2nd National Conference Recent Innovations in Science and Engineering (NC-RISE 17) ISSN: 2321-8169
Volume: 5 Issue: 9 45 – 47

Transmission Line Fault Categorization Using Statistical Parameters

Dr. M. A. Beg
Department of Electrical Engineering,
Mauli Group of Instituitions College of Engineering and Technology Shegaon.
ansarbeg@gmail.com

Abstract**—** Modern power system is spread over a vast geographical area , with complex connectivity .The demand for electricity is increasing rapidly due to fast industrial growth and liberalization. This increases the size and complexity of the power system. It is very difficult to maintain the power system under healthy condition. Faults cannot be avoided they can be reduced or their after effects minimized, by early or rapid detection.

Transmission line faults should be detected and faulty section isolated rapidly, using fast acting relay. In this paper a protection scheme, based on wavelet transform and statistical parameters is presented. The line currents are decomposed into various frequency components using wavelet transform. The highest and lowest frequency decomposed components are statistically processed using kurtosis and skewness functions and fed to Artificial neural network for classification.

Keywords*- Probability distributions Wavelet Transform, Kurtosis, Skewnesss, Artificial Neural Network*

*****

I. INTRODUCTION

Identification and diagnosis of the system faults are of great importance to the power engineers in the control center so that an action may be taken at the correct time, and a correct action to isolate this fault is taken by the correct relay in the system.

Power system experiences different types of symmetrical and asymmetrical faults, like L-L-L, L-L-L-G, L-G, L-L, and L-L-G. A method is needed to discriminate between the faults and utilize the characteristics of each type. Several techniques are developed in the past for classifying faults on the transmission system.

Faults frequently occur on transmission lines since the lines are spread over large geographical area. The lines are exposed to all types of atmospheric conditions and are vulnerable to several types of disturbances.

No power system can be designed in such a way that it would never fail. So, one has to live with the failures. In the language of protection engineers, these failures are called faults. There is no negative connotation to the word fault in this context. What is more important is how to prevent the faults and how to mitigate the consequences of the faults. The ill effects of faults are minimized by quickly isolating the faulty element from the rest of the healthy system; thus limiting the disturbance footprint as small an area in time and space as possible.
The fault on the line should be detected rapidly so that circuit breakers can isolate the fault keeping the rest of the system in operation.

S. Soliman, et.al [1] presented the application of Park's transformation for identifying and measuring power system harmonics. It has the ability to identify a large number of harmonics, since it does not need a mathematical model for harmonic components.

T. Dalstein, et.al [2] presented a novel multi-neural network based approach to fault classification of high speed protective relaying and shown its effectiveness in computer simulations on parallel transmission lines. The scheme is based on the use of neural network architecture and implementation of digital signal processing concepts.

S. A. Soliman, et.al [3] presented an algorithm to identify power system faults. The fault identification is achieved using a simple and numerically efficient algorithm based on Park's transformations.

T. Adu, et.al [4] presented a new fault classification technique that is efficient under all conditions that is required for fault recorders. The purpose is to present a new and accurate algorithm that is compatible with a fault recorder monitoring several connected transmission lines.

Motivated by the research in the area of intelligent system and wavelet analysis this paper proposes a classification method for symmetrical and asymmetrical faults based on wavelet transform and statistical parameters.

This paper is organized as follows: Statistical parameters used for feature extraction are introduced in section II, discrete wavelet transform is discussed in section III. The model system is described in section IV.Proposed technique and results are presented in section V.The conclusion is presented in section VI.

II. STATISTICAL PARAMETERS

A statistical parameter is a parameter that indexes a family of probability distributions. It can be regarded as numerical characteristic of a population or a model. Statistics is a quality that is calculated from a sample data. It is used to give information about unknown values in the corresponding population. The statistical parameters Kurtosis and Skewness are used as an input to ANN for classification of faults.
1. The Skewness value

The skewness characterizes the degree of asymmetry of a distribution around its mean. While the mean, standard deviation, and average deviation are dimensional quantities, that is, have the same units as the measured quantities, the skewness is conventionally defined in such a way as to make it

ISSN: 2321-8169
45 – 47

non-dimensional. It is a pure number that characterizes only the shape of the distribution. The usual definition is,

$$skew(x_1 \dots x_N) = \frac{1}{N}\sum_{i=1}^{N}\left[\frac{x_i - \bar{x}}{\sigma}\right]^3 \qquad (1)$$

Where, $\sigma = \sigma(x_1 \dots x_N)$ is the distribution's standard deviation.

