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FAULT ANALYSIS ON TRANSMISSION LINES USING ARTIFICIAL NEURAL NETWORK

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ABSTRACT

In power distribution technique it is essential to minimize transients, line voltage dips and spikes which are present due to the occurrence of fault detection. As a fault occurs in the power system, the necessary steps are taken to remove the fault in transmission line using relays & circuit breakers conventionally. But, if this fault occurrence is predicted in advance, then we can maintain a better voltage profile and quality power to consumers.

We introduce a neural network in the power system, which can learn and therefore be trained to find solutions, recognize patterns and classify data. One can use a control methodology in Artificial Neural Network (A.N.N) which can classify & predict the future events. The magnitude of control variables based on previously acquired samples is taken and these values are used to recognize the type of abnormal event that may occur on the network. An analysis of the learning & generalization characteristics of elements in power system is presented using Neural Network (NN) toolbox in MATLAB.

KEYWORDS: Transmission line, Faults, Protection, neural network.

INTRODUCTION

In the early development stages of electric power distribution, the issue of supply quality was not addressed with the due importance. Today this aspect is gaining increasing importance owing to the fact that more sensitive loads are connected to the electrical scheme, and represents the aim of the modern Custom Power concept. In this term describes the value-added power that electric utilities will offer their customers the application of power electronic controllers to utility distribution method and/or at the supply end of many industrial and commercial customers.

The neural network represents a network with a finite number of layers consisting of solitary elements that are similar to neurons with different types of connection among layers. The number of layers is desired to be minimal in order to decrease the problem solving time. Basically, we can design and train the neural networks (NN) for solving particular problems which are difficult to solve through the human beings or the conventional computational method. The computational of the training comes down to the adjustments of certain weights which are the key elements of the Artificial Neural Network. This is one of the key differences of the NN (neural network) approach to problem solving than conventional computational method. This adjustment of the weights takes place when the NN is presented with the input data records and the corresponding target values. In the possibility of neural network training with off-line data, they are found useful for power system. The neural network (NN) applications in transmission line protection are mainly concerned with in improvements in achieving more effective and efficient fault diagnosis and distance relaying. NN application can be used for overhead transmission lines, as well as in power distribution systems. Back propagation neural network approach is studied and implemented. The voltage and current signals of the line are observed to perform these three tasks. The detailed coefficients of all phase current that are collected only at the sending end of a transmission line are selected as parameters for fault detection classification.

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NEURAL NETWORK (ANN)

The power and usefulness of artificial neural networks (ANN) have been demonstrated in several applications including the speech synthesis, diagnostic problems, medicine, business and finance, signal processing, robotic control, computer vision and many other problems that fall under the category of pattern recognitions system.

This is due in part to the massive parallelism employed through the brain, which makes it easier to solve problems with simultaneous constraints. It is with this type of problem that traditional artificial intelligence techniques have had limited success. Field of NN, however, looks at a variety of models with a structure roughly analogous to that of the set of neurons in the human brain.

The neural networks are composed of simple elements operating in parallel. Neuron model shown in Figure 1 is the one that widely used in ANN with some minor modifications on it.

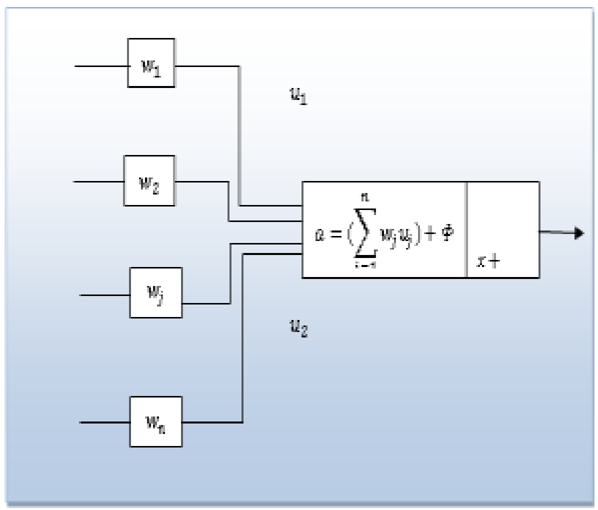

Fig: 1 Artificial Neuron Network Model

Artificial neuron given in this figure has N input data, denoted as u1, u2,…uN. In each line connecting these inputs to the neuron is assigned a weight, in which is denoted as w1,w2,….,wN respectively. The threshold in artificial neuron is usually represented by Φ and the activation is given by the formula

$$a = \left(\sum_{j=1}^{n} w_j u_j\right) + \Phi$$

FEED FORWARD NEURAL NETWORK

A feed forward neural network (NN) is a biologically inspired classification technique. It consists of a number of simple neuron-like processing units, organized in layers. In which every unit in a layer is connected with all the units in the previous layer. These connections are not all equal: in each connection may have a different strength or weight.

