International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

Recognising Faults of Transmission Line using Wavelet Analysis, Having Renewable Energy Source

Rajbir Kaur[1], Navneet Singh Bhangu[2]

[1]M.Tech Scholar, Department of Electrical Engg, GNDEC, Ludhiana, Punjab

[2]Dr, Electrical Engg. GNDEC Ludhiana, Punjab

Abstract: ***Electric power system comprises of various complex elements, there are chances of instability, disturbances and faults in distribution and transmission lines. Distribution and Transmission lines are essential links between generating units and consumers. A transmission line may have faults such as single phase, double phase and three phases to ground. There are various schemes which are associated to modern relay that can work with recloser for protecting the faulted phases; also there should be precise selection for finding the right phase. One of the major concerns in the power sector is the day-to-day increasing power demand but the unavailability of enough resources to meet the power demand using the conventional energy sources. Demand has enlarged for renewable sources of energy to be utilize along with conventional system to satisfies the energy demand. Renewable sources like wind energy and solar energy are the prime energy sources which are being utilized in this regard. The center of attention is to investigate the faults in transmission lines having renewable energy resources as source of energy for power stations using the wavelet analysis for the sole aim of reliable power transmission. Different schemes for detection and classification of faults on transmission lines using renewable sources are studied and analyzed; the method involves Wavelet transform which uses fast, accurate and well-built mathematical tools .It can be done by means of particular algorithm.***

Keywords: Wind Energy Conversion System, Supervisory Control and Data Acquisition system, Circuit breaker, Wavelet Transform, Renewable energy, Extra high voltage, Discrete wavelet transform, Continuous Wavelet Transformation

1. Introduction

One of the major concerns in the power sector is the day-to-day increasing power demand but the unavailability of enough resources to meet the power demand using the conventional energy sources. Demand has increased for renewable sources of energy to be utilized along with conventional systems to meet the energy demand. Renewable sources like wind energy and solar energy are the prime energy sources which are being utilized in this regard. The nonstop use of fossil fuels has cause the fossil fuel deposit to be reduced and has drastically affected the environment depleting the biosphere and cumulatively adding to global warming. Wind energy is abundantly available at many places that has made it possible to harvest it and utilize it properly. In order to tackle the present energy crisis one has to develop an efficient manner in which power has to be extracted from the wind energy. The power conversion mechanisms have been greatly reduced in size in the past few years.

2. Renewable Energy Scenario in India

Renewable Energy in India is a sector that is still undeveloped. India was probably the first country in the world to set up a separate ministry of non-conventional energy resources in early 1980s. However the results have been very mixed and in recent years it has lagged far behind other developed nations in using renewable energy (RE). RE contribution to energy sector is less than 1% of India's total energy needs. India is one of the largest and fastest growing economies in the world with an expansive populace of above 1.35 billion people. There is a elevated demand for energy, which is currently pleased mainly by coal, foreign oil and petroleum, which apart from being a non-renewable, and therefore non-permanent solution to the energy crisis, it is also detrimental to the environment. The price of crude oil has risen sharply over the last few years, and there are no signs of a change in this trend. Thus, it is imperative that India obtains energy security without affecting the booming economy, which would mean that alternative energy sources must be developed. This would mean that the country must switch from the non-renewable energy (crude oil and coal) to renewable energy. Figure 1 gives an account of installed power capacity of various power generation systems.

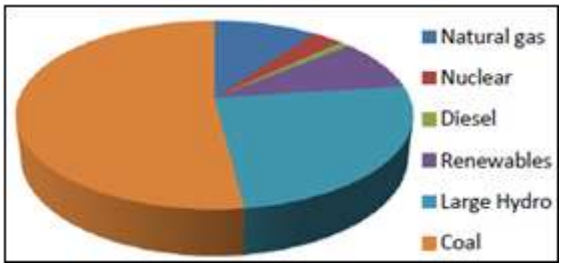


Figure 1: Percentage of installed Power capacity in India

India is determined to become one of the world's leading clean energy producers. The Government of India has already made several provisions, and established many agencies that will help it achieve its goal. Renewable Energy, excluding large hydro projects previously accounts for 9% of the total installed energy capacity, comparable to 12,610 MW. In combination with large hydro, the capacity is more than 34%, i.e. 48,643MW, in a total installed capacity of 1,44,980 MW. Refer figure 2.

