Use of Mexican Hat Wavelet for Detection and Localization of Faults in Transmission Lines

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Abstract— To transmit the electrical power from utility to end-user the power transmission and distribution lines plays an important role. They are the vital links that accomplish the indispensable (essential) continuity of service. As we know that the generating stations are located far away from the end-users and they run the distance over hundreds of kilometers, this leads to rise the probability of occurrence of fault in the transmission line. Since faults affect the power system, so it is necessary to isolated it immediately. Fault analysis is very important factor in power system engineer to maintain the system stability and in order to return the system in normal operating condition with minimum interruptions. In case of the digital distance protection schemes signal processing is an important key. The proposed model is based upon a combination of the impedance calculation and the continuous wavelet transformation (CWT) method. This method also detect the disturbances occurs in the transmission line with distance of fault occurrence. In order to verify the algorithm and to create fault signals MATLAB / Simulink is used. Simulation results show that the performance of the proposed fault detection indicator.

Key words: Continuous Wavelet Transformation, Electrical power, Fault, Simulation, Transmission line

I. INTRODUCTION

By using the fourier transform(FT) the new signal processing technique developed called as wavelet transform(WT) and this transform is mostly used to signal processing application [1]-[3]. The wavelets possess multidimensional characters. And this process is able to adjust their scale to the nature of the signal features. The zoom in or zoom out facility is provides by WT analysis [3]. In addition to this wavelets can be orthonormal and are able to capture deterministic features. Hence, WT can decompose a signal into localized contributions labeled by so-called dilation and translation parameters[3]. For monitoring the quality of an electric power system, an ac waveform at rated voltage and frequency is a proper index. Hence any electric power disturbance or fault can be though of as a deviation from that ac waveform. The other problem which can be noticed that when fault is occurred In power system the value of fault current is almost greater than the prefault value of current in any system element. For this purpose the use of current magnitude as an indicator of a fault of the power system is a very simple and effective fault detecting method. The wavelet transform has ability allowing the localization in time and frequency domain [4]. In this proposed work mexican hat transform is apply to analyse the three phase currents of a power system, along with it the faulty -phase can be identified. In this paper the moving data window technique is implemented for the algorithm. The simulation study of the paper shows the fault detection indicator is with fast response time, this plays an important role in protection of transmission line.

II. PROPOSED CONCEPT WITH ALGORITHM

In case of high voltage and extra high voltage transmission lines protection, distance protection is mostly used protective scheme. The impedance of the line from relay location upto the fault point can be measure by this scheme. As the impedance is propotional to the distance along the line, and the measuring is called a distance relay. Now-a-days moderm distance relays are used and they provide high-speed of fault clearance. They are located where over current relays become low, but there is difficulty in grading time for complicated networks. Recently carrier current protection is used for 132KV and above system. In carrier current protection uses distance relay as relaying units and operate under the control of carrier signals. If carrier signal gets failure then distance relay act as back up protection.

The distance relays are double actuating quantitys relays. Its one coil energized by current. The relay operates when the torque produced is such that when the ratio of voltage to current (V/I) reduce bellow a set value. When fault occurred on a transmission line, the fault current increases and the voltage at the fault point decreases. The quantities 'V' and 'I' are measured at the location of PT's and CT's. according to the distance between PT and the fault point, the PT is locates. If fault is nearer to PT, measured voltage is lesser, on the other if fault is further measured voltage is more. So by assuming fault resistance constant, each value of V/I measure form relay location corresponds to distance between the relaying point and the fault along the transmission line. This protection is called impedance protection or distance protection. The advantage of distance protection is that it is a high speed protection and simple to apply.

