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Location of Faults In Transmission Line Using Fast Fourier Transform And Discrete Wavelet Transform In Power Systems

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Abstract - This paper demonstrates the usage of fast fourier transform and wavelet transform in locating faults using a simple transmission line. Transmission lines connect the generating stations and load centers. Hence, the chances of fault occurring in transmission lines are very high. Signal processing is the most important part of the digital distance protection schemes. The proposed model effectively helps in locating the fault such as L-G,LL,LL-G,LLL using MATLAB/SIMULINK. In doing so it describes the method of analysis of above two transforms in SIMULINK environment using the above two transforms. MATLAB simulation results show the wavelet method of transforms is a good and powerful tool to estimate the disrupts location on the transmission line when fault occurs.

Index Terms—Transmission line faults, Fast fourier transform, wavelet transform, MATLAB/SIMULINK.

I. INTRODUCTION

In recent years, concern over the quality of electric power has been increasing rapidly since poor electric power quality causes many problems for the affected loads, such as malfunctions, instabilities, short life time and so on. Poor quality of electric power is normally caused by power line disturbances such as impulses, notches, glitches, momentary interruptions, wave faults, over voltages, under-voltages, and harmonic distortion. In order to improve electric power quality, the sources and causes of such disturbances must be known before appropriate mitigating action can be taken. However, in order to determine the causes and sources of disturbances, one must have the capability to detect and localize those disturbances and further identify (classify) the types of disturbances.

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. Therefore, in such instances, the power system components are subjected to the greatest stresses from excessive currents. These faults give rise to serious damage on power system equipment. Fault occurs on transmission and distribution 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 clear the fault as soon as possible in order not to cause such damages. Flashover, lightning strikes, birds, wind, snow and ice load lead to short circuits.

Deformation of insulator materials also leads to short circuit.

Electromagnetic transients in power system result from a variety of disturbances on transmission and distribution lines, such as faults. Fault location estimation is very important issue in power system engineering in order to clear faults quickly and restore power supply as soon as possible with minimum interruption. This is necessary for health of power equipment and satisfaction of customer. Fourier transform are used to abstract fundamental frequency component but it has been shown Fourier transform based analysis sometimes are not exactly enough. 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 frequency.

A typical simple transmission line is taken and is analyzed in this paper. This transmission line is subjected to a L-G fault at a particular time instant. The fault location techniques are proposed and analyzed through fourier and wavelet transform methods. The simulations are carried on MATLAB/SIMULINK. It is found that the wavelet transform method is more accurate in locating the various faults of a distribution line.

II. FOURIER TRANSFORM

The fourier transform decomposes a signal into orthogonal trigonometric basis functions. A fast fourier transform is an efficient algorithm to compute the

discrete fourier transform and its inverse. There are many distinct FFT algorithms involving a wide range of mathematics, from simple complex-number arithmetic to group theory and number theory. the calculation of the DFT can become very time-consuming for large signals (large N). The fast fourier transform algorithm does not take an arbitrary number of intervals N , but only the intervals $N=2^m$, $m \in \mathbb{N}$. The reduction in the number of intervals makes FFT very fast.

The fourier transform only retrieves the global frequency content of a signal. Therefore, the fourier transform is only useful for stationary and pseudo-stationary signals. The fourier transform does not give satisfactory results for signal that are highly non-stationary, noisy, a-periodic, etc.

III. WAVELET TRANSFORM

Wavelet transform is a mathematical technique used for many applications 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. Wavelet is a waveform of effectively limited duration that has an average value of zero. Wavelet transform is to analyze non-stationary signals i.e.; whose frequency response varies in time. Wavelet transform gives variable resolutions. It can analyze signals simultaneously in time and frequency domain.

Wavelet transform decomposes a time domain signal into various levels of smaller frequency spectra. Each of these levels represents that part of the original signal in that particular time and in that particular frequency spectrum.

The wavelet transform is a mathematical tool, much like a Fourier transform in analyzing a stationary signal, that decomposes a signal into different scales with different levels of resolution by dilating a single prototype function. The decomposition into scales is made possible by the fact that the wavelet transform is based on a square integral function and group theory representation.

Wavelet analysis represents the next logical step: a windowing technique with variable-sized regions. Wavelet analysis allows the use of long time intervals where we want more precise low-frequency information, and shorter regions where we want high-frequency information.

Figure 1 wavelet analysis

The formulae for converting Scale to Frequency are given as:

$$Fa = \frac{Fc}{a\Delta}$$

Where

Fa = Pseudo-frequency corresponding to scale a , in HZ

a = Scale

Fc = Centre of frequency of a wavelet in HZ.

Δ = Sampling period

Wavelet analysis is the breaking up of a signal into shifted and scaled versions of the original wavelet.

IV. RESULTS

In this paper only the L-G faults have been analyzed to compare the results from the two transform methods. An L-G fault is introduced for a certain time and its fault currents are seen. From the simulation results of the simulink block, it has been observed that from the fast fourier transform algorithm a fault current of 2.62 mA has been noted and from the discrete wavelet transform a fault current of 0.061 mA has been observed. Hence, it is seen that though both the transforms give information regarding the disturbances in the power system, the discrete wavelet transform gives more accurate results.

Waveform 1: Discrete wavelet transform fault location algorithm

Waveform2 : Fast fourier transform fault location algorithm

V. CONCLUSION

Wavelet transform and fast fourier transform is used in this paper to extract the features of disturbance signals and is found to detect disturbance correctly even in the presence of noise.

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