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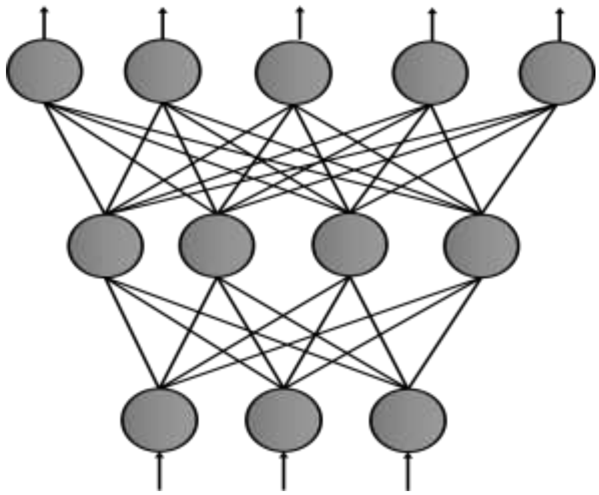

Error! No text of specified style in document. ***2 Feed forward neural network***

The weights on these connections encode the knowledge of a network system. Often the units in a neural network are also called nodes.

The data enters at the inputs and passes through the network, in layer by layer, until it arrives at the outputs. During normal operation, that is when it acts as a classifier, it is no feedback between layers. This is why they are called feed-forward neural networks. The following figure we see an example of a 2-layered neural network with, from top to bottom: an output layer with 5 units, a hidden layer with 4 units, respectively. The network has 3 input units.

BACK PROPAGATION NEURAL NETWORK

Back Propagation neural network learning algorithm is used to train the multi-layer feed forward neural network (FFNN). Signals are received at the input layer, passed through the hidden layer, and reach to the output layer, and then fed to the input layer again for learning. The learning process primarily involves determination of connection weights and patterns of connections. The BP neural network (NN) approximates the non-linear relationship between the input and the output by adjusting the weight values internally instead of giving the function expression explicitly. Further, the Back Propagation neural network can be generalized for the input that is not included in the training patterns in NN. The BP algorithm looks for minimum of error function in weight space using the method of gradient descent.

PROPOSED FAULT DETECTOR AND LOCATOR BASED ON NEURAL NETWORKS (NN)

Functional blocks of the proposed fault detector are shown in Figure .4 Voltage signals at the transmission line end S (relay location) will be acquired by the relay at buses. After preprocessing, it is fed to the fault detector (FD) to detect a fault, and if the fault is detected by FD, the fault classifier (FC) estimates the type of the fault that occured in the transmission line. The proposed fault detector (FD) is designed to indicate the presence or absence of a fault. The occurrence of the fault is classifying.

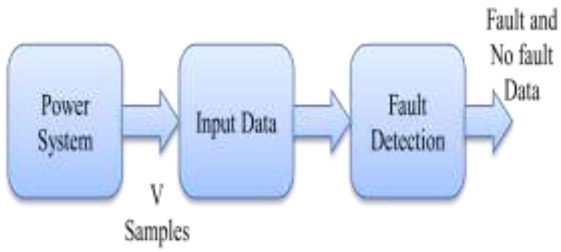

Fig: 3 Major blocks constituting the fault detector

Design Process of Ann Fault Detector

The design process of the ANN fault detector goes through the following steps:

1. Preparation of a suitable training data set that represents cases that ANN needs to learn to process further.
2. Selection of a suitable ANN structure for a given application for better output.
3. Training the ANN with suitable data.
4. Evaluation of the trained ANN using test patterns until its performance is satisfactory or error reduced.

Fault Detector

In order to build up an ANN, the inputs and outputs of the neural network have to be defined for recognition of pattern. The inputs of the network must provide a true representation of the situation under consideration. The generation process of input patterns to the ANN fault detector (FD).

Inputs and Outputs

In order to build up an ANN, the inputs and outputs of the neural network have to be defined for pattern recognition. The inputs to the network should provide a true representation of the situation under consideration. The process of generating input patterns to the ANN fault detector (FD).

The input (Voltage) patterns are generated as a string of samples corresponding to a sampling frequency. These signals are used to simulate a continuous sampling process (62 samples per 50 Hz cycle). The ANN output is indexed with either a value of $\neq 0$ in the case of fault present or 0 in the case of fault absence.

The input layer gives the three phase current and voltage. The outputs of the hidden layer with the sigmoid activation function are calculated and transferred to the output layer, which is composed of only one neuron. The output value of the neuron in the output layer with the sigmoid activation function calculated to gives the state of the transmission line: $\neq 0$ (the presence of a fault) or 0 (the non-faulty situation).

