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Identification And Classification Of Transmission Line Faults Using Wavelet Spectral Analysis

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Abstract

Wavelet analysis is splitting of signals in to small and transformed forms of an original wavelet. Wavelet transform is a representation of a function by wavelets. Wavelets are scaled and translated copies of fast decaying oscillating waveform. The main objective of this paper is the detection of line faults and classification of the line faults in the transmission line wavelet transformation. In order to analyze current waveforms during fault condition Discrete wavelet transform is used (DWT). The discrete wavelet transform has been implemented for power system fault analysis. Most of the work focuses on the balanced power system by using per phase and also analyzing the fault with different types of wavelets. Matlab/ Simulink is used to generate signal and validate the accuracy of the decomposed signal. It is inferred from the simulation results that the performance of the proposed fault detection indicator is promising and can be easily implemented for computer relaying application.

Keywords: Transmission line, Faults, wavelets and Discrete Wavelet Transform

1. Introduction

Power system plays an important role in electrical engineering. In order to ensure the continuity of supply it is important to ensure that fault will be cleared at the earliest without any delay. Since our generating stations are located away from load centers. The power is transmitted over long distances,

the occurrence of fault are more hence losses will increase. These losses will disturb the stability of the power system. In order restore the stability of the system faults analysis plays an important role [1].

There are various methods for fault detection. But these methods mainly focus on the voltage and current wave form pattern of the fault. Some of the techniques used are Artificial neural network[2], kalmen filtering based algorithms, Fourier analysis based algorithms[3] , FIR filtering analysis based algorithms[4] and Short term Fourier transform (STFT) [5][6]. The existing techniques has limitations, supports only time plots, and these plots could not be exported as a image file and appropriate information of power systems needed.

This paper proposes a technique of wavelet analysis in which splitting of signals at various levels are allowed [7]. Here the basic task is explained at low and high frequencies, hence through the large window low frequency components will be replicated and through small windows discontinuities are obtained. The proposed system will be implemented using MAT lab [10]. The proposed approach revealed efficient fault type detection

2.Wavelet Transfor

Wavelet is term used to describe the short term series. Wavelet transform is an excellent tool for detection of non-stationary vibration of signal [frequency changes with time]. Wavelet transform uses small windows for high frequency and large windows for low frequency. The most popular application of wavelet transform techniques are given

as follows: (1) continuous wavelet transform (CWT) and (2) Discrete wavelet transform (DWT). Large amount of data in terms wavelet co-efficient will be generated in CWT. Hence it leads to large computational burden, in order to overcome from this DWT is used. Wavelet transform can be applied in power system for analysis of power quality, partial discharge, forecasting in power system, power system measurement, protection and transient.

2.1.Analysis of wavelet transform

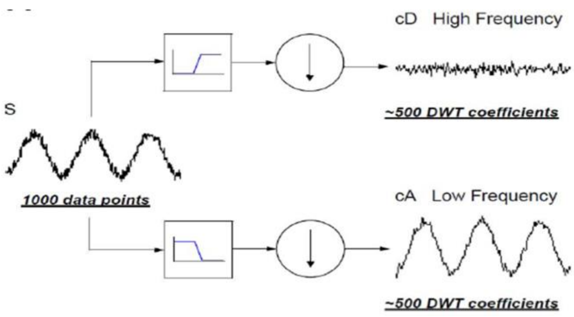

Fig 1. Analyses of signal using wavelet transform

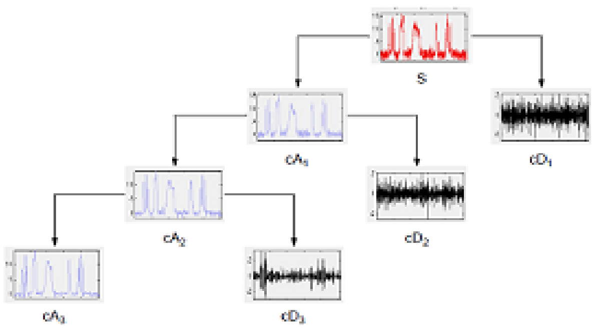

Fig 2 DWT multi filter bank frame work

Wavelet transform by using high pass (HP) and low pass (LP) filters successfully implemented. Hence by applying 3rd level decomposition, the original signal 'S' passes through the two complementary filters and appears as two signals estimated and complete. The estimations are high scale and low frequency component signals. The signal split into an estimated and complete. The estimation is then itself split into a second level estimation thus the process will continue until the individual details consist of a single sample.

