ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Improvement of Reliability of Power System Using Discrete Wavelet Transform

C. Thimma Reddy
PG Scholar,
Department of EEE,
Madanapalle Institute of Technology & Science.

Dr. B. Rama Kumar
Professor,
Department of EEE,
Madanapalle Institute of Technology & Science.

ABSTRACT:

In the power system, reliability and stability must be ensured to provide continuity of service. Relays play a key role in power system protection. Before employing them in the system, their parameters should be pre-determined. Transmission line is a medium between the generating stations and the loads (Industries & Households). As these lines run over several kilo meters there is a chance for occurrence of fault. These faults are Line to Ground (LG), Line to Line (LL), Line to Line to Ground (LLG), and Symmetrical faults (LLL). In order to maintain stability, faults should be cleared at a short span of time [1]. To clear the faults, first we need to detect the type of fault with location.

The proposed system uses Discrete Wavelet Transform to determine the fault levels in power system [2]. It is used to extract the hidden factors i.e. transients, from the faulty current signals by performing decomposition at different levels. Test system is modeled and fault signals are imported to workspace and tested the reliability of the algorithm. The proposed system is modeled in MATLAB/SIMULINK to detect, classify and locate all the possible faults in the transmission line in the power system, which are nothing but parameters of relays.

Keywords :

Transmission Line, Faults, Relay Parameters, Transients, Discrete Wavelet Transform.

1.INTRODUCTION:

Electricity is very important component to Universe. Power System is a system which generates electricity and dispatch to the loads; these are generally industries and households. Power System consists of Generating stations, Transmission lines and Load centers.

Transmission line interconnects the generating station to different load centers. They run over several kilometers and fascinate to faults. To maintain continuity of operation, it is essential to clear the faults within a short period. Relays play main role in protection of transmission line, and assimilated to detect the abnormal condition in the system, which notices faults and isolate the faulty part from the power system, with negligible disturbance in the system. There are several relaying schemes [3] available; they are

* Differential relaying scheme .
* Distance relaying scheme.
* Over current relaying scheme, etc .

Out of these schemes, distance relaying is used for transmission line protection, due to their high speed fault clearance compared to other schemes. A distance relay estimates the electrical distance from fault point to relay position and then compare to threshold value, which is a pre-determined parameters of the relay.

To determine parameters of a relay we need to have measuring techniques, to detect changes in system configuration, source impedance and fault resistance. There are several techniques available like, Artificial Neural Network (ANN), Fuzzy Logic & Fuzzy Neuro, Wavelet based systems, etc to clear the faults with in a short span of a time.

The aim of this paper is to determine the parameters of relay circuit before employing them in protection system by calculating the threshold values from fault detection, fault classification and fault location with respect to relay point. Now, "Discrete Wavelet Transform", which is a wavelet based measuring system, is proposed. [4]

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

1.FAULTS IN TRANSMISSION LINE:

Transmission line faults can be categorized into two types, they are

* Shunt faults.
* Series faults.

2.1 Shunt Faults:

Shunt faults are further classified as symmetrical and unsymmetrical faults. Symmetrical faults will have equal phase voltages i.e. balanced, on the other hand unsymmetrical faults have different phase voltages. The unsymmetrical faults are

* Phase to Ground Fault
* Phase to Phase Fault.
* Phase to Phase to Ground Fault.

Phase to Ground Fault :

The block diagram of single phase to ground fault is shown figure 1, here "p" denotes fault point, "ZF" represents fault impedance and "IA", IB",IC" are respective phase currents.

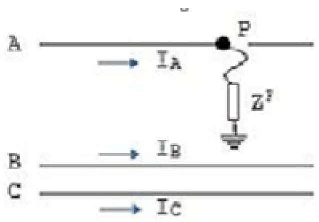


Fig.1: Single phase to ground fault

The fault current can be given as

$$I_F = I_A = \frac{3E}{Z_1+Z_2+Z_3+3Z^F}$$

Where
Z1=Positive sequence impedance Z2=Negative sequence impedance
Z0=Zero sequence impedance
E=Voltage at fault point.

