"STUDY OF FAULT DETECTION IN TRANSMISSION LINES USING WAVELET AND CONTOURLET FEATURES"

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ABSTRACT: *Transmission line protection is an important issue in power system engineering because 85-87% of power system faults are occurring in transmission lines. This paper presents a technique to detect and classify the different shunt faults on a transmission lines for quick and reliable operation of protection schemes. Discrimination among different types of faults on the transmission lines is achieved by application of evolutionary programming tools. This work evaluates a new method for faults detections in transmission lines in HVDC systems. The proposed method uses voltage and current synchronized data. The HVDC systems are simulated using MATLAB software. The method for detection of faults in transmission line uses a self-adaptive threshold and presents a redundancy, which allows the detection of faults even in situations where loss of either voltage or current signal occurs. A monopolar and a bipolar system are simulated using Simulink/MATLAB®. Results might show that percentage errors are lower than 0.01% for all analyzed cases in the monopolar system and lower than 0.5% for all analyzed cases in the bipolar system. We plan to extend the system by adding contourlet transform for adding better accuracy of fault detection.*

Keywords: *The Wavelet Transform, The Discrete Wavelet Transform*

1. INTRODUCTION

Fault detection and classification on transmission lines are important task to safeguard electric power systems. A fundamental part of a protective relay is a selector module which classifies the type of fault that has occurred and also to classify the "normal state". Reliable phase selection of the faulted phase is thus vitally important in order to avoid either tripping of the incorrect phase or unnecessary three-phase tripping. Moreover, a necessary requirement of phase selectors is high speed operation as the selection process must be completed in the immediate post-fault period before breaker opens. Traditional phase selection schemes suffer from some drawbacks due to complexity of the system model, lack of knowledge of its parameters, effect of remote-end infeed, fault resistance, mutual-coupling from adjacent parallel lines, etc. They do not have the ability to adapt dynamically to the system operating conditions, and to make correct decisions if the signals are uncertain. Fault detection and classification is a very challenging task. Different attempts have been made for fault classification including approaches based on traveling waves [1-2], adaptive Kalman filtering [3], fuzzy logic, neural networks[4], and the fusion of different artificial intelligence techniques. Several researchers have proposed different techniques for fault classification of transmission lines using different types of neural networks and their combination with different transforms, such as wavelet and hyperbolic-s [5]. Although the neural-network based approaches have been quite successful in determining the correct fault type, the main disadvantage of neural-network is that it requires a considerable amount of training effort for good performance, especially under a wide variation of operating conditions (such as system loading level, fault resistance, source impedance, etc.). Moreover, another disadvantage of neural-network-based algorithms is that the training may not converge in some cases, as the starting point is chosen at random and can end up in a local minimum [6-7].

2. LITERATURE SURVEY

1 The stability of power system is largely affected by faults on the transmission line and time required to clear the faults. About two-third of the faults occur on transmission line network. Thus, power system stability and power quality is largely dependent on transmission line protection schemes. Quick detection of faults helps in faster maintenance and restoration of supply resulting in improved economy and reliability of power system. Wavelet Transform (WT) is an effective tool in analyzing transient current signals associated with faults both in frequency and time-domain. Kim Chul-Hwan, et al used WT to detect high impedance arcing faults [1]. A protection scheme using Haar wavelet to detect dc component for identifying the faulty phases was introduced in [16]. A wavelet based multi-resolution analysis for locations of faults on transmission lines had been proposed by D. Chanda, et al [2]. Distance protection schemes using WT based phasor estimation was reported in [3]-[4]. Wavelet based protection scheme for fault detection, classification and location was proposed by S. Abdul Gafoor, et al [17]. In [5]-[6], protection schemes based on WT had been proposed for series and parallel transmission systems. A protection scheme using wavelet based transient extraction for fault detection for transmission lines was proposed by P. Venugopal Rao et al [7]. For three terminal transmission lines wavelet transform based approach had been proposed, in which first and second peaks of fault generated transients are used for estimating fault location [18]. The performance of the scheme can be improved by using synchronized sampling of signals from both the ends of transmission lines with the help of Global Positioning System (GPS) clock. GPS based algorithms with better performance and accuracy had been proposed in [8],[9],[19]. Artificial Neural Networks (ANN) which have excellent properties capabilities of pattern recognition and non-linear mapping were used to estimate the fault location [10]-[11]. M. E. Masoud and M.M.A. Mahfouz introduced a protection scheme for transmission lines based on alienation

coefficients of current signals [12]. Protection Scheme which considers effect of fault incidence angle had been introduced by F.B.Costa et al [13]. Andre De Souza Gomes, et al developed a fault detection and classification algorithm based on model parameter analysis [14]. Distance Relay protection scheme for long and short transmission lines was introduced by Mohammed Ismail et al [20]. Shaik Abdul Gafoor et al developed a transmission line protection scheme using detail coefficients based alienation technique using current signals of local buses [21]. FACTS devices help in enhancing transfer capability of transmission system, thereby minimizing gap between stability and thermal limits. However, these pose challenges in conventional distance protection schemes. A protection scheme has been proposed for transmission lines with UPFC by Ravi K. Goli et al using wavelet transform [15].

