Fault Identification In Power System With DWT And Multiclass Support Vector Machine

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Abstract- *Powers system is now rapidly growing in size and complexity due to increase in demands. All the sectors such as power generation, power transmission, and distribution and load systems are affected due to this growth. Reliability of the electrical system is affected due to different types of faults like short circuit condition in power system network which results in economic losses and shrinks the reliable operation of power system. Electrical fault generated due to many abnormal condition such as failures of transformers and rotating machines, human errors and environmental conditions. The fault may be LG, LLG, LLL or LLLG types.*

In this paper, Fault detection and identification in electric power transmission has described using wavelet transform and multi-class SVM classifier. The developed method of fault identification has shown a capability of detecting a fault either it is due to single line to ground and double line to ground or all the three phases fault. The results obtained in simulation shows the validation of the proposed methodology for the scenarios considered.

Keywords- Fault Detection, Power system, Wavelet Transform, Transmission Line, SVM,

I. INTRODUCTION

Nowadays, fault detection and diagnosis of contemporary commercial structures represents a major challenge and an energetic subject of studies. Fault means the partial or total failure of a device and the detection is the capability to apprehend the purposeful potential of a device. Fault detection is crucial in lots of industries to offer secure operation of a technique. To decide the kind, length, area and time. Fault detection is used to taking pictures of the fault and estimating the time of fault prevalence. Fault is an unpermitted deviation of at the least one feature property or parameter of the machine from the suited condition. it causes like design errors, implementation mistakes, human mistakes, use, wears, deterioration, damages, getting old. Consequences of the fault are worse performances, power waste, waste of raw materials, economic losses lower exceptional, decrease manufacturing, environmental damages, human damages Device fault and prevention are the concerns with non-public protection, reliability, failure value. In the past, fault detection of electrical machines becomes primarily based on simple techniques which include over modern and overvoltage detection. after detection, the system had to be offline to clean the fault. In non-stop operations, however, a shutdown of the motor might not be perfect; for this reason, it's miles important to locate the fault speedy and find out correctly its vicinity and rigorousness. An early detection of an initial fault avoids hard outcomes and decreases monetary loss, bringing approximately handiest short downtime for the working method. In the reality, each accurate analysis and early detection of incipient faults cause speedy unscheduled protection and quick downtime for the system underneath consideration. In addition, they save you the dangerous and sometimes devastating outcomes of faults and failures. Usually, failure prevention may be identified as the method of fault detection, diagnosis, and analysis. if a fault is detected, upkeep is made speedy and to restore full shielding capability. In instances in which maintenance can't be with no trouble performed, trade safety is placed in carrier or operations are taken to a strong, secure country till the maintenance can be made. The two techniques of fault diagnosis are classification technique and the inference method. Classification methods are used while structural information is available between the symptom and fault. Inference technique is used for fault analysis. Vibration is the to and fro or repetitive motion of an item from its factor of rest. The rotating machines produce vibrations that are a function of the gadget dynamics, along with the alignment and balance of the rotating parts. Vibration size is an effective, non-intrusive approach to monitor system circumstance all through startups, shutdowns and regular operation. Vibration analysis is used by and large on rotating gadget together with steam and gas mills, pumps, automobiles, compressors, paper machines, rolling turbines, machine equipment, and gearboxes. Vibration analysis is used to decide the operating and mechanical situation of the gadget. a first-rate advantage is that vibration analysis can perceive developing problems earlier than they end up too serious and purpose unscheduled downtime. This will be completed with the aid of accomplishing ordinary tracking of device vibrations either on a non-stop basis or at scheduled durations.

Everyday vibration monitoring can discover deteriorating or faulty bearings, mechanical looseness, and worn or damaged gears. Vibration analysis also can come across misalignment and unbalance before these situations result in bearing or shaft deterioration. Vibration is an extensively measured parameter in many business programs. Vibrations response measurements provide precious facts on common faults. The wavelet includes both the analyzing form and the window. But, wavelets were applied in many different areas including nonlinear regression and compression. Wavelet decomposes a signal in each time and frequency in phrases of a wavelet, known as mom wavelet. Wavelets are an effective statistical tool which can be used for a huge range of packages, namely signal processing, data compression, business supervision of gear-wheel and so on. Wavelets provide a time-scale record of a sign, allowing the extraction of functions that vary in time. This belonging makes wavelets a really perfect tool for studying indicators of a transient or non-desk bound nature.