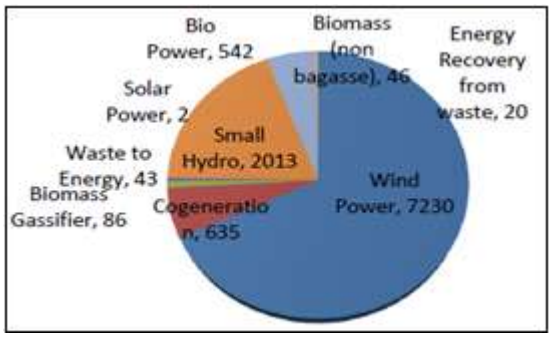


Figure 2: Renewable energy generations in India

3. Related Work

When a fault occurs, protection equipment initiates operation of breakers, to de-energize faulted part. This must be done before excessive currents and voltages caused by the fault inflict damage to the connected equipment . CBs have the purpose to automatically connect or disconnect different parts of the power system in order to isolate the faults and/or re-route the power flow. In order to open all circuits that supply fault current, more than one CB typically reacts. Various bus arrangements are used to minimize the number of circuits that must be opened in a case of a fault. Depending on a bus arrangement and status of available breakers, different breakers will automatically react in case of different faults. Once defensive relay detects fault, it sends a trip command to subsequent breakers. CBs react and open circuits that supply fault current. In the case of a HV transmission line, after some time a breaker involved in the fault clearing assumes that fault is cleared and it will try to reclose itself automatically. Typical switching sequences occurring because of a fault present somewhere on a transmission line. Process of reclosing can be repetitive a couple of times and it is initiate in order to conclude whether fault, which caused opening of breaker, is present. In the case that fault is present after a reclosing, breaker will wait for the pre-selected time out to pass and initiate reclosing again. If after selected number of attempts of reclosing, fault is still present, breaker lockout is taking place. There will be no more attempts to reclose automatically the breaker again. The length of switching sequences and time outs depend not only on the type of the breaker, but also on location of the circuit breaker and the type of protective relay connected to it, as well as the reclosing logic used in the given system. In the case of breaker lockout the assumption taken by the operators is that fault is permanent. Special order is issued to the maintenance for the breaker to be closed back in again once an inspection of the breaker, analysis of the causes and possible repair are completed.

Existing Model of Power System

The Matlab/Simulink model for existing power system is shown in figure 3. Each block has their parameters which can be changed manually according to the situations.

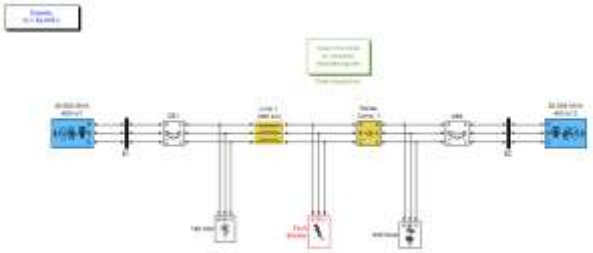


Figure 3: Existing model of power system

The model consists of two power stations feed the load through transmission lines linked through two bus bars. The source of power production used in power stations is non renewable source.

From the above, two types of faults are recognize: Temporary and Permanent. Each of these faults will begin different actions among utility human resources. In the case of a temporary fault, operator will become aware of CB status change on the corresponding one-line power system topology diagram. This information is observed through the Supervisory Control and Data Acquisition (SCADA) system.

Switching succession of openings and reclosing of a group of circuit breakers will end with CBs that were involved in the switching case being restore. All the equipment actions are executed automatically and fault is cleared. In this case there is no need for operator action, but incidence of the event is recorded and archived. In the case of a everlasting fault, operator will notice CB status change on the one-line topology diagram. Sequence of openings and reclosing of a group of breakers will finish with CBs that were involved in clearing the fault staying open. Automatic fault clearing has disconnected faulted part from the rest of the power system, and further attempts to automatically restore the system to the original healthy state are not taken. This is called breaker LOCKOUT.

Disconnected part must be restored by hand after inspection and repair. There are few features of the existing approach that should be further evaluate to indicate what possible improvements to the described process are: data availability, response time and decision quality, and personnel productivity .A general review of literature available on identification and categorization of transmission line faults in power system using various methods has been accessible. This is likely to give us that wavelets are mathematical functions that cut up data into dissimilar frequency components, and then study each component with a resolution coordinated to its scale.

They have advantages over conventional Fourier methods in analyzing physical situation where the signal contains discontinuities and sharp spike. Wavelets were developed independently in the fields of mathematics, physics, electrical engineering, and seismic geology. Interchanges between these field during the last 10 years have led to many new wavelet applications such as image compression, human vision, radar, and earthquake prediction. This introduces wavelets to the interested technical person outside of the digital signal processing field.

