A Survey Paper on Wavelet Transform And Other Fault Diagnosis Techniques Used In Transmission Line Protection

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Abstract—The fault diagnosis of Electric Power System is a process of discriminating the faulted System elements by protective relays and subsequent tripping by circuit breakers. The adaptation of protective distance relay to determine the presence and location of faults in a transmission based on the measure of fixed settings such as line impedance has been achieved by the application of several different techniques. Fault location estimation is very important factor in power system, for the modern power systems a fast, accurate and robust technique for real-time purposes is required. Therefore the stable operation of power system is achieved by good fault diagnosis technique. In this paper, present the literature survey of various techniques for fault diagnosis.

Keywords: Distance Protection; Wavelet Transform; Fuzzy Logic; ANN; Power System.

I. INTRODUCTION

Transmission line systems have great importance in power system. Faults that occur frequently with transmission lines system should be clear as fast as possible. Distance relaying principle, due to their high speed fault clearance compared with the over current relays is a widely used protective scheme for the protection of high and extra high voltage (EHV) transmission and sub-transmission lines. Fault location estimation is very important issue in power system engineering in order to clear faults quickly and restore power supply as soon as possible with minimum interruption. It’s very important to detect and classify the fault for efficient and reliable operation of power system. There are various techniques for fault classification like fuzzy logic based, artificial neural network based, wavelet transform based, and Fourier transform based analysis.

II. NEURAL NETWORK

Neural networks, more accurately called Artificial Neural Networks (ANNs), are computational models that consist of a number of simple processing units that communicate by sending signals to one another over a large number of weighted connections. They were originally developed from the inspiration of human brains. Kaastra and Boyd (1996) developed neural network model for forecasting financial and economic time series. Kohzadi et al. (1996) used a feed forward neural network to compare ARIMA and neural network price forecasting performance. Dewolf et al. (1997, 2000) demonstrated the applicability of neural network technology for plant diseases forecasting. Zhang et al. (1998) provided the general summary of the work in ANN forecasting, providing the guidelines for neural network modelling, general paradigm of the ANNs especially those used for forecasting, modelling issue of ANNs in forecasting and relative performance of ANN over traditional statistical methods. Sanzogni et al. (2001) developed the models for predicting milk production from farm inputs using standard feed forward ANN. Kumar et al. (2002) studied utility of neural networks for estimation of daily grass reference crop evapotranspiration and compared the performance of ANNs with the conventional method used to estimate evapotranspiration. Pal et al. (2002) developed MLP based forecasting model for maximum and minimum temperatures for ground level at Dum Dum station, Kolkata on the basis of daily data on several variables, such as mean sea level Pressure, vapour pressure, relative humidity, rainfall, and radiation for the period 1989-95. Gaudart et al. (2004) compared the performance of MLP and that of linear regression for epidemiological data with regard to quality of prediction and robustness to deviation from underlying assumptions of normality, homoscedasticity and independence of errors: The details of some of the application in the field of agriculture will be discussed in the class. In the context of economic data, Swanson and White (1997) investigate the performance of neural network models in forecasting nine quarterly seasonality adjusted US macro econometric time series, finding that they generally outperform traditional economic approaches even where there is no explicit non-linearity. The use of separate ANNs, for faults involving earth and not involving earth has proved to be convenient way of classification of transmission faults based on RBF neural networks by Mahanty et al., (2004). For simple and reduced architecture and better learning capability a modular neural network, is proposed by Lahiri et al., (2005), Pradhan et al., (2001) to discriminate the direction of faults for transmission line protection. Such a network considers corresponding phase/ground voltage and current information as input and thereby the redundant inputs in conventional approaches are eliminated. The existing ANN based solutions easily converge on local minima whenever input patterns with large dimensionality are present and when designed for specific applications, are prohibitively expensive or infeasible for real time implementations. It is observed that the ANN based distance relays need much larger training sets and hence the training of these networks is time consuming and further research work shall produce a hardware realization with proper modification in the learning methodology and pre-processing of input data that.
would improve the learning rate performance, efficiency and the reliability many folds. Presently research efforts are in the direction of evolutionary computational techniques such as genetic algorithms (GA) for determining the neural network weights and thereby avoid training of ANN.

III. FUZZY LOGIC AND COMBINED ANN/FUZZY LOGIC TECHNIQUE

Zadeh introduced the concept of fuzzy set theory in 1965 for dealing with uncertain and ambiguous properties of events (Zadeh, 1965). It was introduced in power system networks to solve uncertainty problems that arise due to the continuously varying power system parameters. Fuzzy logic is the way the human brain works, and we can mimic this in machines so they will perform somewhat like humans (not to be confused with Artificial Intelligence, where the goal is for machines to perform EXACTLY like humans). Fuzzy logic control and analysis systems may be electro-mechanical in nature, or concerned only with data, for example economic data, in all cases guided by “If-Then rules” stated in human language. Fuzzy logic is a superset of conventional (Boolean) logic that has been extended to handle the concept of partial truth- truth-values between “completely true” and “completely false”. It is the logic underlying modes of reasoning which are approximate Related Searches rather than exact.