II. RELATED WORK

As a powerful tool of signal analysis, wavelet transform has good localization properties in time and frequency domain, Dong focus to any details of the analysis object with taking fine time or frequency step length of high frequency, express any changes existing in the object, so as to get accurate feature separation results from the measurement data with bad SNR [1].

Mayuresh et.al, In this paper investigation approach used for fault detection using wavelet transform and neural network. The present a discrete wavelet transform and neural network method approach to transmission line fault detection. This paper details coefficients energy of the phase signals, and as an input to neural network to classify the faults on power transmission lines. The features are extracted from the current signals by using wavelet transform. The feature vector is then given as input to the neural network [2].

Oualmakran et al, presented a combined study of knowledge based methods for fault location where Artificial Intelligence (AI) method was said to be supreme among the others. Yet it is found that there is a lot of work to be done in developing novel technique, integrating the goals and inserting the evolving features of power distribution networks [3].

III. DISCRETE WAVELET TRANSFORM

The transient voltages and currents during fault carry high frequency component or harmonics which carry important information regarding type and location of fault. The wavelets transform can be very effectively used in analyzing transient phenomenon of the fault signals. Multi-resolution analysis is one of the tools of discrete wavelet transform, which decomposes the original signal to low frequency signal called approximations and high frequency signals called details. The number of decomposition steps is influenced from the sampling frequency of the original signals. The first decomposition step the signal is decomposed into D1 component of high frequency band and A1 component of low frequency band. The frequency band of D1 component is (fs/2-fs/4) Hz and A1 component is (fs/4-0), fs Hz being the sampling frequency. In the second decomposition step, A1 component extracted from the first decomposition step is again decomposed. Therefore, D2 component of high frequency band and A2 component of low frequency band is achieved. Frequency band of D2 component is (fs /4-fs /8) Hz and the frequency band of A2 component is (fs /8-0)Hz.

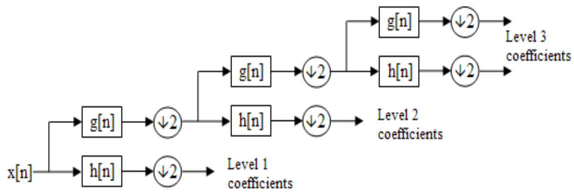

Fig. 1. Multi-level DWT

The signal of the desired component can be extracted via repetitious decomposition. The no. of decomposition steps should be decided through comparing the scale of sampling frequency with that of the frequency component of the desired signal. Fig. 1 shows the multi resolution steps of the signal $eq.\, c\ (j + 1)$.

IV. FAULT DETECTION

The fault detection methodology is explained in this section for the grid-connected wind power system as follows:
A grid-connected wind power system is simulated in MATLAB where different types of fault are created. The voltage signal is extracted at PCC under faulty conditions. The signal is then passed through wavelet transform to get the time frequency analysis for identification of faulty situations.

The voltage signal is processed through to find the mean and de-correlation. This is the 1st level of processing.

Then, X data size is reduced and filtered for better data redundancy

Then, the principal components (PC) of the input data are determined.

In the current study, the independent components are calculated based on fixed point iteration.

V. PROPOSED METHOD

The proposed single line diagram of the simulated power network is shown in fig. 2.

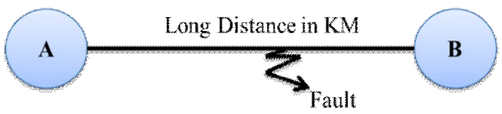

Fig. 2 Single line diagram transmission line

Power system described in this paper consists of two sources A and B with buses 1 and 2 separated by a 200 km long transmission line. Various parameters are described in the table 1.