3. THE WAVELET TRANSFORM

The wavelet transform (WT) has broad application in the analysis of stationary and nonstationary signals. These applications include the removal of electrical noise from the signals, detection of abrupt discontinuities, and compression of large amounts of data. The use of WT in corrosion studies is not the exception, as shown by the works published in the literature [9–12].

With the WT, it is possible to decompose a signal into a group of constituent signals, known as wavelets, each with a well defined, dominant frequency, similar to the Fourier transform (FT) in which the representation of a signal is by sine and cosine functions of unlimited duration. In WT, wavelets are transient functions of short duration, that is, limited duration centered around a specific time. The problem of the FT is that when passing from the time domain to the frequency domain the information of what happens in time is lost. Observing the frequency spectrum obtained using the FT is simple to distinguish the frequency content of the signal being analyzed but it is not possible to deduce in what time the components of the signal of the frequency spectrum appear or disappear. Unlike the FT, the WT allows an analysis in both time and frequency domains giving information on the evolution of the frequency content of a signal over time

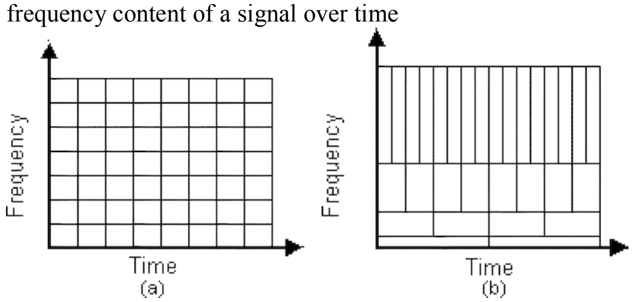


Figure 1: The Wavelet Transform

4. THE DISCRETE WAVELET TRANSFORM

The DWT is considered a suitable tool for the elimination of electric noise as a novel alternative that replaces procedures of attenuation of electrical noise with the use of low-pass filters of the systems Lock-In Amplifier or fast Fourier transform (FFT) that alone can be used in the circumstances in which the electrical noise has a very small overlap of bands or completely different and separated from the signal and the noise to be able to use the method of filtering, this being an important limitation in the moment of processing digitally signals not stationary whose content changes over time.

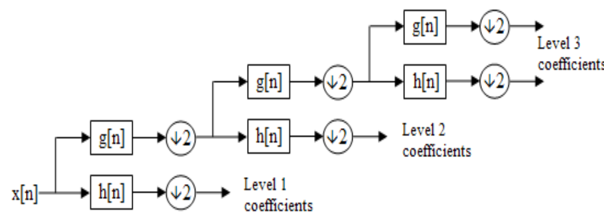


Figure 2: The Discrete Wavelet Transform

4. PROBLEM STATEMENT

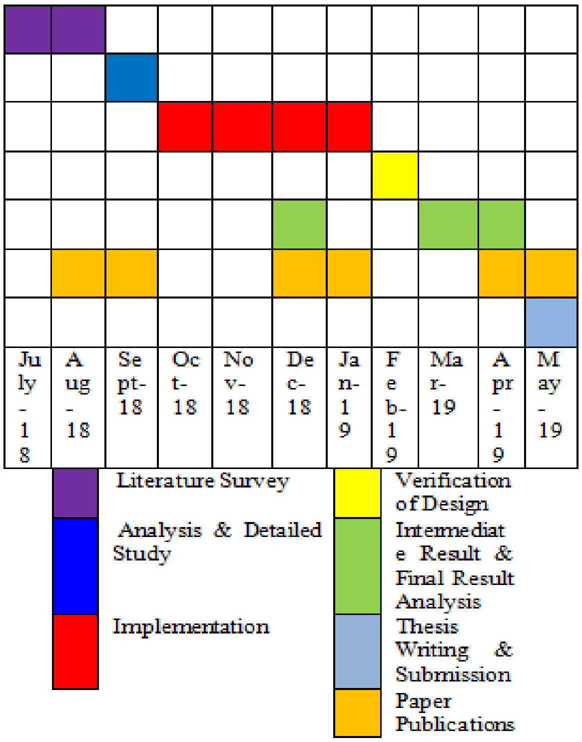
To develop an transmission model using Simulink software and to analyze the current signature of the transmission line. Use this current signature and give it to a wavelet and contourlet block. Each of the wavelet and contourlet blocks will process this data, and find features from it. These features will be then given to a linear classifier for training and evaluation purposes. This classifier will then find the fault from the current waveforms and produce it at the output. The output for each of the feature extraction techniques will be compared in terms of accuracy and delay of processing.

5. PROPOSED WORK

The proposed work can be divided into the following modules,

1. Development of transmission line model and current patterns
2. Development of DWT feature extraction
3. Development of Contourlet feature extraction
4. Evaluation using kNN classifier
5. Result comparison and optimization if needed

6. PLAN OF RESEARCH WORK



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