Phase to Phase Fault :

The block diagram of phase to phase fault is shown in figure 2.

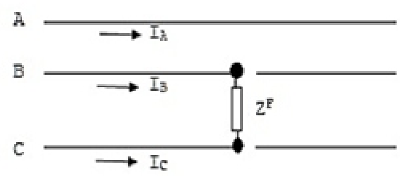


Fig.2: Phase to phase fault

The fault current can be calculated by using the equation.

$$I_F = I_B\text{-}I_C = \frac{\sqrt{3}E}{Z_1+Z_2+Z^F}$$

Phase to Phase to Ground Fault:

The block diagram of phase to phase to ground fault is shown in figure 3. Fault impedance may not be involved.

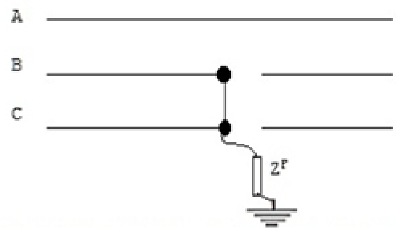


Fig.3: Double phase to ground fault

The fault current in double line to ground fault is the combination of all sequence components currents. We can calculate all sequence currents of phase "A". [5] The fault current is given as

$$I_F = I_B + I_C = 3I_{A0}$$

Zero sequence current of phase 'A' is given as

$$I_{A0} = \frac{Z_1 * I_{A2} - E}{Z_0+3Z^F}$$

Negative sequence current of phase 'A' is given as

$$I_{A2} = \frac{Z_1 * I_{A1} - E}{Z_2}$$

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Positive sequence current of phase 'A' is given as

$$I_{A1} = \frac{E}{Z_1 + \frac{Z_2(Z_0+3Z^F)}{Z_2+Z_0+3Z^F}}$$

Symmetrical Fault:

Symmetrical fault can also be known as three phase fault with or without ground. The block diagram of three phase fault is shown in figure4.

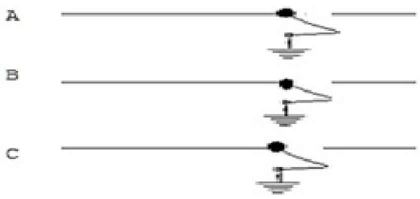


Fig.4: Three phase fault

In symmetrical fault, negative sequence and zero sequence components become zero, the fault current is given as follows

$$I_F = \frac{E}{Z}$$

2.2 Series Faults :

In broken conductor faults the load currents can't be neglected, as these are the only currents that flow in the network. The pre-fault load currents are assumed to be balanced. These faults are classified as follows

* One conductor open,

* Two conductors open,

The one conductor open fault is mathematically identical to double phase to ground fault, except that the voltages measured [6]. The two conductor open fault is mathematically identical to phase to ground fault.

3.DISCRETE WAVELET WAVEFORM:

The discrete wavelet transform is a multi-resolution analysis and is used extensively in power system applications to analyzing transient phenomenon associated to abnormal conditions i.e. Faults.

The discrete wavelet transform (DWT) consists only two filters, one is low pass filter and other is high pass filter. The output of low pass filter is known as "approximations" and is denoted by A(k), on the other hand output of high pass filter is known as "details", denoted by D(k) [4]. The block diagram of third order discrete wavelet transform is shown in figure 5.

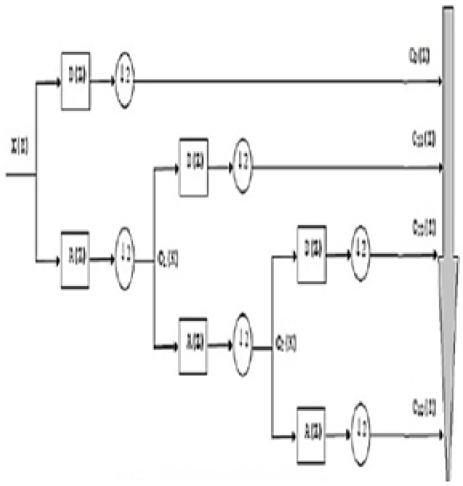


Fig.5: Discrete Wavelet Transform

We consider detail coefficients only, as low pass filter gives output almost same as input i.e. smooth version of input. For DWT, some special families of wavelet functions are developed and these are commonly known as mother wavelets. These are Daubechies, Haar, Coiflets and Symlets.

