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# Transmission line Fault Detection, Classification and Location by using DWT (Discrete Wavelet Transform)

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**Abstract:** This paper focused on identification of simple power system faults using wavelet based analysis of transmission line parameter disturbances. Generally the transients are non stationary waves. Wavelets are best choice to analyses the transient signals. The faults in transmission lines are line to ground fault, line to line fault and three phase faults.. Many researches are even going on to enhance the techniques to solve these problems. Here discrete wavelet transform is used for extract the hidden factors from the fault signal by performing decomposition at each level. These transients can be analyzed by using DWT ( Discrete Wavelet Transform) and the fault can be classified. The maximum detail coefficient, energy of the signal and the ratio of energy change of each phase currents are calculated from the transients produced by each phases due to faults using Discrete Wavelet Transform (DWT) and thus detecting and classifying transmission system faults. MATLAB Simulation results presented here validates the component models and the chosen fault detection scheme.

**Keywords:** Transmission line faults, fault detection, matlab simulink, discrete wavelet transform.

## I. INTRODUCTION

The major faults in transmission lines are line to ground fault, line to line fault and three phase faults. These faults can be identified and classified using discrete wavelet transform. Transmission lines, among the other electrical power system components, suffer from unexpected failures due to various random causes. These failures interrupt the reliability of the operation of the power system.

According to fault transients, there are number of algorithms have been developed for detection of faults and its classification. In this proposed algorithm, how transient features are extracted from original fault signal is an important issue. Wavelet Transform (WT) is selected as the strongest tool to analyze the fault because of its perfect time frequency localization ability (2-6).

A fault occurs when two or more conductors come in contact with each other or ground in three phase systems, faults are classified as Single line-to-ground faults, Line-to-line faults, double line to ground faults, and three phase faults. For it is at such times that the power system components are subjected to the stresses because of excessive currents These faults give rise to serious damage on power system equipment. Fault which occurs on transmission lines not only effects the equipment but also the power quality. So, it is necessary to determine the fault type and location on the line and to clear the fault as soon as possible in order not to cause such damages. Flash over, lightning strikes, birds, wind, snow and ice-load lead to short circuits. Deformation of insulator materials also leads to short circuit faults. It is essential to detect the fault quickly and separate the faulty section of the transmission line. Locating ground faults quickly is very important for safety, economy and power quality. In this wavelet based fault analysis, analyzing the energy levels of wavelets of each phase and zero sequence currents and thus detecting and classifying the faults. Figure 1 shows the block diagram of discrete wavelet transform based transmission line fault analysis.

## II. DISCRETE WAVELET TRANSFORM (DWT)

Discrete Wavelet Transform is found to be useful in analyzing transient phenomenon such as that associated with faults on the transmission lines. Multi-Resolution Analysis (MRA) is one of the tools of Discrete Wavelet Transform (DWT), which decomposes original, typically non-stationary signal into low frequency signals called approximations and high frequency signals called details, with different levels or scales of resolution. It uses a prototype function called mother wavelet for this. At each level, approximation signal is obtained by convolving signal with low pass filter followed by dyadic decimation, whereas detail signal is obtained by convolving signal with high pass filter followed by dyadic decimation Wavelet theory is the mathematics, which deals with building a model for

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non-stationary signals, using a set of components that look like small waves, called wavelets. It has become a well-known useful tool since its introduction, especially in signal and image processing. The DWT is easier to implement than Continuous Wavelet Transform CWT because CWT is computed by changing the scale of the analysis window, shifting the window in time, multiplying the signal and the information of interest is often a combination of features that are well localized temporally or spatially This requires the use of analysis methods sufficiently, which are versatile to handle signals in terms of their time-frequency localization. Frequency based analysis has been common since Fourier's time; however frequency analysis is not ideally suited for transient analysis, because Fourier based analysis is based on the sine and cosine functions, which are not transients. These results in a very wide frequency spectrum in the analysis of transients Fourier techniques cannot simultaneously achieve good localization in both time and frequency for a transient signal. The main advantage of WT over Fourier Transform is that the size of analysis window varies in proportion to the frequency analysis. WT can hence offer a better compromise in terms of localization. The wavelet transform decomposes transients into a series of wavelet components each of which corresponds to a time domain signal that covers a specific octave frequency band containing more detailed information.Such wavelet components appear to be useful for detecting, localizing, and classifying the sources of transients. Hence, the wavelet transform is feasible and practical for analyzing power system transients. Following figure shows the high frequency and low frequency splitting of transient signal.