3.System Study

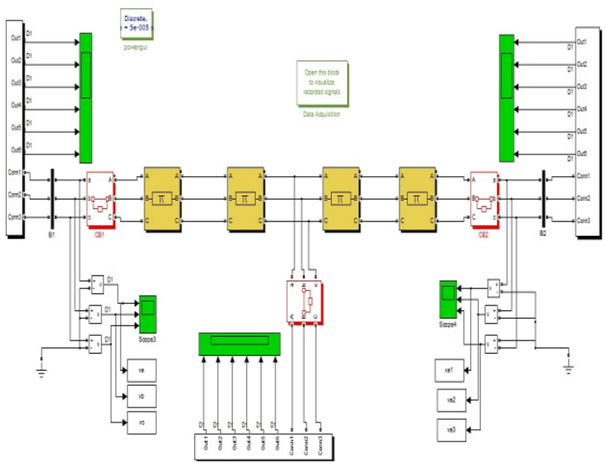

Fig 3: Simulink block diagram of 400kv transmission line model with fault breaker at mid point

Transmission line consisting source S1, S2,and S3. S1, S2 are both ends of the transmission line S3 fault at the midpoint. The line extends to 320km the voltage in the system is 400kv, 50 Hz. To improve the detection of transmission line faults the transmission system is divided into four equal PI sections having 80 Km length (i.e., 4×80 km=320 km). The current waveforms replicated from the simulation are fed as input to the sampling network. Simulation is done in MAT lab

3.1.Simulation using MATLAB

The model signals are decomposed using daubechies 4 which is represented by command db4 in MATLAB using 3 level decomposition to identify the type of fault.

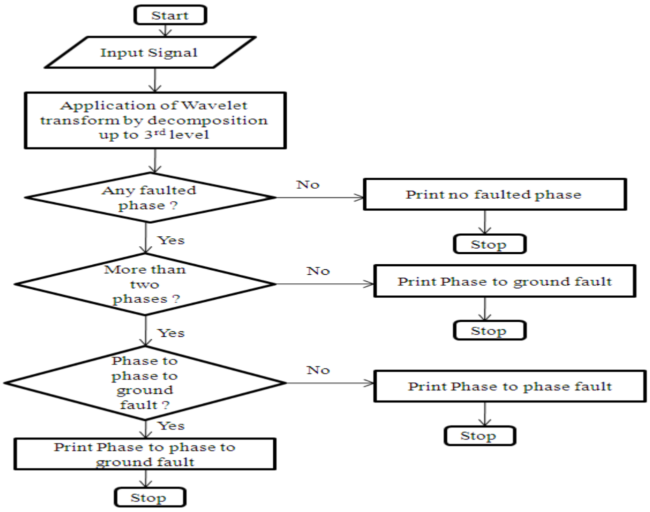

Fig 4: Flow chart for proposed technique

Db4 WAVELET TRANSFORMATION ATDIFFERENT DECOMPOSITION LEVEL

The captured signals are analyzed using different signal processing tools. Before analyzing signal must be filtered. In order to locate the fault, the filtered signal is used.Input AC voltage=400kv, Frequency=50Hz, Circuit breaker transition time= 0.04 sec.