The history of wavelets beginning with Fourier, compare wavelet transform with Fourier transforms, state properties and other special aspect of wavelets, and finish with some applications such as Power systems, image compression, musical tones, and de-noising noisy data. The automation of power system fault identification using information convey by the wavelet analysis of power system transients. Probabilistic Neural Network (PNN) for detecting the type of fault is used.

PNN focused on identification of simple power system faults. Wavelet Transform (WT) of the transient disturbance caused as a result of incidence of fault is performed. The detail coefficient for each type of simple fault is distinguishing in nature. PNN is used for differentiate the detail coefficients and hence the faults. The use of wavelet to determine the type of fault and automation incorporating PNN could achieve an accuracy of 100 percent for all type of faults. Back propagation algorithm could not distinguish all of phase-ground, double-line to ground faults.

4. Objectives and Problem Formulation

Problem Formulation

Demand has enlarged for renewable sources of energy to be utilized along with conventional systems to meet the energy demand. Renewable sources like wind energy and solar energy are the prime energy sources which are being utilized in this regard. The uninterrupted use of fossil fuels has caused the fossil fuel dump to be summary and has considerably exaggerated the environment depleting the biosphere and cumulatively totting up to global warming. Wind energy is abundantly available at many places that has made it possible to harvest it and utilize it properly. In order to tackle the present energy crisis one has to develop an efficient manner in which power has to be extracted from the wind energy. The power alteration mechanisms have been seriously condensed in size in the earlier period of few years. The improvement in power electronics and material science has helped engineers to come up very small but influential systems to hold out the high power demand.

Present power system includes generating stations with non renewable sources, transmission and distribution lines, protection system, control system etc. In future, renewable energy sources like wind energy or wind energy conversion system (WECS) can be used or replace the existing or some parts of existing system. Present transmission lines and distribution lines are used for power transmission from WECS, and protection of these transmission and distribution lines is of major concern. Few techniques are employed to analyse the faults on transmission lines.

Objectives

Keeping in view the study of the existing research, the present work has been undertaken with the following objectives:

- To study the wavelet techniques for power system fault analysis.
- To make a model for a power system having renewable energy resource as a source of energy of a power station in MATLAB simulator.
- To analyze the system transmission faults using DWT.
- To identify and classify various types of faults based on the analysis.

Methodology

Wavelet is a squat duration wave. It is a mathematical origin function used to split a given function or continuous-time signal into different scale components. This wavelet analysis is a signal processing tool which is awfully useful to analyze a signal. It allows the decay of a signal into different levels of pledge. The basic function is expand at low frequencies and compacted at high frequencies, so that outsized windows are used to attain the low frequency components of the signal while small windows are used to attain reflect discontinuities.

Unlike Fourier, this relies on a single basis function. This is a new form of signal analysis is far more efficient than Fourier analysis whenever a signal is dominated by transient behaviour or discontinuities. In wavelet analysis we repeatedly talk about approximations and facts. The approximations are high scale, low frequency apparatus of the signal. The facts are the low scale, high frequency components. The filtering procedure at its most critical level, like the innovative signal decomposes through two complementary filters and emerges as two signals. This decay process can be iterated, with succeeding approximations being decayed in turn, so that one signal is broken down into many minor resolution components. This decomposition process called as Multi Resolution Analysis (MRA).

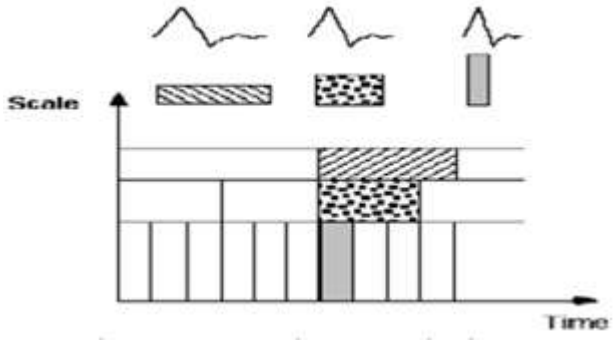


Figure 4: Wavelet Resoloution

The figures show about wavelet resolution process and decomposition process of a signal. Wavelet transform are classified into discrete wavelet transforms (DWTs) and continuous wavelet transforms (CWTs).