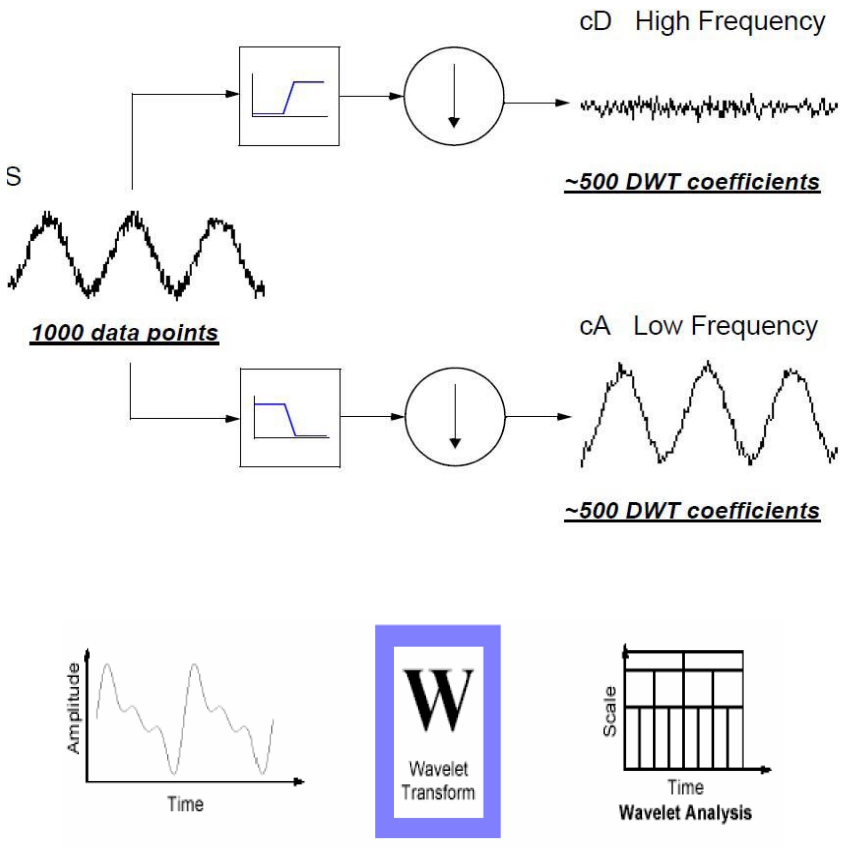


Fig.ure 1- .Analysis of signal using wavelet transforms

## III. SYSTEM STUDY AND WORK PROCESS

Different types of faults were simulated using MATLAB simulation and after recorded transient signals they were decomposed using wavelet toolbox to get there maximum details coefficient, energy of these signals and then making compression to these signals to get the ratio of energy change from the first level and how faults make changes to the energy of these signals. Simulation was carried out for all different single phase to ground fault but only shown here is Phase-A to ground all different double Phase with or without ground are simulated and analyzed but only shown here are Phase-AB (double phase fault) and AB-G (double line to ground fault and three phase faults.

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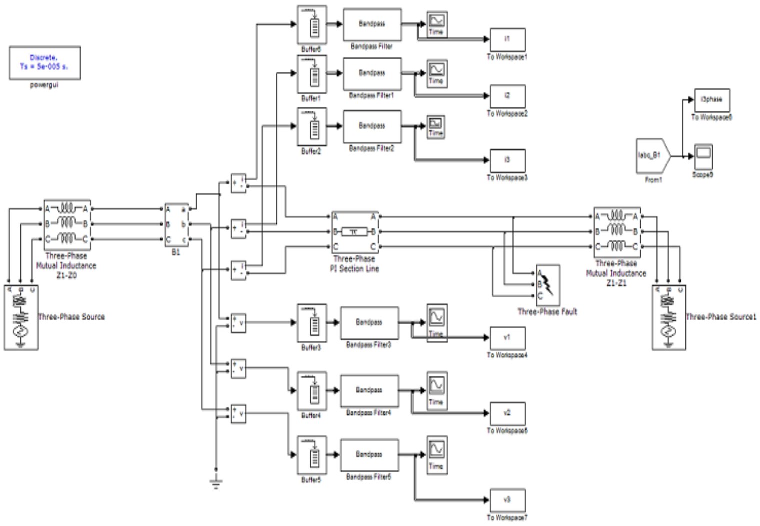