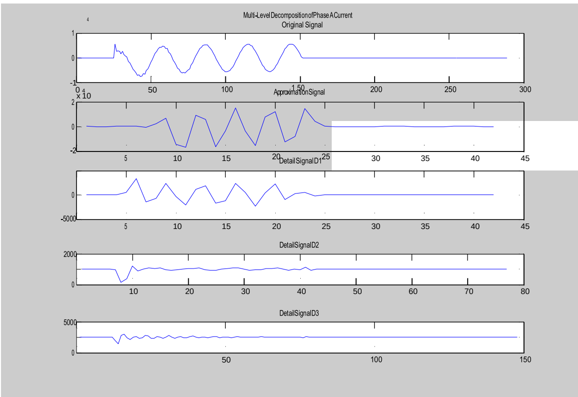

Fig 5: Detection fault with the current signal using Db4 wavelet transformation at decomposition level 'd3'

It can be observed the Db4 wavelet is applied to faulted current signal at decomposition level-3 (d3). So the number of samples can be reduced with increasing decomposition level i.e., the original signal contains 300 samples, but the samples at decomposition level 3 will be 150. So the number of samples can be reduced to detect faulted phase and also fault location.

4.Results And Discussions

In the proposed technique, the two important aspects like data window length having desired evidence to obtain required wavelet and second one is short sufficient to produce at expected speed.

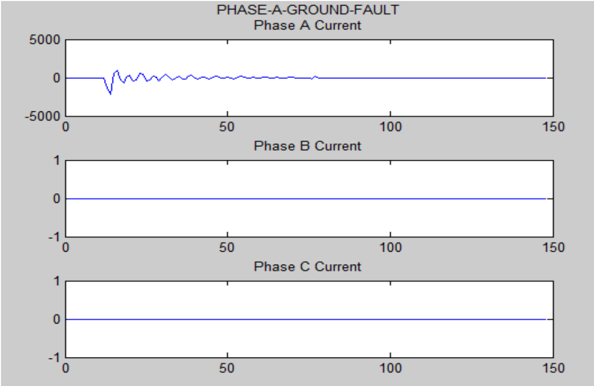

Fig 6. Simulation result for current at bus 1 due to phase A to Ground fault

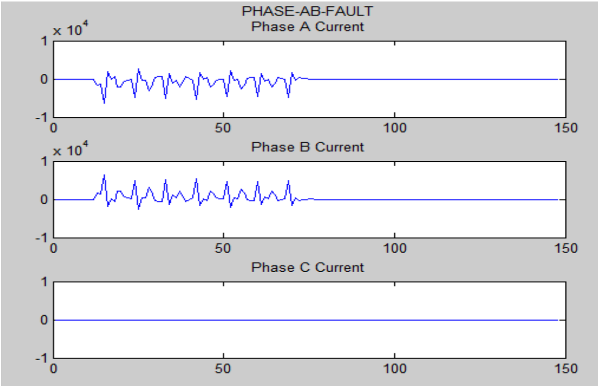

Fig 7. Simulation result for current at bus 1 due to Phase A to Phase B fault

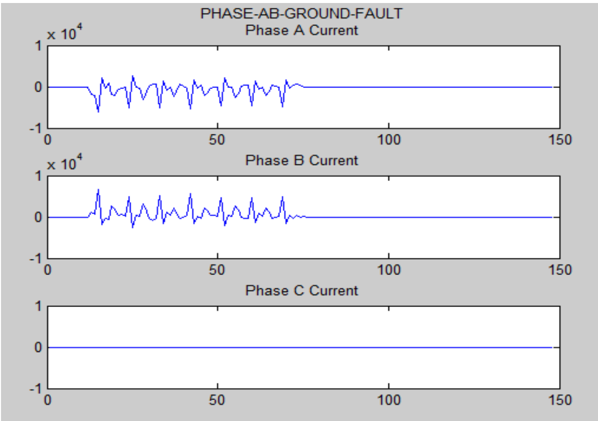

Fig 8. Simulation result for current at bus 1 due to Phase A, Phase B to Ground fault

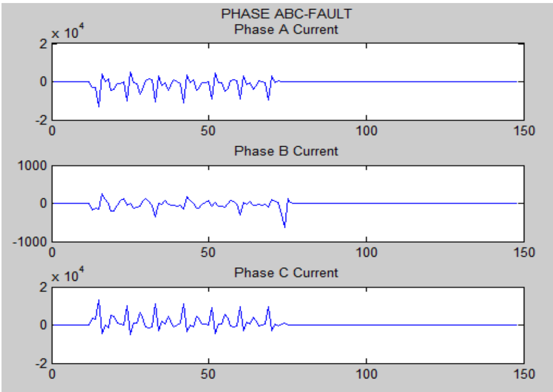

Fig 9. Simulation result for current at bus 1 due to Phase A, Phase B and Phase C fault