A positive value of skewness signifies a distribution with an asymmetric tail extending out towards more positive x; a negative value signifies a distribution whose tail extends out towards more negative x.

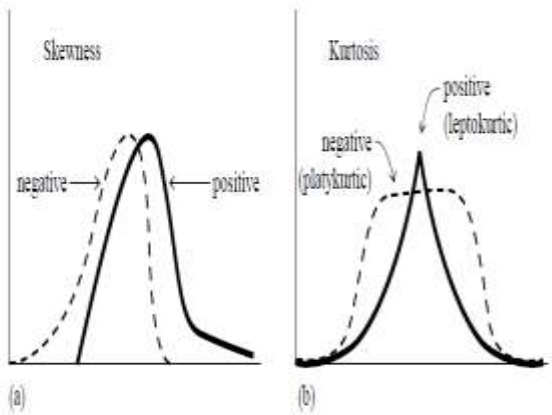

Figure 1. Distributions whose Skewness and Kurtosis are significantly different from a normal distribution. (a) Skewness, (b) Kurtosis

2. The kurtosis Value

The kurtosis is also a nondimensional quantity. It measures the relative peakedness or flatness of a distribution. A distribution with positive kurtosis is termed leptokurtic, and a distribution with negative kurtosis is termed platykurtic. The conventional definition of the kurtosis is

$$kurt(x_1 \cdots x_N) = \left\{\frac{1}{N}\sum_{i=1}^{N}\left[\frac{x_i - \bar{x}}{\sigma}\right]^4\right\} - 3 \qquad (2)$$

Where, the −3 term makes the value zero for a normal distribution.

III. DISCRETE WAVELET TRANSFORM

Fault being a non-stationary phenomenon, information about particular spectral components occurring at the time of fault occurrence is very important. Wavelet Transform is capable of providing both the time and frequency information simultaneously, hence giving a time–frequency representation of the signal. It expands a signal in terms of a wavelet, generated using translation and dilation of a fixed wavelet function called the mother wavelet.

Wavelets analyze any signal by using an approach called the multi resolution analysis (MRA), i.e., it analyzes the signal at different frequencies with different resolutions.

IV. SYSTEM UNDER CONSIDERATION

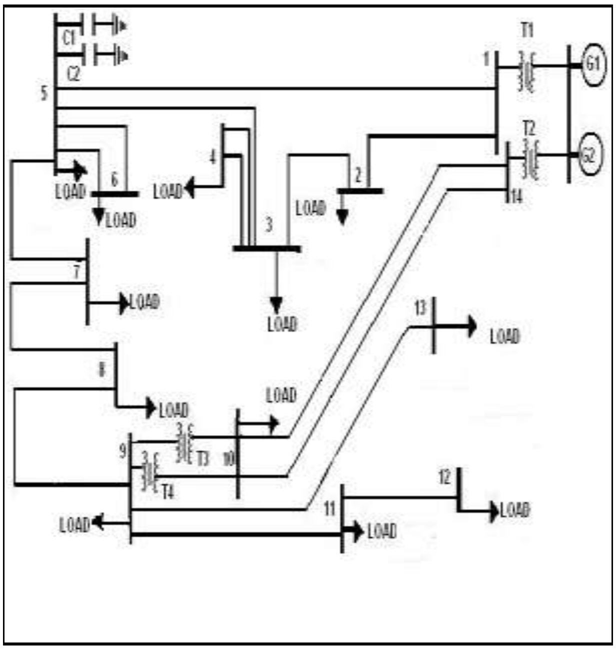

Figure 2. Single line diagram of power system.

It is a 132 KV network with 14 buses. The two lines between bus 10 and bus 14 are 220 KV lines and remaining are 132 KV lines. The transmissions lines have been modeled using the frequency dependent phase model in PSCAD/EMTDC. This 132 KV network is interconnected with 220 KV network.