On the basis of above discriptions, the proposed fault detection and faulted-phase selection algorithms is discribed bellow; In this three distance relays are required to locate seven faults such as L-L, L-L-G, L-L-L faults. These relays are called as phase measuring units, are energized by line to line voltages and difference in the line currents, hence they measure the positive sequence impedance. The positive sequence impedance of the line upto the fault point [5] is given by;

$$Z_{phase} = \frac{V_A}{I_A + KI_{A0}}$$

$$\text{where} \quad K = \frac{Z_0 - Z_1}{Z_0}$$

From the above formulae the impedance of the total line can be known. The distance to the fault will be obtained proportional to the imaginary component of the measured impedance. Now the total flowchart of the proposed algorithm is as shown bellow;

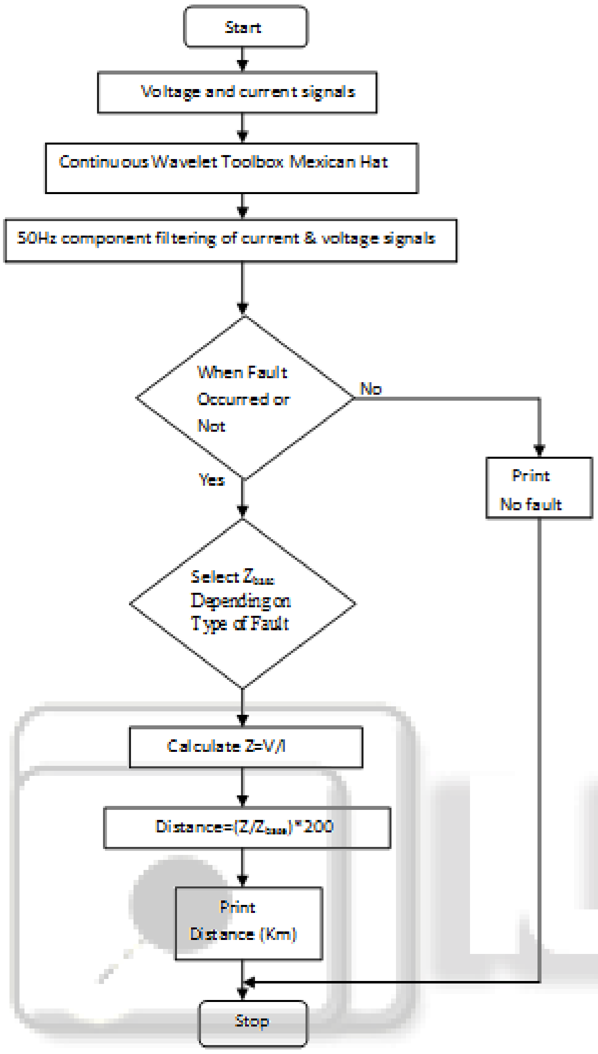

Fig. 1: flowchart of proposed algorithm

III. METHODOLOGY

A. Simulation System:

For analysing the performance of the proposed algorithm, we adopt MATLAB /Simulink for fault data generation and algorithm implementation. To study and analyse the transmission line fault following circuit arrangement may be used. The figure(b) Shows the single line diagram of the simulated system. The transmission line is of 500KV, 50Hz and the length of line is 200Km.

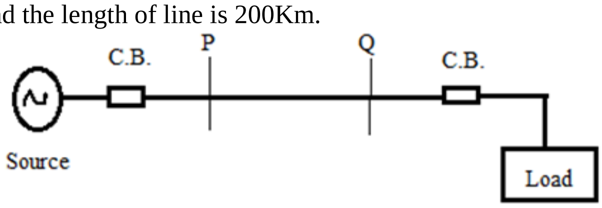

Fig. 2: Single line diagram of simulated system

B. Fault in Transmission Line:

Under this we consider all the possible causes to illustrate the performance of the proposed fault indicator under internal fault events.

1) L-G Fault:

In this single phase say 'a' to ground fault is created/selected. As a simulation case, their fault locations are tabulated in table along with the %error. The %error shows the deviation from the calculated value, using mother wavelet maxican hat.

