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Detection of Fault Location in Transmission Lines using Wavelet Transform

Shilpi Sahu (M.E. Student), Dr. A. K. Sharma (H.O.D)
Department of Electrical Engineering, Jabalpur Engineering College, Jabalpur, (M.P.), India

Abstract -This paper presents a technique to detect the location of the different faults on a transmission lines for quick and reliable operation of protection schemes. The simulation is developed in MATLAB to generate the fundamental component of the transient voltage and current simultaneously both in time and frequency domain. One cycle of waveform, covering pre-fault and post-fault information is abstracted for analysis. The discrete wavelet transform (DWT) is used for data preprocessing. It is applied for decomposition of fault transients, because of its ability to extract information from the transient signal, simultaneously both in time and frequency domain. MATLAB software is used to simulate different operating and fault conditions on high voltage transmission line, namely single phase to ground fault, line to line fault, double line to ground and three phase short circuit.

Keywords- *Simulink, Transmission line Fault Detection, Wavelet, Discrete Wavelet Transform,*

I. INTRODUCTION

Fault location and distance estimation is very important issue in power system engineering in order to clear fault quickly and restore power supply as soon as possible with minimum interruption. This is necessary for reliable operation of power equipment and satisfaction of customer. In the past several techniques were applied for estimating fault location with different techniques such as, line impedance based numerical methods, travelling wave methods and Fourier analysis. Nowadays, high frequency components instead of traditional method have been used. Fourier transform were used to abstract fundamental frequency components but it has been shown that Fourier Transform based analysis sometimes do not perform time localization of time varying signals with acceptable accuracy. Recently wavelet transform has been used extensively for estimating fault location accurately. The most important characteristic of wavelet transform is to analyze the waveform on time scale rather than in frequency domain. Hence a Discrete Wavelet Transform (DWT) is used in this paper because it is very effective in detecting fault- generated signals as time varies .This paper proposes a wavelet transform based fault locator algorithm. For this purpose, 735KV, 300km, 50Hz transmission line is simulated using power system BLOCKSET of MATLAB.

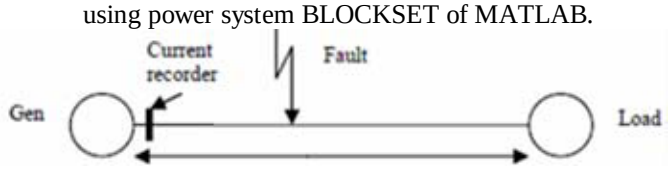
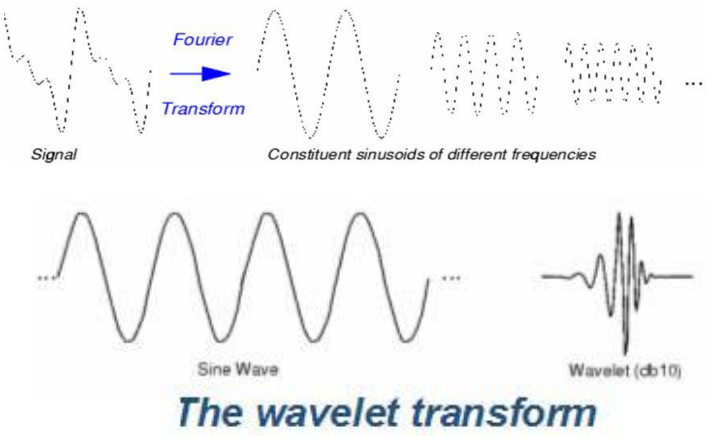


Fig.1- sample power system network

II. WAVELET TRANSFORM

Wavelet transform (WT) is a mathematical technique used for many application of signal processing. Wavelet is much more powerful than conventional method in processing the stochastic signal because of analyzing the waveform in time scale region. In wavelet transform the band of analysis can be adjusted so that low frequency and high frequency components can be windowing by different scale factors. Recently WT is widely used in signal processing application such as de noising, filtering, and image compression. Many pattern recognition algorithms were developed based on the wavelet transform. According to scale factors used the wavelet can be categorized into different sections.



