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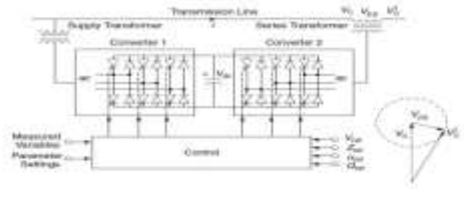
IV. UPFC

The UPFC is the most versatile FACTS controller developed so far, with all encompassing capabilities of voltage regulation, series compensation, and phase shifting.It can independently and very rapidly control both real- and reactive power flows in a transmission. It is configured as shown in Fig. and comprises two VSCs coupled through a common dc terminal.



The implementation of the UPFC using two "back – to –back" VSCs with a common DC-terminal capacitor

One VSC converter 1 is connected in shunt with the line through a coupling transformer; the other VSC converter 2 is inserted in series with the transmission line through an interface transformer.The dc voltage for both converters is provided by a common capacitor bank.The series converter is controlled to inject a voltage phasor, Vpq, in series with the line, which can be varied from 0 to Vpq max. Moreover, the phase angle of Vpq can be independently varied from 00 to 3600.In this process, the series converter exchanges both real and reactive power with the transmission line.Although the reactive power is internally generated/ absorbed by the series converter, the real-power generation/ absorption is made feasible by the dc-energy–storage device that is, the capacitor.The shunt-connected converter 1 is used mainly to supply the real-power demand of converter 2, which it derives from the transmission line itself. The shunt converter maintains constant voltage of the dc bus.In addition, the shunt converter functions like a STATCOM and independently regulates the terminal voltage of the interconnected bus by generating/ absorbing a requisite amount of reactive power.

V. PROBLEM FORMULATION

A. Existing System

Normal UPFC model has been design accordingly which can work only on givcn input dataThis input data can be analogies to the gridIn our project we will be going to design neural system for upfc which will design its constraints for grid for contionous supply The basic control method is such that the shunt converter controls the transmission line reactive power flow and the dc-link voltage. The series converter controls the real power flow in the transmission line and the UPFC bus voltages. Experimental works have been conducted to verify the effectiveness of the UPFC in power flow control in the transmission line.

B. Proposed System

In power system transmission, it is desirable to maintain the voltage magnitude, phase angle and line impedance. Therefore, to control the power from one end to another end, this concept of power flow control and voltage injection is applied .Modeling the system and studying the results have given an indication that UPFC are very useful when it comes to organize and maintain power system.
The proposed method algorithm provides a very good performance under various channel conditions, with a short observation time and at low signal-to-noise ratios, with reduced complexity. considered. The UPFC is modeled as two controllable voltage sources; Vser represents the series inverter and Vsh represents the shunt inverter . Two perpendicular components: one in-phase with the system bus voltage and the other in quadrature are used to represent both compensation voltages generated by each inverter of the UPFC The validity of the proposed algorithm is verified using signals generated and acquired by laboratory instrumentation, and the experimental results show a good match with computer simulation results.

C. Implemented Work

As per proposed System of UPFC a Simple module can be designed according the below diagram using MATLAB SIMULINK .

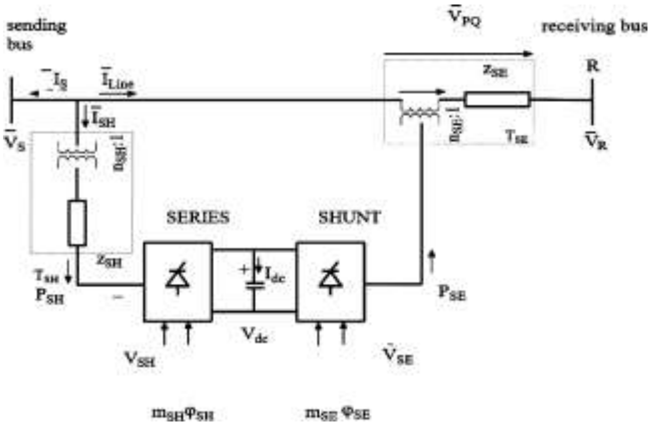


Fig 1. Simple Prototype of UPFC.