Table 1. Simulation Parameter

S.no	Parameter	Describe
1	Frequency	50Hz
2	Length of transmission line	100Km
3	Fault impedance	0.4 ohm
4	Each fault duration	6.7 ms
5	No. of generator	3

The power system was simulation model shown in fig.3

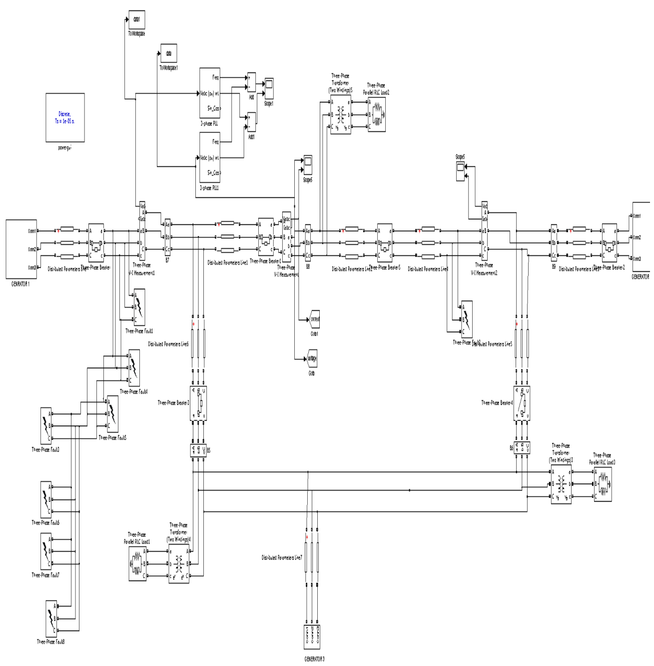

Fig. 3 Simulink diagram of power System

VI. SVM BASED CLASSIFICATION

The samples of Phase Ground data and other types of data is labeled as positive and negative examples and used to train the SVM. A similar set of data is then input to SVM for classification to check the checking error. Training is again performed on diversified data set to check for training of SVM on all the possible voltage values involved in the fault, short circuit and other types of line faults. As shown in figure 4, input values are obtained for the supervisory control and data acquisition system and used initially as test data to train the SVM. SVM is recommended for classification as it can provide a higher dimensional input space for parameters and provides a Binary Classification. The classification is actually the set of data points on either side of the hyper-plane which is represented by the Support Vector Machine. The Input to the SVM in phase-ground and other types of faults are:

Phase A to Ground Voltage
Phase B to Ground Voltage
Phase C to Ground Voltage
Phase A to Phase B to Ground Voltage
Phase B to Phase C to Ground Voltage
Phase C to Phase A to Ground Voltage
Phase A to Phase B to Phase C to Ground Voltage

For the set of these 6 input parameters, the proposed SVM based classifier maps to an optimal hyper-plane to classify the Phase to Ground Faults and other types of faults. Thus the following mapping is represented by the SVM classifier shown in figure 4.

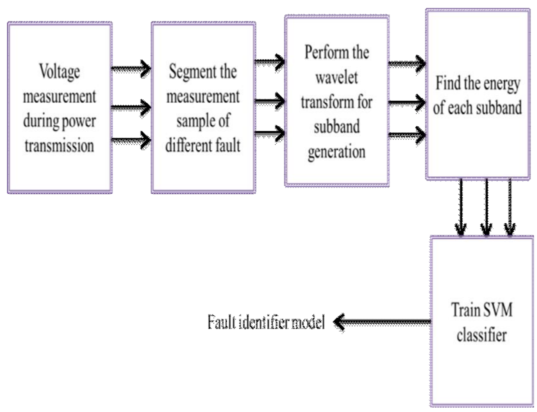

Fig. 4 Proposed SVM classifier

VII. SIMULATION RESULTS

The three-phase fault detection simulator is used to simulate various types of faults at varying locations along the transmission line with different fault resistances.

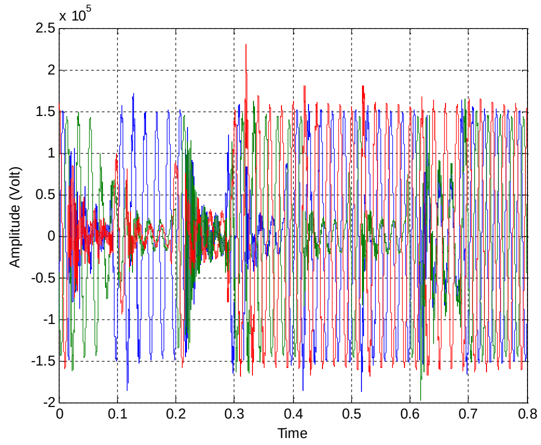

Fig. 5 The voltage waveform for simulation with and without fault at one location

