**POWER SYSTEM FAULT DIAGNOSIS USING MACHINE LEARNING**

# Abstract:

Power Systems has many challenges which include fault diagnosis, load frequency control, unit commitment, load scheduling, optimization etc. In the above-mentioned fault diagnosis is one of the major issue. This can be resolved by using traditional and artificial intelligence-based techniques. This paper focus on fault detection, classification and location identification in electrical transmission systems using machine learning. The simulation results concluded that the present method is efficient in detection, classification and location estimation of the faults on the transmission lines with satisfactory performance.

Keywords: Fault Diagnosis, Artificial Intelligence, Deep Neural Network, Recurrent Neural Network.

# I. Introduction:

Electrical power systems important asset of every nation, We mostly depend on the electrical power. The electrical power systems were are grown very rapidly in the past few decades that resulted in a large increase in the number of lines in operation and their length. The transmission lines are exposed to open environment so that the faults are unavoidable. These faults as a result of lightning, short circuits, faulty equipment, mis-operation, human errors, overloading and ageing etc.

When a fault occurs in transmission lines it is very important to detect, classify and to find the fault location to restore the power delivery. The time needed for the restoration of the power will reflect in power quality. Therefore a sophisticated detection technique and an accurate location on the line is an important requirement for fault detection.

Most of the faults can cause large currents or voltage changes so that they can be detected using the traditional protective relays. But some faults, such as high impedance faults will cause small current and voltage changes. So that it is difficult to detect by a traditional protective relay. For those problems, we need an efficient fault detection, classification and location methods.

# II. Power System Faults:

Fault is an abnormal condition in the electrical systems. The faults in the electric transmission lines are short circuit faults and open circuit faults etc. Open circuit faults are very rare in the transmission lines but the short circuit faults are very common these faults are may be due to natural climatic conditions and mis-operation. The transmission of electric power is doing in 3 phase lines. The short circuit faults in the 3 phase transmission lines are classified as symmetrical faults and unsymmetrical faults.

## A. Symmetrical faults:

Symmetrical faults are most severe faults and rarely occurs in the power system. These faults are balanced. These faults are of two types LLL fault and LLL-G faults, When ground involves in the fault then that is called as LLL-G fault else called as LLL fault. These faults remain balanced in the system. The analysis can be done by using per phase analysis.

## B. Un-symmetrical faults:

These faults are very common and less severe than the symmetrical faults. These faults are classified as the line to ground (L-G), line to line (L-L), double line to ground fault (LL-G) faults. These faults are unbalanced in nature and cause unbalanced currents to flow in the phases. The study of un-symmetrical faults can be done by using symmetrical components.

# III. Fault Detection and Classification Techniques:

There are plenty of techniques proposed over the past years. Those techniques have their own advantages and disadvantages. The fault classification and location identification must be very fast in order to improve the power quality.

## A. Discrete Wavelet Transform:

Discrete wavelet transform (DWT) is a very important technique for the feature extraction from certain frequency bands in signals. Discrete wavelet transforms with Multi-Resolution Analysis (MRA) can be used to analyze the high-frequency signals for a short duration. The main drawbacks of DWT are the choice if appropriate mother function suitable for the application, computational complexity and time etc.

## B. Artificial Neural Networks:

Artificial neural networks are (ANN) are a family of non-linear statistical models and learning algorithms that are intended to imitate the behavior of connected neurons in biological neural systems. Different ANN models have been used for different applications. Feedforward neural network (FNN) the simplest neural network configuration which can be characterized as a single layer or multi-layer perceptrons. An FNN often has an input layer, output layer and at least one hidden layer. The node or neurons will fully connected with adjacent layer to process in data. The weights will be assigned and the bias for the nodes decides the output of the network given an input.

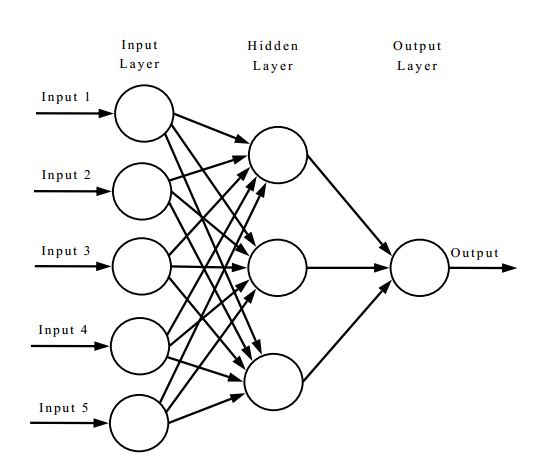


Fig. 1 Artificial neural network

Fig. 1 shows the artificial neural network with multi-input and a single output. From the late 1980’s researchers are using Back-propagation algorithm with FNN. There are several types of FNN networks such as Radial basis function networks (RBFN), Probabilistic neural networks (PNN) etc.

## C. Support Vector Machines:

Support vector machine (SVM) was invented by Cortes and Vapnik in 1995. The main idea of SVM classifiers is to find the optimal hyperplane that maximizes the margin between two groups of examples. SVM uses non-linear kernel functions to map the examples into higher dimensions. SVM prevents overfitting due to its structural risk-minimizing nature. SVM is a very powerful tool for classification problems. SVM with other techniques were also implemented such as DWT, ST etc. Even though SVM gives better results, it has a problem with parameter optimization.

## D. Decision Trees:

Decision Trees (DT’s) refers to the class of tree-like graphs capable of decision making. DTs will look like trees models with nodes. Concretely, three types of nodes found in a DT, namely root node, internal nodes and leaf nodes. Decision-making starts from the root node and the flow goes along the path that satisfies the test conditions. Decision trees can be trained with many algorithms such as greedy algorithm, random forest etc. Decision trees are easy to understand by humans as per the conditions, but the main drawback is their stability.

## E. Fault Location Identification Techniques:

The accurate location of faults in the transmission lines and distribution system greatly reduces the time to restore the power. The conventional fault location methods can be classified into two groups, travelling wave based schemes and impedance measurement based schemes.

### a) Travelling Wave Based Fault Locators:

Travelling waves will get generated due to switching operations and faults such as short circuit faults and open circuit faults. Travelling waves phenomenon for fault location is classified into four different types. Two of them are generated wave analysis and the remaining two are external wave injection to the transmission line at a single end and at both ends. The time of reflection of the wave is proportional to the fault location.

### b) Impedance Measurement Based Fault Locators:

These schemes provides another alternative for the fault location estimation problem. Let us consider that a single line to ground fault occurred in a transmission line with a fault resistance at a distance x from the sending end. The fault will draw the fault current based on the fault resistance. The measurements units will measure that voltages and currents, then the algorithms will estimate the fault location x as function of line impedance i.e single ended

### c) Other Fault Locators:

# IV. Deep Neural Networks:

Deep neural networks are improved version of the artificial neural networks. These networks need to be trained with large amount of data. These networks consist of hidden layers more than two to three. Deep neural networks are capable to extract features by their self and can provide better results when compared to many other techniques.

# V. Simulation Results and Discussions:

The power system studied in this paper is shown in the fig. x.

# VI. Conclusions:

From the results we can conclude that these results are satisfied

# REFERENCES