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Design &Analysis of wind Turbine using Evolutionary computing Techniques

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Abstract— A reliable protection system is a primary requirement of today's power systems to reduce damage of transmission line due to unexpected faults. An accurate identification and diagnosis of fault is must to ensure the reduced outage time, operating costs, and customer complaints. The paper presents the approach based on the wavelet transform of the fault transients. The approach adopted here addresses the detection and classification of various types of fault which occurs on transmission line and presents a comparison with simulation results.
Keywords —Fourier, Power Transmission and Distribution, Discrete Wavelet Transform, Multi resolution analysis (MRA)

I. INTRODUCTION

Since transmission and distribution networks are the important components of power system network, transmission line makes a vital part in power system. Electric power systems are constantly affected with faults which disturb the system's reliability, security and delivered energy quality. The faults may occur due to lightning strike, tree branches falling on transmission line, fog and many more. This may give raise to the consequence of permanent damage to the line insulators. Along with other electrical components, the transmission line suffers from the unexpected failures due to various faults. The interaction of different conductors with one another or even with ground in three phase systems leads to cause faults in the system. The different kinds of faults observed are classified as Single line-to-ground faults, Line-to-line faults, Double line-to-ground faults, and three phase faults which subsequently lead the power system components to suffer the excessive stresses from abnormal current conditions resulting into serious power system equipment damage. Protecting of transmission lines is one of the important tasks to safeguard electric power systems. To achieve an effective protection, it is must to immediately diagnose the fault so as to isolate the faulty line from the system. Subsequently fault classification and its location must be performed for restoration and speed recovery of the system. In power system protection schemes classification of fault types in a radial and non-radial system are the important issues. This can be done by detecting, localizing and classifying different fault types. A number of algorithms have been developed for detection of faults and its classification. Many researches had been done using wavelet transform to analyse the performance of it. The wavelet transform provides a better detection when the signals changes abruptly, so it is praiseworthy for fault detection since the faulted signals changes abruptly. The paper presents the fault identification and classification approach including the use of wavelet transform.

Wavelet transform (WT) is a signal processing technique evolved from the Fourier transform (FT) and has been widely used to signal processing application. It is becoming a common tool for analyzing localized variations of power within a time series.

In the proposed work, power system will consist of one power source S and one renewable energy source (sun, wind, and biomass) connected through the single circuit power line. The technique used here for fault analysis is wavelet analysis which is significantly more productive than Fourier analysis whenever any transient behavior or discontinuities dominates the signal.

II. SIGNAL ANALYSIS USING WAVELET TRANSFORMS

Wavelet transform was introduced towards the start of 1980s by attracting in the field of speech and image processing. The wavelet multi resolution analysis is another effective strategy for signal analysis and is appropriate to address travelling wave signals. Wavelets can offer a number of resolutions in time as well as frequency domains. The windowing of wavelet transform is balanced naturally in accordance with low and high-frequencies, for instance, long time intervals are used for low frequency components and vice versa. Fourier analysis splits up a signal into sine waves of variable frequencies. Similarly, WT can also decompose a signal into localized contributions labelled by so-called dilation and translation parameters. These parameters signify the details regarding distinct frequency component involved in the analysed signals. The filtering process begins basically with the decomposition of the original signal through two complementary filters resulting into two signals. This decomposition procedure can be iterated, in such a way that the successive approximations too undergo decomposition, consequently one signal split down into multiple lower resolution components. This decomposition process called as Multi Resolution Analysis (MRA).

The Wavelet Transform supports a time-frequency representation of the signal and uses multi-resolution technique which analysis different frequencies with different resolutions. This kind of wavelet analysis is known as the continuous wavelet transforms (CWT). It is formally represented as:

$$Y(s,\tau) = \int f(t)\Psi^{*}s,\tau,(t)dt \text{ -------------------1}$$

In equation 1, * denotes complex conjugation. The equation shows the decomposition of a function f(t) into a set of basic functions which are known as wavelets. The variables s and t used in the equation represent the scale and translation parameters respectively. The actual Wavelet Sequence is usually a sampled version of CWT and its calculation might consume considerable time as well as resources, with respect to the expected resolution. The Discrete Wavelet Transform (DWT) involves sub-band coding and is observed to produce a fast computation of Wavelet Transform. The pros include its simple implementation and minimization of computation time and resources.

$$\Psi_{j,k}(t) = \frac{1}{\sqrt{so^{j}}}\Psi\,(t k\tau o so^{j}/so^{j}) \text{ ------------------------2}$$

Equation 2 includes integer's j and k and s0 > 1 is a fixed dilation step which decides the translation factor o. A digital signal is represented in time-scale version using digital filtering techniques in case of DWTs. In order to perform signal analysis, the intended signal is passed through filters possessing distinct cut off frequencies at distinct scales. The DWT is computed by successive low pass and high pass filtering of the discrete time-domain signal.