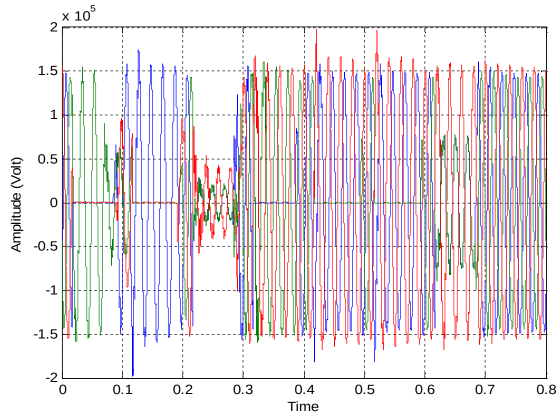

Fig. 6 The voltage waveform for simulation with and without fault at 2nd location.

These voltage signals is segmented for different fault condition based on the fault timing and shown in the figure given below

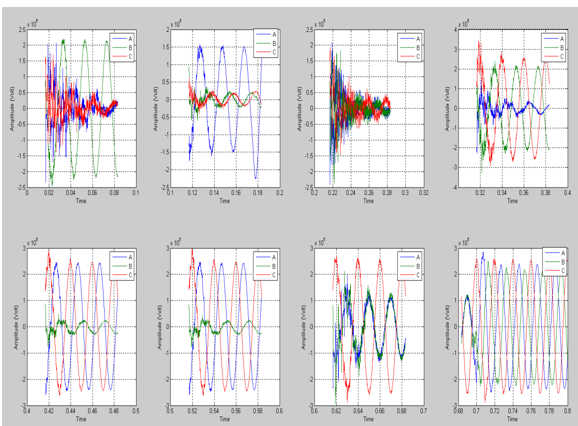

Fig. 7 Segmented waveform of voltage at location near to fault location in order of fault of 'ACG','BCG', 'ABG',' AG',' BG', 'CG', 'ABCG' and 'No fault '

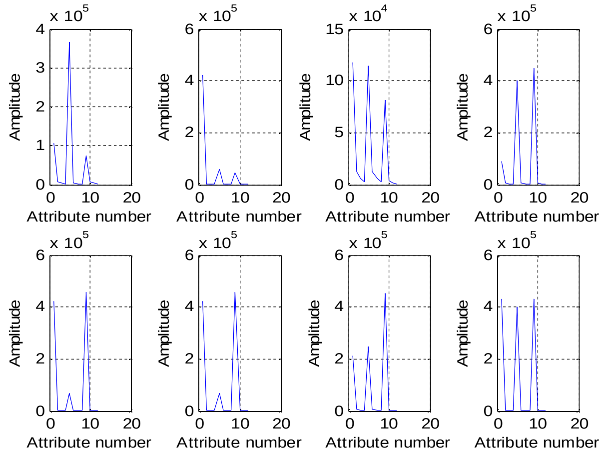

Fig. 8 Wavelet Feature

A multiclass SVM classifier has been trained with the feature shown in figure 8, and applies for fault detection. The Gaussian kernel has been used for SVM classification. The fault detection accuracy has been achieved of 87.5 %. Table of classification by proposed method is shown below table 2 .

Table 2. Simulation Fault Results

S.no	Actual fault in simulation	Fault by SVM classifier
1	Phase A to Ground Voltage	Phase A to Ground Voltage
2	Phase B to Ground Voltage	Phase B to Ground Voltage
3	Phase C to Ground Voltage	Phase B to Ground Voltage
4	Phase A to Phase B to Ground Voltage	Phase A to Phase B to Ground Voltage
5	Phase B to Phase C to Ground Voltage	Phase B to Phase C to Ground Voltage
6	Phase C to Phase A to Ground Voltage	Phase C to Phase A to Ground Voltage
7	Phase A to Phase B to Phase C to Ground Voltage	Phase A to Phase B to Phase C to Ground Voltage
88	No fault	No fault

VIII. CONCLUSION

The proposed method has been implemented successfully. This work describes the method for fault detection and classification in power system for different type of fault. The haar wavelet transform along with multiclass SVM classifier shown the ability of the classification between normal and faulty condition and it also classify symmetric and unsymmetrical fault .The 87.5 % accuracy has achieved with a misclassification between two unsymmetrical faults only.

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