V. PROPOSED TECHNIQUE AND RESULTS

The technique proposed in this section uses samples of line currents. The relative magnitudes of these components from prefault to the fault stage are used to identify a fault.

Capture four cycles (1600 samples) of 3 line currents. These samples are decomposed up to 5 levels i.e. d1 to d5, using DWT (Discrete Wavelet Transform) with Daubechies 4 (db4) as the mother wavelet as shown in figure 3. The kurtosis is calculated from d1 coefficients using equations (2). The skewness is calculated from d5 coefficients using equation (1).

The skewness and kurtosis for each line current are fed to the ANN to classify the symmetrical and asymmetrical faults.

ISSN: 2321-8169
45 – 47

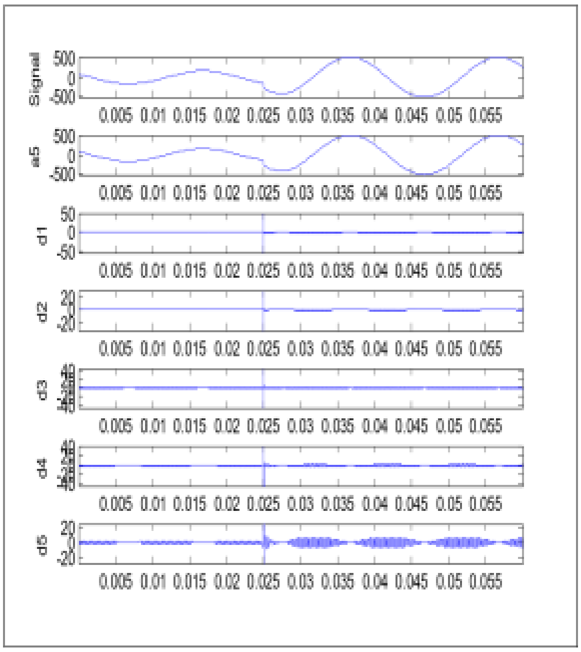

Figure 3. Wavelet decomposition of line to ground fault current

The Multilayer Perceptron (MLP) is widely used neural network for General Classification or Regression. A Multilayer Perceptron (MLP) is a feed forward artificial neural network model that maps set of input data onto a set of appropriate outputs. A MLP consist of multiple layer of nodes in a directed graph, with each fully connected to the next one. Except for the input nodes, each node is a neuron (or processing element) with a nonlinear activation function. MLP utilize a supervised learning technique called backpropagation for training the network

Neural net was trained with more than 500 training patterns simulating all relevant fault types, fault start times and faultless situations. It has been found out, that a net with 2 node in hidden layer, 4 processing elements and 2 outputs is suitable for this type of classification.

For generalization the randomized data is fed to the network and is trained for different hidden layers. The numbers of Processing Elements (PEs) in the hidden layer are varied. The network is trained and minimum MSE is obtained. The correct classification accuracy of symmetrical fault events was 91% and that of asymmetrical faults was 83 %.

VI. CONCLUSION

A method based on statistical parameters and wavelet transform for classification of symmetrical and asymmetrical faults is proposed in this paper. Coefficients of detail 1 and 5 level have been used to extract distinguishing features after statistical processing. The statistical parameters, kurtosis and skewness are given as input to ANN.The classification accuracy needs to be increased which can probably be achieved by incorporating more statistical parameters.

REFERENCES

[1] S. Soliman, R. A. Al-Ammari, M. E. El-Hawary, A. H. Mantaway "Park's Transformation Application for Power System Harmonics Identification and Measurements," Electric Power Components Elsevier Journal,pp777-789, published online: 21 Jun 2010.

[2] T. Dalstein and B. Kulicke, "Neural network approach to fault classification for high-speed protective relaying," IEEE Trans. Power Delivery, vol. 10, pp. 1002–1011, Apr. 1995.

[3] S. A. Soliman, M. Belkhayat, "Power Systems Fault Type Identification Based on Park's Transformation Algorithm" IEEE Large Engieering Systems Conference on Power System Engineering 26-28 July 2006 pp 141-145

[4] T. Adu, "An Accurate Fault Classification Technique for Power System Monitoring Devices", IEEE Transactions on Power Delivery, Vol.17, NO. 3, pp.684-690, 2002.