RESULTS AND DISCUSSION

The principle of variation of voltage and current signals before and after the fault incidence is used and a fast and reliable ANN-based fault detector/classifier module is designed to detect the fault and classify the fault type.

On classifying the different types of faults, the following graphs of ‘P’ and ‘Q’ according to its Bus No. as shown from Fig. 4-5 were obtained to realize which bus is affected the most due to the occurrence of fault in the system. Table 1 and Table 2 shows the data of active powers and reactive powers of the five buses during the fault.

Table. 1 Active Power of Buses during Fault

FAULT TYPE	BUS 1	BUS 2	BUS 3	BUS 4	BUS 5
ag	0.9229	0.6560	0.5361	1.5431	0.8278
bg	0.9208	0.6540	0.5341	1.5360	0.8247
cg	0.9224	0.6512	0.5336	1.5397	0.8263
ab	2.4665	1.7780	1.8498	3.8933	1.2584
ac	2.4643	1.7779	1.8483	3.8856	1.2553
bc	2.4685	1.7801	1.8512	3.8970	1.2597
abg	2.7335	1.7914	1.7987	4.4724	1.7977
acg	2.7353	1.7940	1.8009	4.4732	1.7984
bcg	2.7579	1.7997	1.8104	4.5223	1.8190
abc	9.2136	11.4734	11.4495	11.8804	2.5437

Table. 2 Reactive Power of Buses during Fault

FAULT TYPE	BUS 1	BUS 2	BUS 3	BUS 4	BUS 5
ag	0.7440	6.8477	6.5422	9.6566	9.9341
bg	0.7405	6.8188	6.5251	9.5242	9.8961
cg	0.7406	6.8248	6.5364	9.5530	9.9154
ab	2.5648	12.6518	10.9092	16.7097	15.1006
ac	2.5835	12.6082	10.8793	16.6143	15.0641
bc	2.6058	12.6669	10.9110	16.7754	15.1166
abg	2.6700	16.5893	14.8816	21.5815	21.5720
acg	2.6738	16.5516	14.8688	21.5509	21.5810
bcg	2.7214	16.8306	15.0593	21.8823	21.8281
abc	7.3863	18.5277	17.3072	27.0995	30.5240

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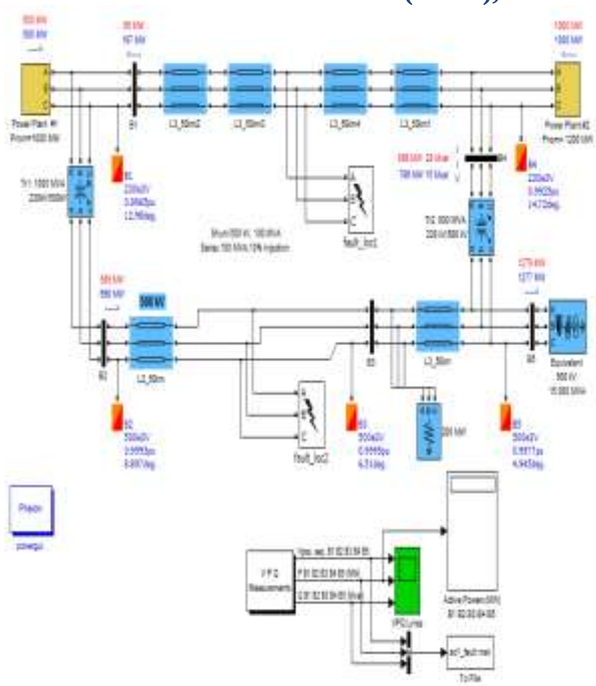

Fig: 4 Simulation model

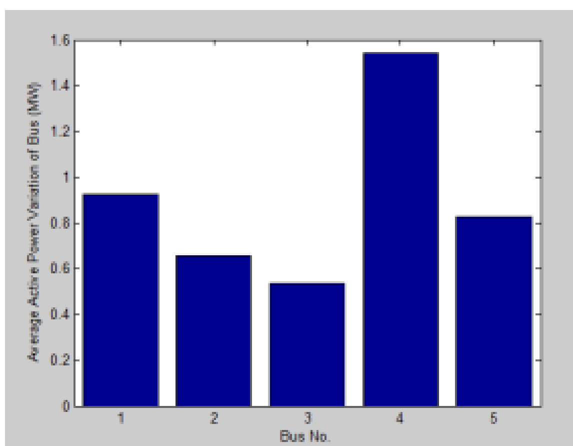

Fig: 5 Waveform of Classified Active Power 'P' for fault between phase 'a' and Ground at Buses