In this work, the discrete wavelet transform (DWT) was used. For any function (f), DWT is written as.

$$DWT(m,k) = \frac{1}{\sqrt{a_0^m}} \sum_n x(n) g\left(\frac{k - nb_0 a_0^m}{a_0^m}\right) \quad (1)$$

Where:
g (n) is the mother wavelet,
x (n) is the input signal, and
k is integer variable refers to a particular sample number in an input signal.
DWT is implemented by using a multi-stage filter.

III. TRANSMISSION LINE

An overhead transmission line is one of the main components in every electric power system. Transmission lines connect the generating stations

and load centers. As the generating stations are far away from the load centers they run over hundreds of kilometers. Since faults can destabilize the power system they must be isolated immediately. Fault analysis is very important issue in power system engineering in order that to clear faults quickly and restores power supply as soon as possible with minimum interruption. When a fault occurs on an electrical transmission line, it is very important to detect it and to find its location in order to make necessary repairs and to restore power as soon as possible. The time needed to determine the fault point along the line will affect the quality of the power delivery. Therefore, an accurate fault location on the line is an important requirement for a permanent fault. Transmission line protection is an important issue in power system engineering because 85-87% of power system faults are occurring in transmission lines.

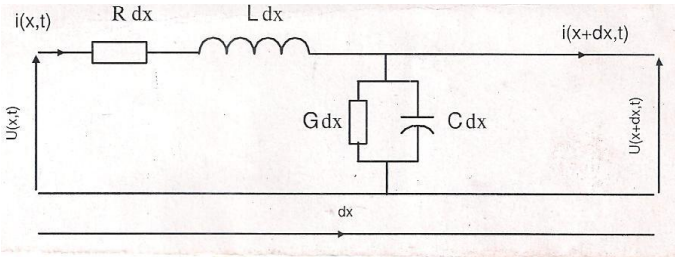


Fig. 2- Single phase transmission line model

VI . BASIC IDEAS & PROPOSED ALGORITHM

Faults take place at different position of transmission line. All the data is collected from sending end of the system. Fault signals (voltages and currents) are collected for a cycle at 50 Hz. These signals are taken in discrete form, samples of current and samples of voltage are taken for all types of faults.

This method presents a wavelet transform (WT) and MATLAB based simulation for estimating fault location on transmission lines. The simulation is developed as a one-end frequency based technique and used both voltage and current effect resulting from remote end of the power system. One cycle of waveform, covering pre-fault and post-fault information is abstracted for analysis. The discrete wavelet transform (DWT) is used for data preprocessing. Discrete Wavelet Transform is applied for determining the fundamental component, which can be useful to provide valuable information to the Distance relay to respond to a fault. It is applied for decomposition of fault transients, because of its ability to extract information from the transient signal, simultaneously both in time and frequency domain. MATLAB software is used to simulate different operating and fault conditions on high voltage transmission line, namely single phase to ground fault, line to line fault, double line to ground and three phase short circuit.