Wavelet transform are categorized as discrete wavelet transforms (DWTs) and continuous wavelet transforms (CWTs) where both are considered as continuous-time transforms since they can be used to represent continuous-time signals. CWTs and DWTs differentiate over the use of scale and translation values as the former operate over every possible scale and translation value while the latter use a specific subset of scale and translation values. The wavelet Transform of a continuous signal x (t) is defined as:

$$WT(a,b)=\frac{1}{\sqrt{a}} \times \int_{-\infty}^{\infty} X(t) * g\left(t-\frac{b}{a}\right)dt \text{-----------3}$$

In equation 3, a and b represent the scaling and translation parameters respectively and g is the mother wavelet function.

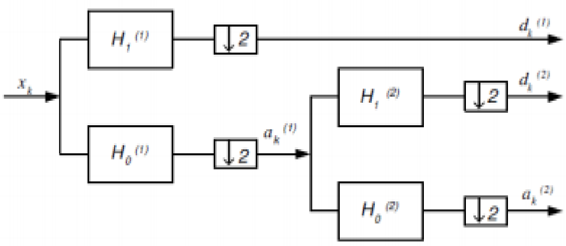


Fig. 1 Wavelet Transform filter bank

Fig.1 shows the wavelet transform filter bank. Digital filtering techniques are used for achieving a time-scale representation of a digital signal. The Discrete Wavelet Transform first splits the signal into approximations and details and analyses the signal at distinguished frequency bands with distinct resolutions. The DWT includes two sets of functions namely wavelet functions and scaling functions which are associated with a low-pass and high-pass filters.

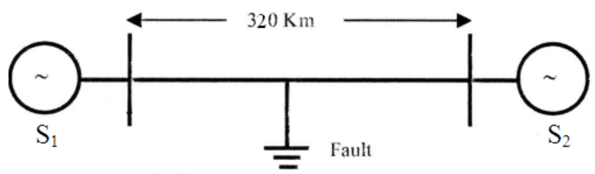
III. OBJECTIVES

The continuously rising complexity of the power systems with the utmost need of mainitaining the quality of power supply demands improved alternative methods of transient analysis for the ultmate goal of developing new equipment to efficiently address the abnormal transient phenomena. The present methods of transients analysis pose limitations in this direction. The present paper is directed to meet the objectives in this regard. It not only aims to study the wavelet techniques for power system fault analysis but also aims the identification of the different type of faults on the system. The paper presents a model for a power system having renewable energy resource as a source of energy of a power station MATLAB simulator and further the system transmission faults are analysed using DWT. Finally, the proposed system is compared with the with the reference system.

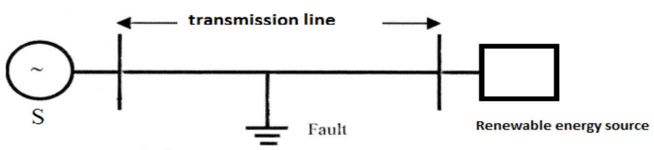
IV. BASIC IDEA AND PROPOSED SCHEME

The detection and classification of the defective phase is an extremely essential factor of transmission line protection. The basic idea is to use the Discrete wavelet analysis to analyse the faulty signal. In order to protect high voltage transmission lines, distance protection scheme is widely used. This scheme works by measuring the impedance of the line from relay location to the fault point. Since the measured value depends upon the distance along the line that is why it is named as distance relay. Modern distance relays are observed to provide high-speed fault clearance and are hence used where current relays become low and where there is complexity in grading time for complicated networks. The latest trend is to use carrier current protection for 132kv and above systems where the relaying units are distance relays and are operated under the control of carrier signals. Even if carrier signal fails, distance relay act as back up protection. Three distance relays L-L, L-L-G and L-L-L referred as phase measuring units are required to locate seven phase faults and are energized by line to line voltages and difference in line currents, so that they measure the positive sequence impedance. As the impedance of the total line length is a known quantity, the distance to the fault will be obtained proportional to the imaginary component of the measured impedance.