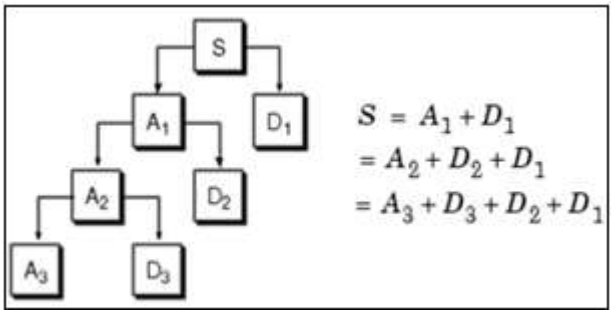


Figure 5: Three level decomposition of signal 'S'

Note that both DWT and CWT are continuous-time transforms. They can be used to represent continuous-time signals. CWTs operate over every possible scale and translation whereas DWTs use a specific subset of scale and translation values or representation grid. The wavelet Transform of a continuous signal x (t) is defined as:

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

Where a and b are the scaling and translation parameters respectively and g is the mother wavelet function.

5. Experimental Model

The simulink modal implemented for three phase power grid connected wind power source with common transmission lines is shown below.

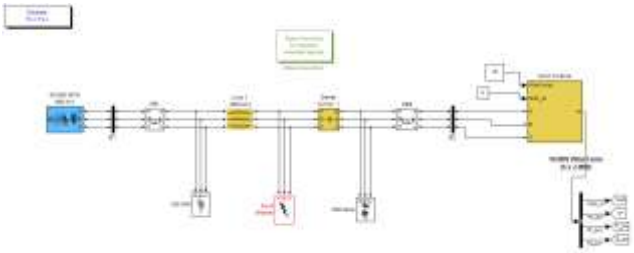


Figure 6: Wind turbine connected grid simulink model

Here the wind farm is represented by a block which includes turbine and drive train, inverter, DC-DC boost converter, generator unit and control unit.

A 10 MW wind farm consisting of five 2 MW wind turbines linked to a distribution system exports power to a 400 kV grid through a 320 km, and feeder. The Type 4 wind turbine accessible in this model contain a synchronous generator connected to a diode rectifier, a DC-DC IGBT-based PWM improved converter and a DC/AC IGBT-based PWM converter model by voltage sources. The Type 4 technology allows extracting greatest energy starting the wind for low wind speeds by optimizing the turbine speed, although minimizing mechanical stresses on the turbine during gusts of wind.

In this the wind rapidness is keep up stable at 15 m/s. The control system of the DC-DC converter is used to sustain the speed at 1 pu. The reactive power created by the wind turbine is keeping pace at 0 Mvar.

Right-click on the “Wind Turbine” block and select “Look under Mask” to see how the model is built. The sample time used to discrete the model (Ts= 50 microseconds) is specified in the Initialization function of the Model Properties.

Open the “Wind Turbine” block menu to see the data of the generator, the converter, the turbine, the drive train and the control systems. In the Display menu select “Turbine data for 1 wind turbine”, check "Display wind turbine power characteristics" and then click Apply. The turbine Cp curves are displayed. The turbine power, the tip speed ratio lambda and the Cp values are displayed as function of wind speed. For a wind speed of 15 m/s, the turbine output power is 1 pu of its rated power, the pitch angle is 8.9 deg and the generator speed is 1 pu.

6. Experimental Results

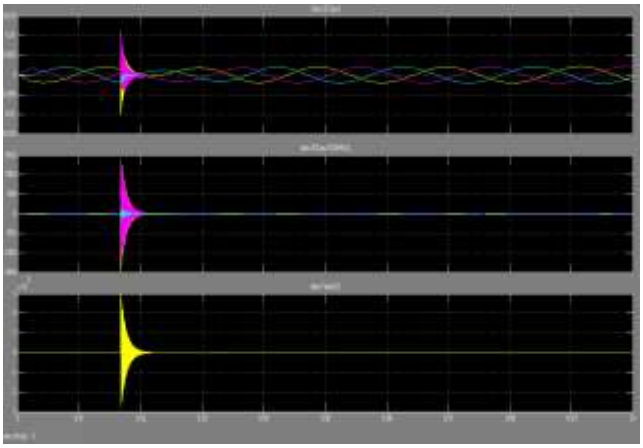
Power and voltage superiority of output from a wind turbine is not steady. Hence a number of form of modulation or filtering is required before connecting to Grid. This is difficult because the wind speed is random in nature and is used to denote this randomness and determine the probabilistic variety of wind. The voltage Fluctuations are due to randomness of wind. Wind speed and direction varies also with height.

Wind turbine connected utility grid transmits electric power over a 300 km transmission line at a specific voltage. Utility grid is connected to bus bar 1 and wind power station is connected with bus bar 2. Various types of faults i.e. symmetric faults or asymmetric faults may occur on the transmission lines. The performance of this Matlab/Simulink model can be judged by identifying the faults occurred. Wavelet analysis is used to analyze the faults. Wavelet transform (WT) is a mathematical technique used for many application of signal processing. Various current and voltage waveforms are obtained by changing the type of fault on transmission line and by analyzing or recognizing the waveforms; the faults can be identified and classified.