The first applications of fuzzy theory were primarily industrial, such as process control for cement kilns. However, as the technology was further embraced, fuzzy logic was used in more useful applications. In 1987, the first fuzzy logic-controlled subway was opened in Sendai in northern Japan. The fuzzy set theory is used for fault type identification on a transmission line by Ferrero et al., (1995), Das et al., (2005), without any computationally expensive training of ANN or expert domain knowledge. These algorithms are fairly accurate only under certain assumptions of fault distance, pre-fault power flow, fault resistance and line length. In fuzzy logic based protection system, accuracy cannot be guaranteed for wide variations in system conditions. So consequently a more dependable and secure relaying algorithm during real time implementation is needed for classifying the faults under a variety of time-varying network configurations. The fuzzy-neuro approaches are sensitive to system frequency changes and require large training sets and a large number of neurons affecting their accuracy and speed in protecting large power networks.

IV. FOURIER TRANSFORM

The Fourier transform decomposes a signal into orthogonal trigonometric basis functions. A fast Fourier transform is an efficient algorithm to compute the Location of Faults In Transmission Line Using Fast Fourier Transform And Discrete Wavelet Transform In Power Systems discrete Fourier transform and its inverse. The Fourier transform only retrieves the global frequency content of a signal. Therefore, the fourier transform is only useful for stationary and pseudo-stationary signals. The Fourier transform does not give satisfactory results for signal that are highly non-stationary, noisy, aperiodic, etc.

V. WAVELET TRANSFORM

WT was introduced at the beginning of the 1980s and has attracted much interest in the fields of speech and image processing since then. Wavelets are a recently developed mathematical tool for signal processing. Compared to Fourier analysis, which relies on a single basis function, a number of basis functions of a rather wide functional form are available in wavelet analysis. The basic difference is that, in contrast to the short time Fourier transform which uses a single analysis window; the WT uses short windows at high frequencies and long windows at low frequencies. Wavelet is much more powerful than conventional method in processing the stochastic signal because of analysing the waveform in time scale region. In wavelet transform the band of analysis can be adjusted so that low frequency band high frequency components can be windowing by different scale factors. Wavelet transform is to analyse non-stationary signals i.e.; whose frequency response varies in time. Wavelet transform gives variable resolutions. It can analyse signals simultaneously in time and frequency domain.

The fundamental frequency components of the post fault voltages and currents need to be extracted as quickly and accurately as possible for the quick response of a digital distance relay. Wavelet approach is one of the new tools in this direction which is useful for power system transient analysis, since the conventional signal processing techniques have the inherent disadvantages of long discrimination time, errors in impedance calculations and misclassifications (during CT saturation and in presence of fault resistance) (Liang et al., 2004; Bhoomik et al., 2009; Magnago et al., 1998). Wavelet transform (WT) has the ability to perform local analysis of relaying signals without losing the time-frequency information. WT in conjunction with AI/Fuzzy/Expert system/SVM based techniques have the advantage of fast response and increased accuracy in fault type and location identification. The ability of wavelets to decompose the signal into different frequency bands using multi resolution analysis (MRA) allows detecting and classifying faults as well as extracting the voltage and current fundamental phasors needed to calculate the impedance to the fault point in distance protection (Osman et al., 2004) and with filtering algorithms proposed by Kleber M.Silva et al., (2010), fast relay operating times are obtained. Discrete wavelet transform based MRA is used for feature extraction by Samantaray et al., (2007) and the features extracted from fault current signals are used to train and test the support vector machine (SVM) for fault classification and the fault location from the relaying point is computed by RBFNN.

VI. CONCLUSION

A literature survey of transmission line protection after the implementation of digital relaying, a lot of work has been done to improve the performance of digital protective relays, but in the context of reformation in the power industry and operation of transmission lines close to the stability limits, new tools and algorithms are needed to maintain system reliability and security within an acceptable level. That might allow distance relay work more accuracy and
precision. The ANN, fuzzy logic, genetic algorithm, SVM and wavelet based techniques have been quite successful but are not adequate for the present time varying network configurations, power system operating conditions and events, each of this techniques having some limitation, it seems that there is a significant scope of research in AI techniques which can simplify the complex nonlinear systems, realize the cost effective hardware with proper modification in the learning methodology and pre-processing of input data And which are computationally much simpler.

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