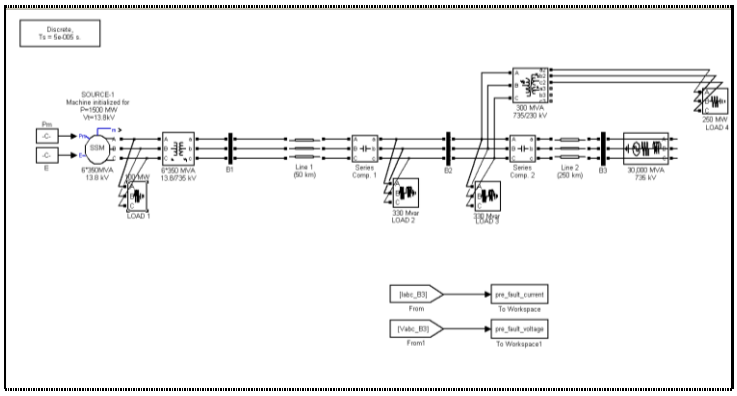


Fig. 3 Transmission line modal without fault

V. SIMULATION RESULTS

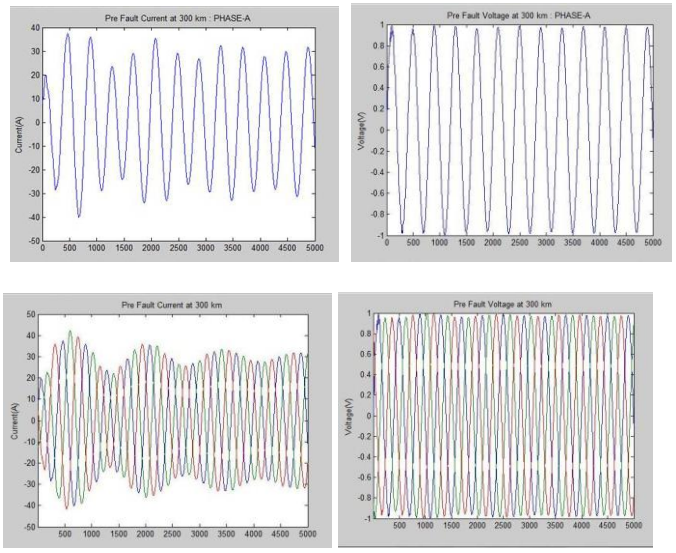


Fig. 4- Pre-fault current and voltage waveform at 300km

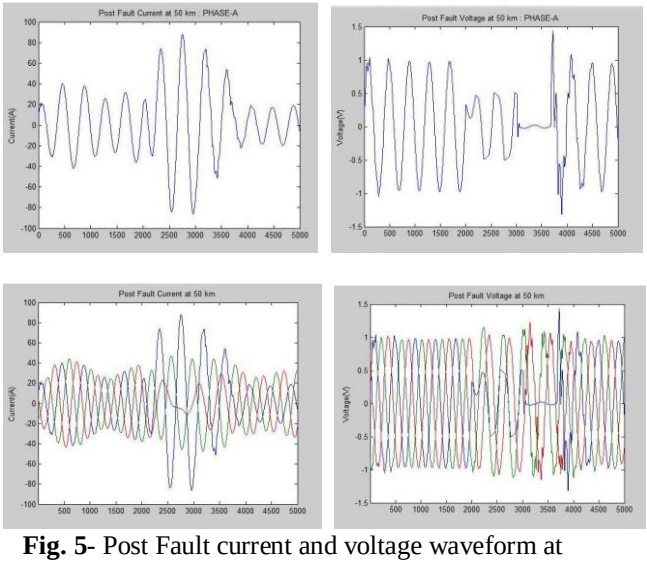


Fig. 5- Post Fault current and voltage waveform at 50km

VI. RESULTS

Percentage error between the actual and obtained distances is calculated as

$$\% \text{ Error} = \frac{(\text{Calculated Distance} - \text{Actual Distance})}{\text{Actual Distance}} * 100$$

Fault location for L-G fault:

The actual distance where the fault is created is compared with distance calculated using wavelet transform and the error between the two (i.e., the actual distance and calculated distance) are tabulated as shown in table 1 different distances.

Table 1

LG Fault		
Actual Distance (KM)	Calculated Distance (KM)	% Error
50	49.37	-1.26
100	100.56	0.56
150	152.92	1.94
200	207.83	3.915

VII. CONCLUSION

The application of the wavelet transform to estimate the fault location on transmission line has been investigated. The ability of wavelets to decompose the signal into frequency bands in both time and frequency allows accurate fault detection. The most suitable wavelet family has been made to identify for use in estimating the fault location on transmission line. Simulation of single line to ground fault (S-L-G) for 735kv, 300km transmission line was performed using SIMULINK MATLAB SOFTWARE. The waveforms obtained from SIMULINK have been converted as a MATLAB file for feature extraction. DWT has been used to analyze the signal to obtain the coefficients for estimating the fault location. Finally it was shown that the proposed method is accurate enough to be used in detection of transmission line fault location.

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