The discrete wavelet analysis has been used for fault analysis of transmission lines in power system which consist of two power sources connected through a transmission line.



The proposed power system involves one power source S and one renewable energy source (sun, wind, and biomass) connected through the single circuit power line. The paper involves the use of wavelet analysis for fault analysis which is observed to be way more efficient than Fourier analysis whenever a signal is dominated by transient behaviour or discontinuities.



V. EXPERIMENTAL OBSERVATIONS

This section presents the experimental setup and the simulation results obtained after simulation of proposed approach in MATLAB.

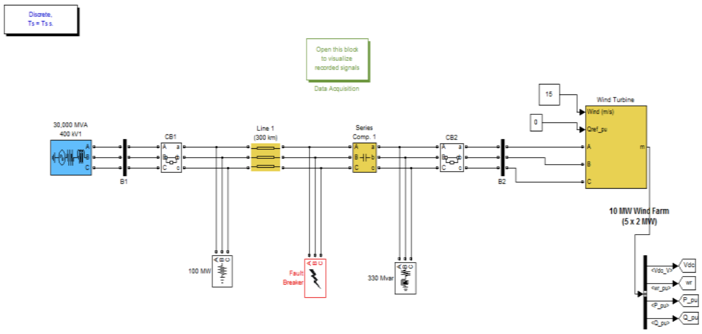


Fig.2 Wind turbine connected grid Simulink model

The figure shows the Simulink modal implemented for three phase power grid connected wind power source with common transmission lines. The wind farm is represented by a block which includes turbine and drive train, inverter, DC-DC boost converter, generator unit and control unit.

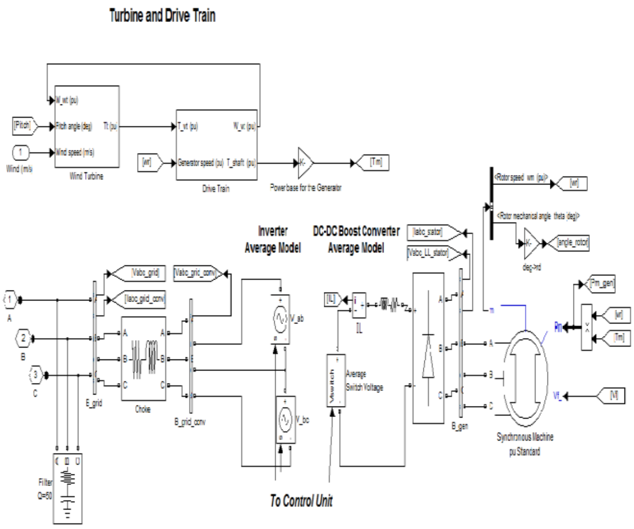


Fig.3: Wind turbine unit

The figure illustrates the most important unit of the system which can be further broken down into different units. This unit is responsible for providing the input from the wind farm. This block is simulated using the Simulink blocks available in the MATLAB.

Post fault samples of three phase current and voltages have been collected from the circuit breaker of the bus bar 1 and 2. This fault signal data is used to perform the wavelet decomposition. The sampling interval is 1ms and the circuit breaker transition time is set to 0.04. The transition time of the fault breaker is set to 0.1 to create fault in the transmission line network. The pre fault and post fault samples obtained by applying different type of faults are analyzed by discrete wavelet analysis. The presence of zero sequence components determines the involvement of ground in fault.

The simulation can be performed by taking the faulty waves from circuit breaker either from one end or two ends of the transmission line. The performance of the proposed methodology has been evaluated by considering different observations.

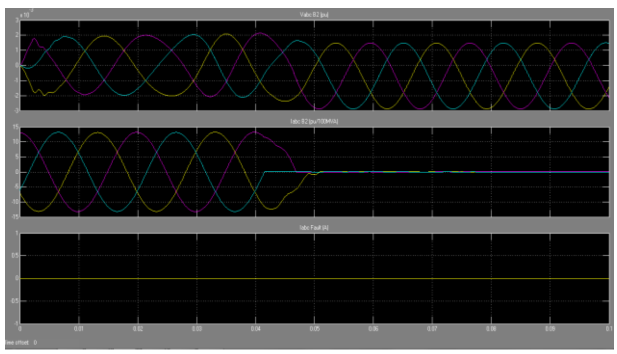


Fig.4 : No Fault condition

The figure presents , the waveforms of voltage and current at bus bar 2 where wind source power station is connected during normal condition, when there is no fault on transmission lines.