Figure 2-Model for detection and classification of faults.

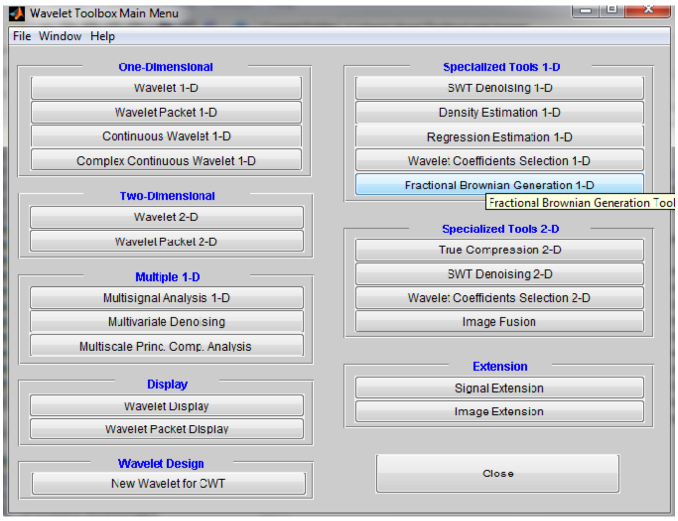


Figure 3- Wavelet toolbox main menu

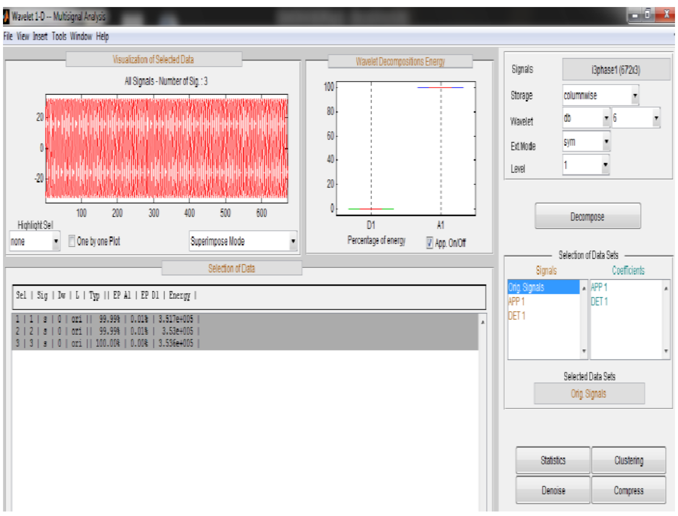

Figure 4-Wavelet 1D - multisignal analysis

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## IV. FAULT CASES STUDY AND RESULTS

### *a. Normal condition*

Three phase current signals at no fault condition and there detail coefficient are shown in figure 4 which indicate that when there are no fault the detail coefficient of these signals are near to reach zero(straight line) and only appear the ending effect of sym. wavelet which also very small and near zero (1*10-3) and the energy of each signal and the rate of energy change (E.ratio) after signals compression are very small.

