ABSTRACT

The requirement and continuity of electric power supply to all the consumers are very much important for the growth of any country. Due to the growing demand, economic and environmental constraints equipments used in power system are utilized to their maximum limits. FACTS devices not only regulate the voltage profile but also increase the power transfer capability and defer the transmission network expansion.

It is necessary to improve the power transfer capacity of the existing transmission system with improved durability, reliability and controllability. To achieve this, various Flexible AC Transmission System (FACTS) devices such as Static var Compensator (SVC), Static Synchronous Compensator (STATCOM), Static Synchronous Series Compensator (SSSC), Thyristor Controller Series Capacitor (TCSC), Unified Power Flow Controller (UPFC) and Interline Power Flow Controller (IPFC) have been installed in the transmission lines.

When the series FACTS controllers are used in the existing transmission lines, despite many advantages, it creates problem to the distance protection relay by means of affecting its reach and directionality. The impedance of the transmission line would vary according to the degree of series compensation which would in turn make the conventional distance protection relay to mal-operate. Thus, the mal-operation of the distance protection relay would lead to instability of the grid network.

The main objective of this thesis is to provide a new protection scheme for the distance protection relay used in series compensated transmission lines. In this work, a Multi-Stable Stochastic Resonance (MSR) based on Complex Wavelet Transform (CWT) and Cross Differential Scheme for
protecting a transmission system with Unified Power Flow Controller (UPFC) in one line is suggested. Fault detection at the sending end is recognized by the Collective Sum Technique (CST) using the current signals of all the three phases with heavy background noise. The noisy signal is processed by parameter compensation, and the processed signal is decomposed by CWT with different scale frequencies. CWT is used to compute the spectral energies of each phase current. The spectral energies of each phase can be used to identify the faulty phases. After fault detection, the three-phase currents are analyzed using FDST for fault classification.

The proposed method is implemented in MATLAB/Simulink and PSCAD. Various simulations were carried out for wide operating parameters such as fault resistance, fault location, fault inception angle, and UPFC operating parameters. The proposed CWT-based MSR scheme effectively detects, classifies, and locates the fault on parallel transmission system including UPFC.

The proposed system is analyzed and compared with two conventional fault extraction methods such as Empirical Mode Decomposition (EMD) and Wavelet Transform with Spectral Analysis Method (WT-SAM). From the simulation results it is proved that the proposed method improves the output SNR and the accuracy of fault identification and classification. Both simulation and performance analyses show that CWT based MSR scheme has great potential to detect and classify the fault effectively within one cycle.