Phase to phase fault:

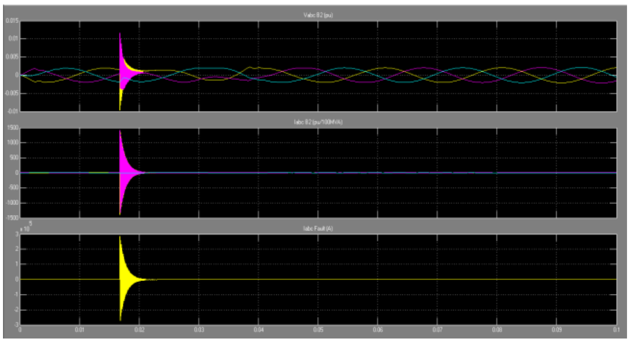


Fig.5 Phase A to Phase B fault

The figure illustrates that this fault is between line A and line B and can be identified from the waveform recognition.

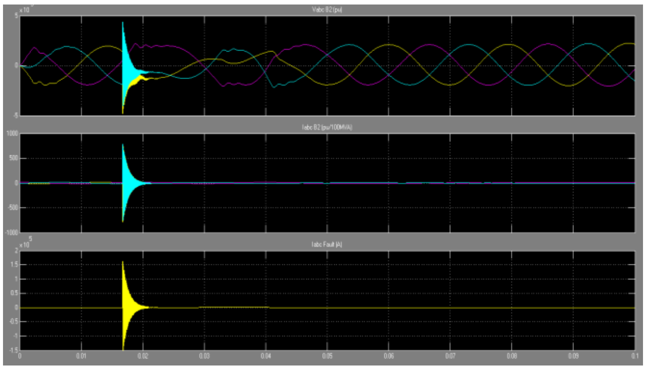


Fig.6 Phase A to Phase C fault

lt is between two lines A and C can be identified.

Phase to Ground Faults:

When faults occur between any phase/ line and ground, it can be identified from the given waveforms.

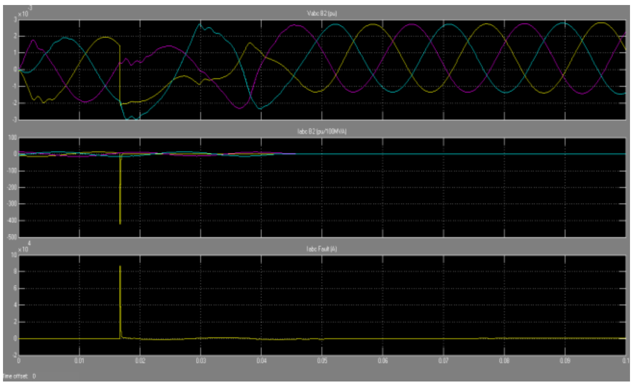


Fig.7 illustrates the fault on transmission line between phase A and ground

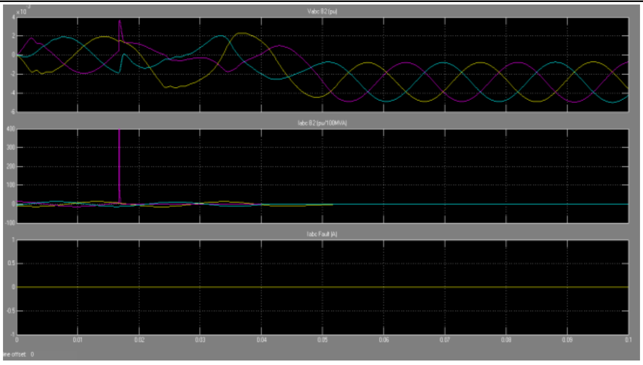


Fig. 8 illustrates the fault on transmission line between phase B and ground

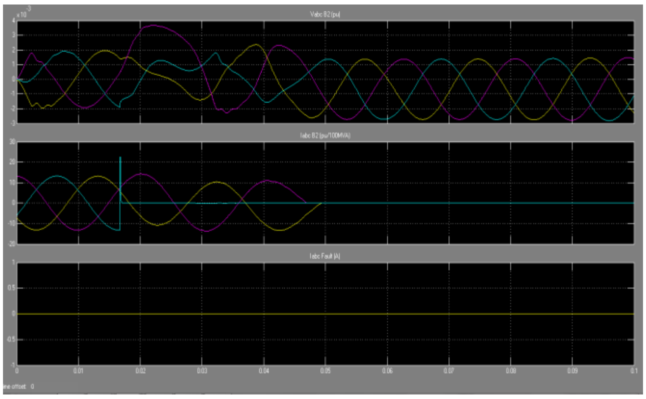


Fig.9 shows the fault on transmission line between phase C and ground.