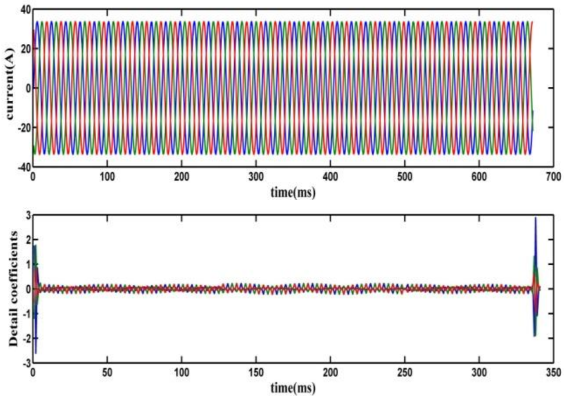


Figure 5-Three phase current signals and its detail coefficients at healthy condition

Table 1-Maximumnorm valu, energy and threshold detail coefficient of three phase at normal condition.

| Phases | Parameters | Values |
|---|---|---|
| A | Maximum norm | 0.5414 |
| | Energy of signal | $3.886*10^5$ |
| | Thre. D coefficient | 0.839 |
| B | Maximum norm | 0.5415 |
| | Energy of signal | $3.909*10^5$ |
| | Thre. D coefficient | 0.743 |
| C | Maximum norm | 0.5414 |
| | Energy of signal | $3.88*10^5$ |
| | Thre. D coefficient | 0.459 |

### *b. Single phase to ground fault*

Three phase current signals with phase A to ground fault are shown and the arrow pointed very clear when the fault inception began (around sample 1800 which is half number of samples from its original signal fault inception time) although two other phases (seems smooth lines) had no change or less change with comparison with this great amount of change at that A phase. This also described by the data included in table 2 as the faulty phase was the highest in detail coefficient (greater than 0.001),energy and the change of energy ratio (higher than normal condition) so it was much cleared to detect the faulty phase.

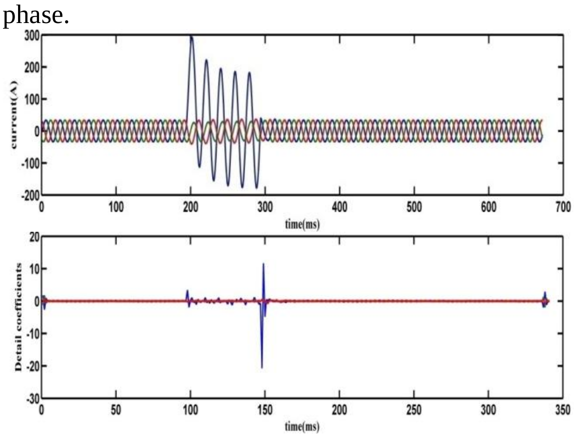


Figure 6-Three phase current signals and its detail coefficients at single phase to ground fault.

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| Fault type | Parameters | A | B | C |
|---|---|---|---|---|
| a-g | Max. norm | 4.775 | 0.6395 | 0.6563 |
| | Energy | $2.324*10^6$ | $3.833*10^5$ | $4.024*10^5$ |
| | Thre. D coeff. | 18.299 | 0.929 | 0.786 |
| b-g | Max. norm | 0.9647 | 3.985 | 0.9932 |
| | Energy | $4.142*10^5$ | $2.11*10^6$ | $3.956*10^5$ |
| | Thre. D coeff. | 5.634 | 15.955 | 5.971 |
| c-g | Max. norm | 0.9467 | 1.295 | 3.697 |
| | Energy | $3.856*10^5$ | $4.022*10^5$ | $1.951*10^6$ |
| | Thre. D coeff. | 8.030 | 8.471 | 16.819 |

Table 2 - Maximum norm value, energy and threshold detail coefficient of three phases at single phase to ground fault.

*c. Double phase fault*

Three phase current signals with phases A-B fault were shown only two faulty phases at fault time catch a great amount of change although the healthy phase had nearly zero change. This also described by the data included as the healthy phase was nearly no change and nearby normal condition in detail coefficient, energy and the change of energy ratio although faulty phases were so different than normal condition and the maximum detail coefficient of these faulty phases were greater than 0.001 this means that these phases were in fault condition and when making compression the amount of energy change ratio of two faulty phases were typically same or in neglected difference amount this will indicate that these faulty phases were not connected to the ground.