4.Proposed Methodology:

The proposed methodology uses the Discrete Wavelet Transform for extracting the transient information in the current waveform, which is used to calculate the parameters of the Relay Circuit.

4.1 Waveform Decomposition:

Three phase signals are fed individually through a Discrete Wavelet Transform filter to decompose current waveforms into a series of wavelet components. These wavelet components are very useful for sensing, focusing and classifying the abnormal conditions in the transmission line. In the proposed system, Daubechies (dB) is used as mother wavelet, which is most commonly used in protection applications and 'dB5'wavelet is used to decompose the current signal effectively.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

4.2 Fault Detection :

A fault detector must have ability to detect the abnormal condition to dispute an output signal, indicating the phase condition. During normal condition, both current and voltage waveforms are sinusoidal. Fault signals can be adulterated with different transient components, such as exponentially decaying DC offset and high frequency damped oscillations. The coefficients of 'Details' are used, whether the fault exists or not [5]. If the absolute sum of all detail coefficients are greater than the threshold value, fault will exist, otherwise no fault in the system.

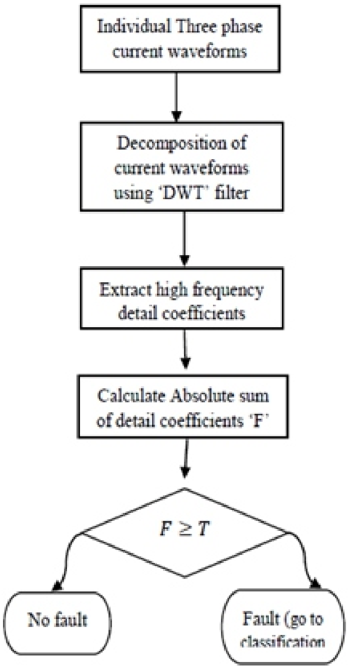


Fig.6: Flowchart for fault detection

Let aA, aB, aC are absolute sums of detail coefficients of individual phase currents. Where,

aA = |sum| of 1st level details of IA
aB = |sum| of 1st level details of IB
aC = |sum| of 1st level details of IC

If 'F' is greater than the threshold value, "T", fault will exist. The step involved in this algorithm is shown in fig.6.

4.3 Fault Classification :

When the algorithm identifies fault in the system, after that it classify the type of fault, it can be performed by individual phase threshold values.

The flow chart of classification is shown in figure 7 [6]. The algorithm starts from last step of fault detection.

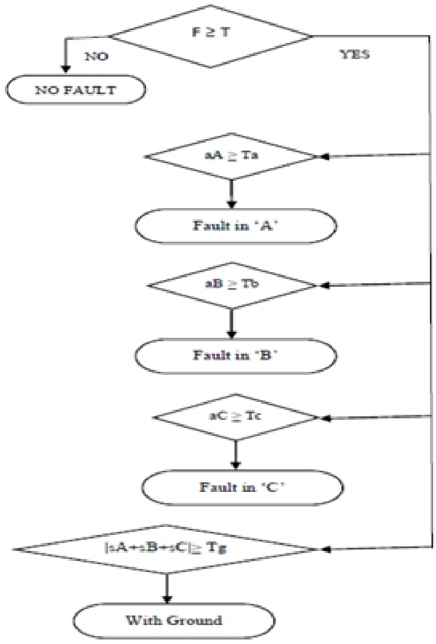


Fig.7: Flow chart for fault classification

Where
Ta = Threshold value of phase 'A'
Tb = Threshold value of phase 'B'
Tc = Threshold value of phase 'C'
sA = Details sum of Phase 'A'
sB = Details sum of Phase 'B'
sC = Details sum of Phase 'C'
Tg = Threshold value of ground

5.Test System:

The test system was modeled in SIMULINK and various fault conditions are generated. The test system is composed of 220 kv transmission lines, with a length of 300 km connected one end to load section and another end to a generating station. The generating station consists of two generators in parallel with a capacity of 247 MVA, 15.75 kv each. The single line diagram of test system is shown in figure 8.