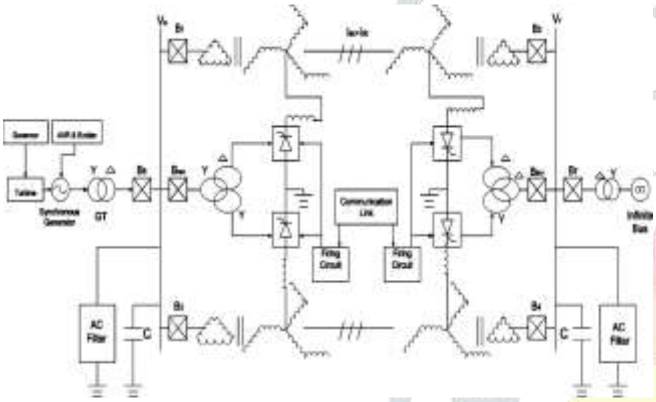


Fig 2. SIMULTANEOUS AC-DC TRANSMISSION SYSTEM

As shown in fig. 1, To provide for proper coordination between the shunt and the series converter control system, a feed-back from the series converter is provided to the shunt converter control system. The feedback signal used is the real power demand of the series converter (Pse). The real power demand of the series converter (Pse) is converted into an equivalent D-axis current for the shunt converter (iDse). By doing so, the shunt converter responds immediately to a change in its D-axis current and supplies the necessary series converter real power demand. The equivalent D-axis current (iDse) is an additional input to the D-axis shunt converter control system as shown in Fig. 2 The real power demand of the series converter Pse is the real part of product of series converter injected voltage Vse and the transmission line current Ise. Vupfc, iDse represent the voltage of the bus to which the shunt converter is connected and the equivalent additional D-axis current that should flow through the shunt converter to supply the real power demand of the series converter.

Parameters:
Transmission System: 500 kV /230 kV
Bus Lines: 5 (B1-B5)
Series Shunt system: 1 System
Pref is increased by 1 pu (100 MW), from 5.87 pu to 6.87 pu,
Qref is kept constant at -0.27 pu
Maximum Power: 100MVA
The series converter can inject a maximum of 10% of nominal line-to-ground voltage (28.87 kV) in series with line .
L=24mh/ph
R=8 ohm/phase
Input Voltage=3phase,110V
Input Current=1A per phase
Length=200km

VI. EXPERIMENTAL SET-UP

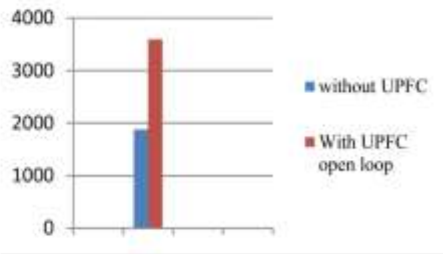


Fig 3. Real power flow without and with UPFC.

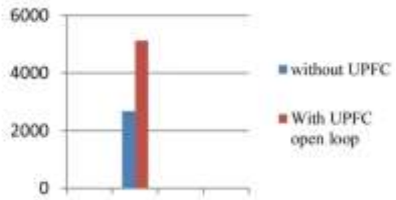


Fig 4. Reactive power flow without and with UPFC.

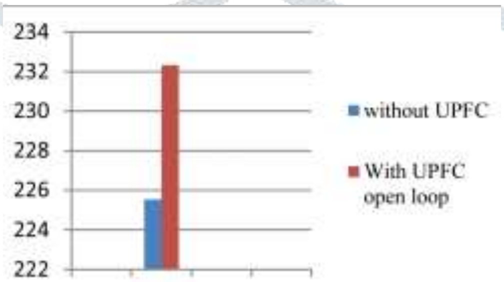


Fig 5. Load voltages without and with UPFC

VII. CONCLUSION

In this paper, ANN based UPFC is used to mitigate various power quality issues like voltage control,Active &Reactive power flow. Test model is analyzed with and without unified power flow controller in the MATLAB/simulink environment.

The results of simulation show that UPFC is very effective to improve the quality of power in power system. Real and reactive powers are maximize with the installation of UPFC in the network.

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