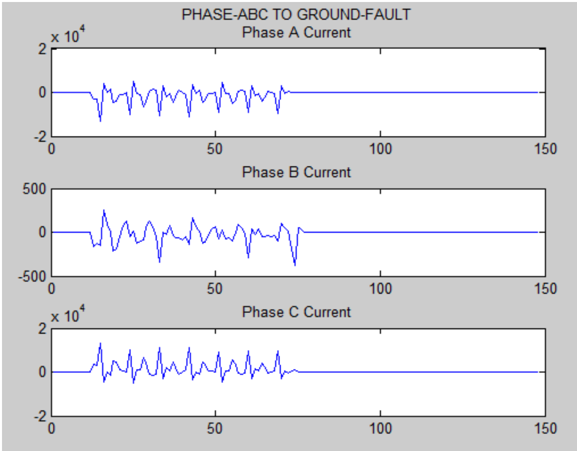

Fig 10. Simulation result for current at bus 1 due to Phase A, Phase B and Phase C to Ground fault

From Fig 6. it can be shown that the sudden spike which is in circled occurs during the phase-A to ground fault in the transmission line. It is observed that sudden spike occurs during the phase-A and phase-B in the transmission line

he classification of the fault along the transmission line and mid point is explained below. Based on the percentage of wavelet energy spectrum of faulted wave for different faults has been classified and energy level of the different faults has been tabled.

Table 1: Wavelet Energy Levels for With-Out Ground Fault

Type of fault / %Ener g y	No- Fault	ABC	AB	BC	CA
Ea	99.9994	90.6569	94.6128	99.9994	90.11130
Eb	99.9933	98.7553	94.5621	99.0723	99.9933
Ec	99.9946	94.2969	99.9946	99.0631	90.2045

Table 2: Wavelet energy levels for with ground faults

Typ e of Fault / %Ene rgy	AG	BG	CG	ABG	BCG	CAG	AB C G
Ea	99.6582	97.1383	96.4346	94.1111	83.4404	89.7138	91.1167
Eb	96.4567	99.8445	96.4008	95.4431	99.4361	95.0082	99.3986
Ec	96.5454	97.0531	99.6562	86.2163	98.2805	91.5415	93.9202

From the above tabular values, we can classify the and small distortion in the healthy phase i.e., phase-C also, because there is no diversion of fault current due to circulating currents. The faulted signals of both phase-A and B are in circled for faulted phase's visibility purpose. From Fig 8 it is observed that no distortion in the healthy phase i.e., phase-C, because in case of double line to ground faults the fault current will be diverted to the ground.fig 9 and fig 10 shows the fault current affected in all three phases. It can be observed that the fault is nearly up to 80 samples and the straight line shows the clearing of fault.types of faults and differentiated the ground and Without ground fault conditions also. For No-fault condition the energy levels of three phases are approximately equal to 100%. The contribution of ground impedance can be recognized based on the percentage of faulty signal wave at each and every phase. It has been observed that the percentage of energy for involving ground fault is more than without ground fault (Phase to Phase fault).

5.Conclusion

In this paper, Transmission line faulted phase and fault location detection using Wavelet transform technique has been proposed. Wavelet transformation gives the benefits of analyzing signals better than previous techniques like Fourier transformation and short-time Fourier transformation. The Simulink model of the Transmission line system has been developed and results have been simulated. Simulation results of transmission line faults at different phases and fault location detection using Wavelet transform technique were carried out by using Matlab/Simulink. Wavelet tool and from the analysis of the simulation results have been presented and analyzed. The transient response of the faulted phase is fast, i.e. the sudden increases in the current signals are obtained very quickly. The Wavelet transform is more efficient than the previous technique. Thus Wavelet transform technique is more useful in the Transmission lines than the distribution systems, because the detection of faulted phase and fault location cost is more, but the time consumption is less and speed of operation is very high

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