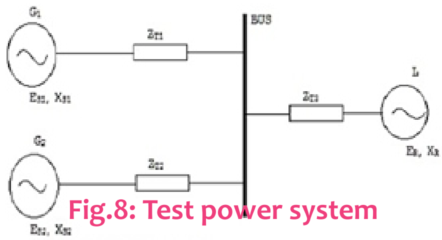


Fig.8: Test power system

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

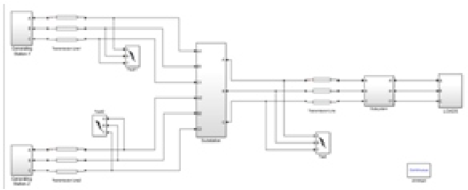


Fig.9: Simulink model of test model

The power system transmission parameters are illustrated in Table-1. The negative sequence parameters are assumed to be negligible.

Table1: Transmission line parameters:

Power Frequency in Hz	50
Transmission line Length in km	300
Positive Sequence Resistance R_1, Ω/km	0.01273
Zero Sequence Resistance R_0, Ω/km	0.3864
Positive Sequence Inductance L_1, H/km	0.93e-3
Zero Sequence Inductance L_0, H/km	4.12e-3
Positive Sequence Capacitance C_1, F/km	12.7e-9
Zero Sequence Capacitance C_0, F/km	7.75e-9

6. SIMULATION RESULTS:

The proposed work was first created in SIMULINK atmosphere. The phase currents are imported to MATLAB atmosphere by workspace. These current signals are given as input to the algorithm, which is made exclusively by discrete wavelet transform. The algorithm checks the accuracy of Threshold values [7]. Further, these threshold values are used as parameters of relaying elements.

6.1 When no Fault in Power System :

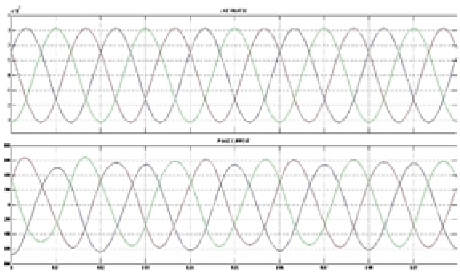
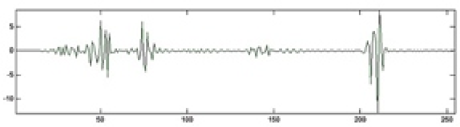


Fig.10: Line voltage



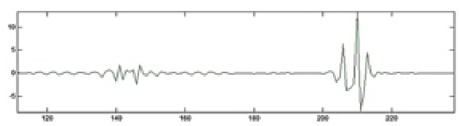


Fig.11: High freq. details of A, B, C currents

6.2 When Fault in phase A with ground:

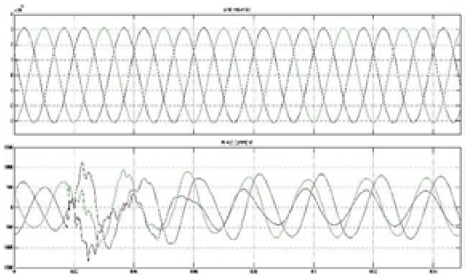


Fig.12: Line Voltage & Phase Current when fault is in phase'A'.