Double Line to Ground Faults:

In few cases, line to line fault is further connected to earth which can be treated as double line to ground fault and can be identified and classified from the below mentioned waveforms.

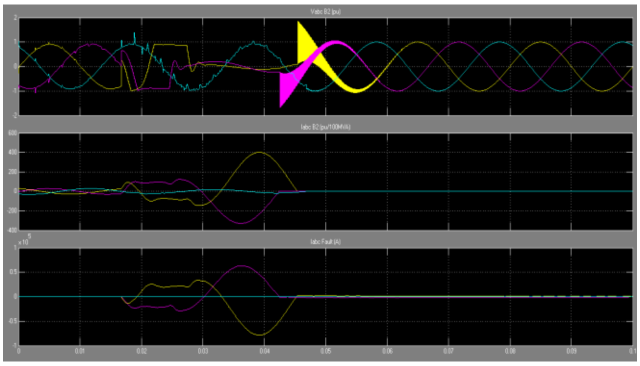


Fig.10 fault on Phase A- Phase B to ground

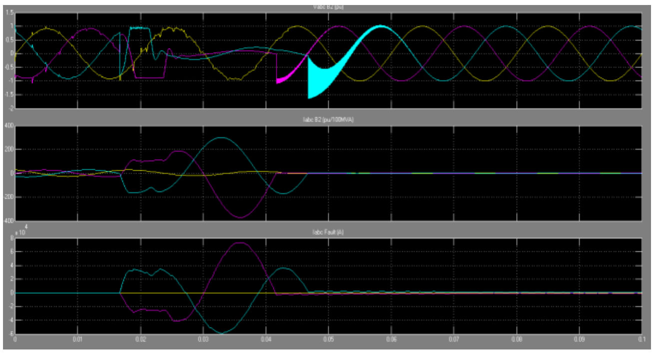


Fig.11 fault on phase B – phase C to ground

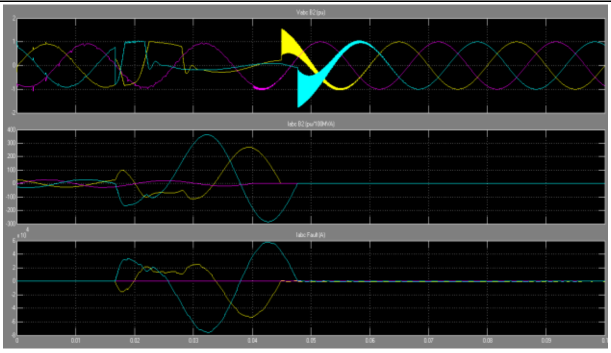


Fig.12 fault on phase A – phase C to ground

Triple line to ground fault (LLL-G)

Triple line to ground fault on transmission line can be identified from the below mention:

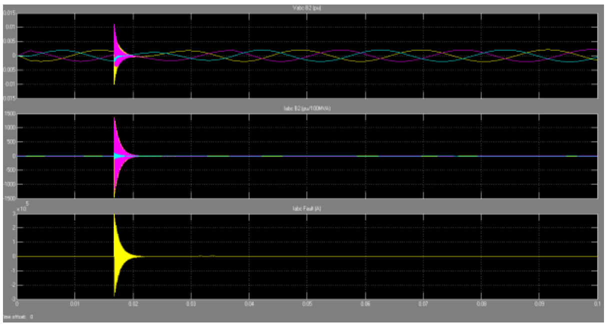


Fig.13 LLL to ground fault

VI. CONCLUSION

The paper aims at detecting and classifying the power system transmission line faults and presents the simulation of all the faults along with a comparison analysis. Faults occur on transmission lines due to various disturbances on transmission line and such faults may lead to serious damages on power system equipment and degrades the power quality. Hence it gets highly important to determine the fault type, location and diagnose it as soon as possible. To achieve this, the wavelet transform technique is used.

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