Bus 1: 0.9229 Bus 2: 0.6560 Bus 3: 0.5361
Bus 4: 1.5431 Bus 5: 0.8278

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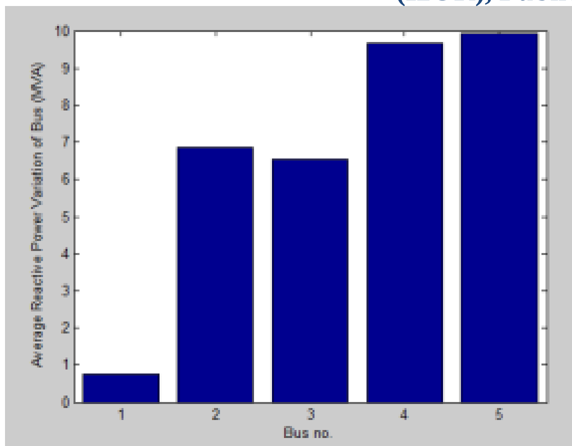

Fig: 6 Waveform of Classified Reactive Power 'Q' for fault between phase 'a' and Ground at Buses

Bus 1: 0.7440 Bus 2: 6.8477 Bus 3: 6.5422
Bus 4: 9.6566 Bus 5: 9.9341

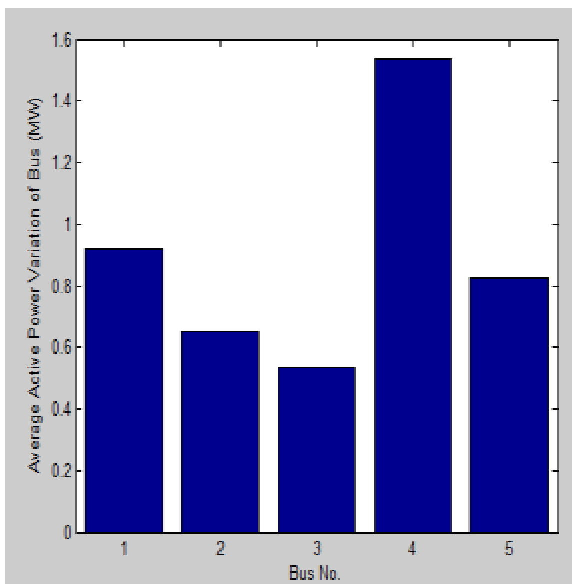

Fig: 7 Waveform of Classified Active Power 'P' for fault between phase 'b' and Ground at Buses

Bus 1: 0.9208 Bus 2: 0.6540 Bus 3: 0.5341
Bus 4: 1.5360 Bus 5: 0.8247

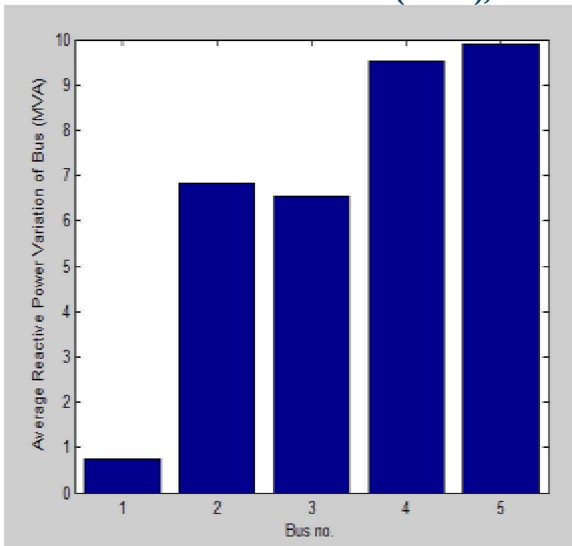

Fig: 8 Waveform of Classified Reactive Power 'Q' for fault between phase 'b' and Ground at Buses

Bus 1: 0.7405 Bus 2: 6.8188 Bus 3: 6.5251
Bus 4: 9.5242 Bus 5: 9.8961

CONCLUSION

Some important conclusions that can be drawn from this thesis are:

1. Neural Networks are indeed a reliable and attractive scheme for an ideal transmission line fault location scheme especially in view of the increasing complexity of the modern power transmission systems.
2. It is very essential to investigate and analyze the advantages of a particular neural network structure and learning algorithm before choosing it for an application because there should be a trade-off between the training characteristics and the performance factors of any neural network.
3. Back Propagation neural networks are very efficient when a sufficiently large training data set is available and hence they have been chosen for all the three steps in the fault location process namely fault detection, classification and fault location.

The result obtained shows higher percent of accuracy for fault location estimation after the training of the system.

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