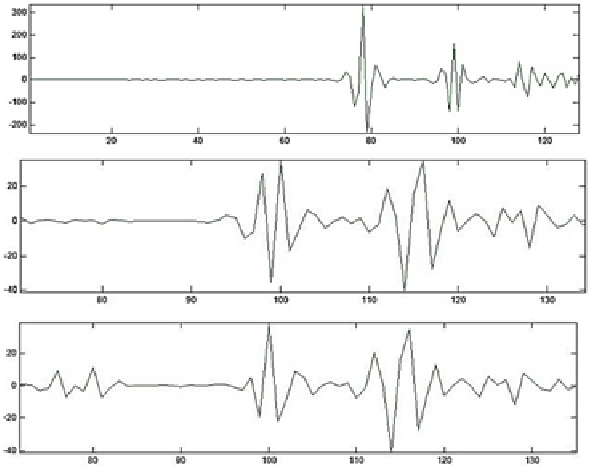


Fig.13: High freq. details of A, B, C Currents in phase 'A' Fault

6.3 When fault in phase B & phase C:

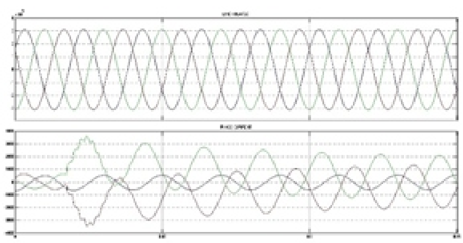


Fig.14: Line Voltage & Phase Current when fault is in phase 'B' & Phase 'C'

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

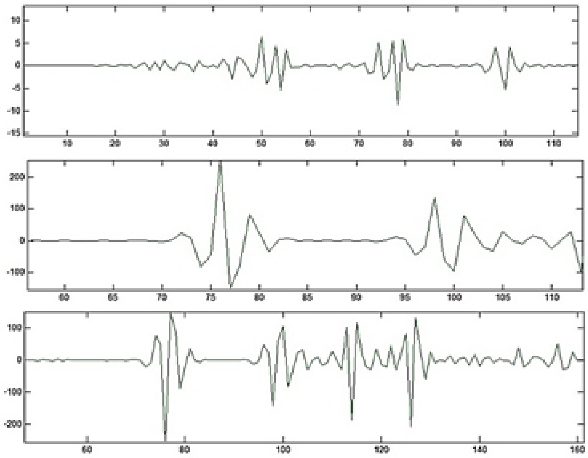


Fig.15: High Freq. Details of A, B, C Currents in phase 'B' & Phase 'C' Fault

The parameters of Relay element are shown in Table-1 and these are nothing but threshold values which are calculated in algorithm.

7. CONCLUSION:

For reliable operation of power system, continuity in transmission of electricity from generating station to load centre is a must. In general, so many faults are occurred in transmission system. In order to maintain stability, we have to make use of relay element which disconnects the faulty sections until the fault is cleared.

For proper operation of relay, we pre-determine the fault levels i.e. parameters of the relay. Discrete Wavelet Transform have certain advantages, viz. less time requirement for detection of fault and accuracy.

REFERENCES:

[1] K. Sarvanababu, P. Balakrishnan, K. Sathiyasekar, "Transmission line Faults detection, Classification and locating using Discrete Wavelet Transform". International Conference on Power, Energy and Control (ICPEC) 2013.

[2] Sudipta Nath, Priyanjali Mishra, "Wavelet Based Feature Extraction for Classification of Power Quality Disturbances". International conference on renewable energies and power quality (ICREPQ'11) Las Palmas de gran canaria, 13th to 15th April, 2011.

[3] S.A.Shaaban, Takashi Hiyma, "Transmission line Faults classification using wavelet transform". Proceedings of the 14th international Middle East power system conference (MEPCON"10), December 19-21, 2010.

[4] J.Upendar, C.P.gupta, G.K.Singh, " Discrete Wavelet Transform Genetic algorithm based fault classification of transmission line". Fifteenth national power systems conference (NPSC), IIT Bombay, December 2008.

[5] Shipli sahu, Dr.A.K.Sharma, "Detection of Fault location in transmission line using Wavelet Transform". International journal of engineering research and applications, Vol.3, Issue 5, Sep-Oct 2013, pp.149-151.

[6] I.J.Nagrath, Kothari, "Power System Analysis". 4th edition Tata-Mcgraw hill.

[7] "Wavelet theory and Applications". A Literature study, R.J.E.Merry, DCT 2005.53.