Wavelet-Alienation Based Protection Scheme for Transmission Systems

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Bhuvnesh Rathore

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Indian Institute of Technology Jodhpur
Department of Electrical Engineering

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Conclusion

The performance of power system is affected by faults on transmission lines which results in disturbance of power flow. Hence there is need for quick detection and classification of fault, such that the performance and the reliability of power system can be improved by clearing of the fault. In this research work, a Wavelet-Alienation based protection scheme has been proposed for transmission systems to detect, classify and locate the faults precisely within a quarter cycle. The three-phase voltage and current signals at various terminals are sampled, which are synchronized with GPS clock. Approximate decomposition of the signals, based on wavelet transform, are obtained over a quarter cycle. The approximate coefficients of current signals, obtained over a moving window of quarter cycle, are then utilized to compute alienation coefficients. A fault index is evaluated by summation of alienation coefficients, is then compared with the pre-defined fault threshold for detection and classification of various faults. Subsequent to fault detection and classification, the approximate coefficients of three-phase voltage and current signals, of all the terminals, are fed as input to the Artificial Neural Network (ANN), to locate the fault on transmission system to a fair accuracy.

The proposed algorithm has been established by testing the same on different transmission systems. These transmission systems include two-terminal, multi-terminal and two-terminal transmission system with FACTS devices such as TCSC (series compensation), STATCOM (shunt compensation) and UPFC (hybrid compensation). Two-terminal transmission systems are most prominently used for transmission of power from one node to another. Multi-terminal lines play an important role in transmitting the power economically, to cope up with the demand in the present scenario of increased industrialization. The protection schemes are influenced by the compensated devices which are used for enhancement of power transfer capability and the power quality. Such devices include SSSC, STATCOM, UPFC, SVC, etc. These devices have versatile performance and complex structure. The presence of compensating device in a fault loop affects signals at the relay point, which may lead to over-reach or under-reach, in case of conventional distance protection. This is due to change in apparent impedance, affected by voltage and current signals injected by FACTS devices. The major contributions of the proposed research work are as follows:

a) The proposed algorithm can be implemented for different configurations of transmission systems i.e. it is robust and not system specific.
b) The fault detection and classification can be done within quarter cycle time from the fault incidence time, which makes it fast w.r.t. conventional protection algorithms.
c) For estimating the fault location, only the quarter cycle data was used as input to Artificial Neural Network.
d) The robustness of proposed algorithm has been established with various case studies which include variation of fault location, fault incidence angle, fault impedance, location of FACTS devices and sampling frequency. The algorithm was also found robust in presence of load switching and noise.

Thus, it has been established that the proposed algorithm can be used efficiently to detect and classify various faults on transmission line within quarter cycle and locate the faults accurately making use of only quarter cycle information. The precision of 99.99 % in detection and classification of faults and an accuracy of 99 % in location of faults has been achieved using proposed algorithm.