Post fault samples of three phase current, and voltages have been collected from the circuit breaker of the bus bar 1 and 2. By using the fault signal data wavelet decomposition bas been performed. 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 (apply) fault in the transmission line network. Applying different type of faults and taking part of the waveform from the circuit breaker, before and after the fault incident is analyzed by discrete wavelet analysis. To determine the involvement of ground in fault, presence of zero sequence components have been considered.

Triple line to ground fault (LLL-G)

Triple line to ground fault on transmission line can be identified from the below mention waveforms , all the faults occurred on the transmission line can be identified and classified by waveform recognition.



7. Conclusion and Future Scope

The proposed method of fault analysis of transmission lines in power system using information conveyed by the wavelet analysis of power system is studied. The work presented in the study is focused on identification of simple power system faults using Wavelets. Wavelets are mathematics functions that cut up data into diverse frequency mechanism, and then revise every one component with a resolution corresponding to its scale. Wavelets have advantages over traditional Fourier methods in analyzing physical situations where the signal contains discontinuities and sharp spikes.

A model is designed for a power system in MATLAB simulator in which renewable energy resource is used as power source and is interfaced with utility grid through existing power transmission lines. The renewable energy source used is wind turbine. The power of wind generation is immense, a chronological source of energy, wind can be used both as a source of electrical energy and for irrigation and farming uses. In today's world, where a greener source of energy is the need of the hour, wind energy is a promising resource, waiting to be harnessed to its true potential. Wind turbine and its characteristics showed that it can be properly planned and used to get the highest output, and how to make it more consistent by making effective transmission of power to the clients through transmission lines and also focus on transmission line protection .

The proposed discrete wavelet analysis for identification and classification has been evaluated on a transmission line network having two different sources for power generation i.e. non renewable energy source and renewable energy source. The faulted phases have been detected and type of faults also classified by the waveform recognition. A Matlab/Simulink based model developed to verify the effectiveness of the proposed technique for different system configurations/Parameters.

8. Future Scope

In addition to that observation feasibility of the study with theoretical results the modelling was extended to three phase grid connected other renewable sources and further fault analysis can be done using neural networks or Fourier transforms. The work may be extended to the cost estimation; comparison of cost and reliability with the present system.

References

[1] Adelian Mohammad Ali, Desai Rahul S (2014) "Using Wavelet for Finding Fault Place and Neural Network for Types of Fault in Transmission Lines" International Journal of Engineering Research and General Science ISSN 2091-2730, vol. 2, no. 4, pp. 326-337.
[2] Awad Mahmoud S. et al (2012) "On-line Determination of the Fault Location in a Transmission Line" International journal of emerging sciences ISSN: 2222-4254, vol. 2, no. 2, pp. 210-221.
[3] Bouthiba Tahar et al. (2004) "Fault location in EHV transmission lines using artificial neural networks" International journal of Applied Mathematics and computer sciences, vol. 14, no 1, pp. 69-78.
[4] Chakkor Saad et al. (2014) "Wind Turbine Fault Detection System in Real Time Remote Monitoring" International journal of electrical and computer engineering (IJECE) ISSN 2088-8708, vol. 4, no 6, pp. 882-892..
[5] Chiradeja P. et al. (2009) "Identification of Fault Types for Single Circuit Transmission Line using Discrete Wavelet transform and Artificial Neural Networks" Proceedings of the International Multi Conference of Engineers and Computer Scientists IMECS, ISBN: 78-988-17012-7-5. vol. 2.
[6] Dr. Jha Bhola et al. (2013) "Selection of Optimal Mother Wavelet for Fault Detection Using Discrete Wavelet Transform" International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering vol. 2, no. 6, pp. 2338-2343.
[7] Elmitwally et al. (2010) "Fault Identification of Overhead Transmission Lines Terminated with Underground Cables" 14th International Middle East Power Systems Conference (MEPCON'10), Egypt, Paper ID 202, pp. 452-458.
[8] Graps Amara (1995) "An Introduction to Wavelets" IEEE Computational Science and Engineering, Summer, vol. 2, no. 2.
[9] Jose Prince, Bindu V.R. (2014) "Wavelet-Based Transmission Line Fault Analysis" International Journal of Engineering and Innovative Technology (IJEIT) ISSN: 2277-3754, vol. 3, no. 8, pp. 55-60.
[10] Jha Bhola et al. (2009) "Doubly Fed Induction Generator Analysis Through Wavelet Technique" Journal of engineering science and technology, vol. 2, no. 1, pp. 63-67.