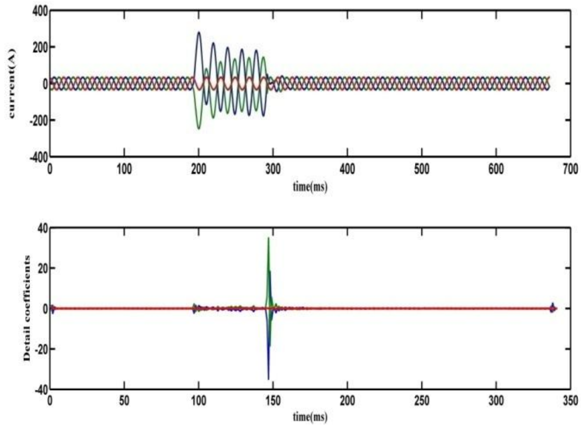


Figure 7-Three phase current signals and its detail coefficients at double phase fault

| Fault type | Parameters | A | B | C |
|---|---|---|---|---|
| ab | Max. norm | **4.5** | **3.976** | 0.5452 |
| | Energy | $\mathbf{2.225*10^6}$ | $\mathbf{1.677*10^6}$ | $3.919*10^5$ |
| | Thre. D coeff. | **24.664** | **24.782** | 0.460 |
| bc | Max. norm | 0.5452 | **2.934** | **2.395** |
| | Energy | $3.925*10^5$ | $\mathbf{1.91*10^6}$ | $\mathbf{1.376*10^6}$ |
| | Thre. D coeff. | 0.843 | **11.819** | **11.693** |
| ca | Max. norm | **3.723** | 0.5458 | **4.248** |
| | Energy | $\mathbf{1.619*10^6}$ | $3.948*10^5$ | $\mathbf{2.179*10^6}$ |
| | Thre. D coeff. | **12.397** | 0.747 | **12.167** |

Table 3-Maximum norm value, energy and threshold detail coefficient of three phases at double phase fault.

*d. Three phase fault*

Three phase current signals with three phase fault were shown in figure shown that at fault inception time there were great change to all phases energy , energy ratio and all maximum detail coefficient of these faulty phases were higher than 0.001 and the energy of each signals were presented in table which were higher than normal condition.

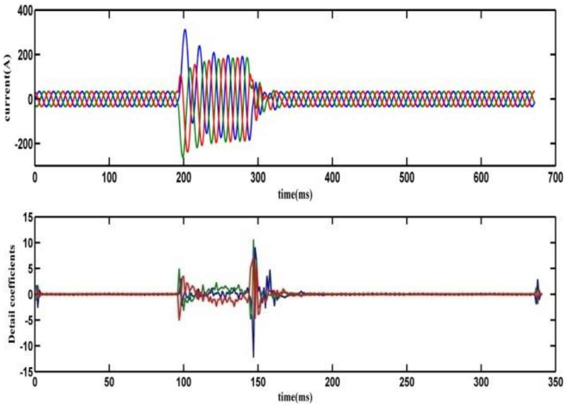


Figure 8-Three phase current signals and its detail coefficients at three phase to ground fault.

| Fault type | Parameters | A | | B | | C | |
|---|---|---|---|---|---|---|---|
| | | Normal condition | Faulty condition | Normal condition | Faulty condition | Normal condition | Faulty condition |
| abc | Max. Norm | 0.5414 | 4.983 | 0.5415 | 4.188 | 0.5414 | 3.856 |
| | Energy | $3.886*10^5$ | $2.601* 10^6$ | $3.909*10^5$ | $2.302* 10^6$ | $3.88*10^5$ | $2.089* 10^6$ |
| | Thre.D. coefficient | 0.839 | 34.374 | 0.743 | 10.454 | 0.459 | 24.465 |

Table 4- Maximum norm value, energy and threshold detail coefficient of three phases at three phase to ground fault.

## V. CONCLUSION

This paper proposed a detection and classification method for the transmission line faults. For the fault detection and classification, a wavelet based current signature analysis technique is used. A theoretical analysis, the complete design process, and the obtained results, in simulation, have been given in this paper. The application of wavelettransform to determine the type of fault was achieved a very good and accurate classification for the change in the signal shape due to fault occurrence. The ability of wavelets to decompose the signal into frequency bands in both time and frequency allows accurate fault detection.

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