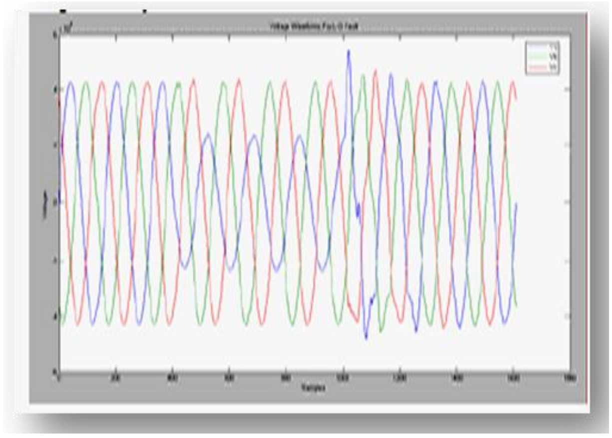

Fig. 3: Voltage Waveform of L-G Fault

L-G Fault of Mexcian Hat		
Actual Distance (KM)	**Calculated Distance (KM)**	**%Error**
50	49.23	-1.26
100	100.46	0.56
150	152.72	1.94
200	207.63	3.915

Table 1: The localization of L-G fault has been tabulated along with %error

2) L-L Fault:

When fault which occures between to phases or in between line-line called as L-L fault(2L). figure(d) showes the behaviors of fault detection L-L fault current.

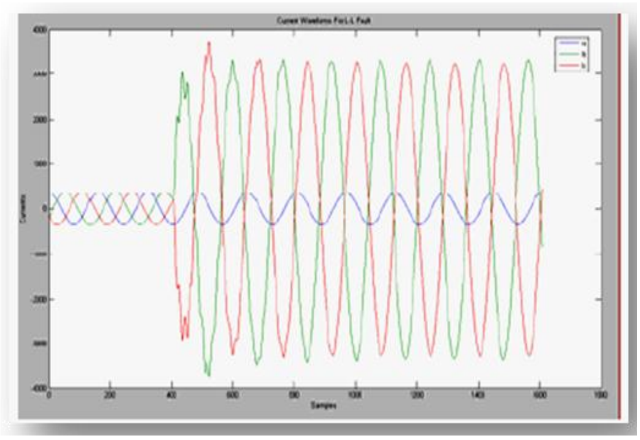

Fig. 4: Current Waveform of L-L fault

L-L Fault of Mexican Hat		
Actual Distance (KM)	**Calculated Distance (KM)**	**% Error**
50	64.69	29.38
100	105.67	5.67
150	144.74	-3.49
200	188.55	-5.725

Table 2: The localization of L-L fault has been done and this results are tabulated

3) L-L-L Fault:

When fault which occurs between three phases or in between L-L-L called as L-L-L fault (3L). figure (e) shows the behaviour of fault detection L-L-L fault voltages.

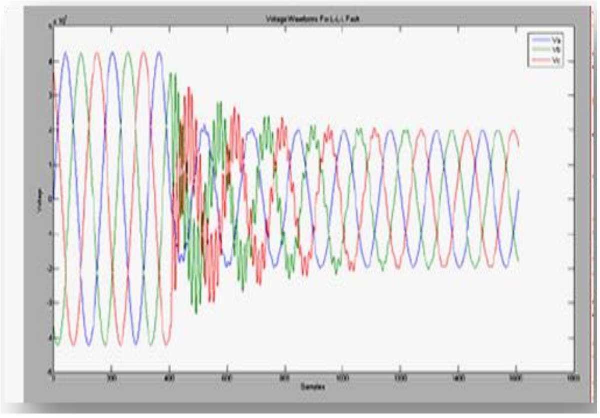

Fig. 5: Voltage Waveform of L-L-L Fault

L-L-L Fault of Mexican Hat		
Actual Distance (KM)	**Calculated Distance (KM)**	**% Error**
50	47.89	-4.22
100	96.04	-3.96
150	145.82	-2.786
200	196.21	-1.895

Table 3: Localizing the L-L-L fault has been done and results are tabulated

IV. CONCLUSION

In the present work, by the use of continuous wavelet transform(CWT) The fault location is calculated using MATLAB simulation model. For all types of fauts under consideration with moving window algorithm the error in the fault location is varied from 10% to 13%. It is observed that fault resistance in the fault increases then the %error also increases. And the increase in % error is rapid at high fault resistances. As we considered the impedance of the circuit during fault condition and under healthy condition to calculate the distance where the fault occurred. %error in the distance measurment increases with the increase in fault resistance. Tests including phase to ground (L-G), phase to phase (L-L) and simulation show that this CWT algorithm is identifying the fault location. In the future the result of this paper is useful in including innovative features in microprocessor based distance relays.

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