Fault Detection on Transmission Lines Using Artificial Neural Network

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Abstract- *Transmission and distribution lines are critical connections between generators and consumers. The goal of this research is to use artificial neural networksto detect faults in electric power transmission lines (ANN). For all three phases, the constructed neural network can identify single line to ground and double line to ground. The results of simulations show that artificial neural network-based methods are effective in detecting problems on transmission lines and achieve satisfying results.*

Keywords- Fault Detection, ANN, Transmission Line, Fault Analysis,etc.

I. INTRODUCTION

When considering its physical dimensions, the transmission line is the most likely element in the power scheme to be exposed. Transmission lines are used to send power or voltage over great distances. The Transmission Line delivers the power or voltage created by the source to the load. Transmission Line faces numerous faults when transmitting owing to brief tree contact, bird or animal interaction, or other natural causes such as thunderstorms or lightning.

The goal of this research is to investigate and use the neural network (NN) technology to identify and detect flaws in a transmission line system. The artificial neural network (ANN) is a useful tool for identifying, isolating, and classifying transmission line faults [1]. Because of the parallelism inherent in neural networks (NN), they can process data quicker than previous methods. The application of this technology in the diagnosis of transmission line faults demonstrates its utility and inspires engineers to apply it to other power systems. The main goal of this paper is to create a neural network-based autonomous learning scheme that acquires knowledge incrementally in real time with as little supervision as possible, as well as to deploy effective strategies for practical application of such a scheme for fault detection and diagnosis. Identification, categorization, and localization of faults play a significant part in transmission line protection.

The number of neurons in each layer is chosen to provide the needed level of problem solving quality. To reduce issue solution time, the number of layers should be kept to a minimum. In general, we may create and train neural networks to address specific problems that are difficult to answer using humans or traditional computing procedures. Adjusting particular weights, which are the fundamental components of the Artificial Neural Network, is how the training is computed [2]. One of the main contrasts between the neural network approach to problem solving and the traditional computational method is this. This adjustment of the weights takes place when the neural network is presented with the input data records and the corresponding target values. In the possibility of training neural networks 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 [3-5].

II. ARTIFICIAL NEURAL NETWORK

An ANN may be considered as a greatly simplified model of the human brain which can be used to perform a particular task or function of interest. The network is usually implemented using electronic components or simulated in software on a digital computer. The massively parallel distributed structure and the ability to learn and generalise makes it possible for ANNs to solve complex problems that otherwise are currently intractable [6].

The typical engineering design model, which consists of exhaustive subsystem specifications and intercommunication protocols, should be contrasted with this operational approach. The designer of artificial neural networks chooses thenetwork topology, performance function, learning rule, and criterion for stopping the training phase, but the system modifies the parameters automatically. As a result, it is difficult to include a priori information into the design process, and it is also difficult to incrementally enhance the solution when the system fails. In terms of development time and resources, ANN-based systems are incredibly efficient. In many difficult problems artificial neural networks (ANN) provide performance that is difficult to match with other technology. Denker 10 years ago said that "artificial neural networks are the second best way to implement a solution" motivated through the simplicity of their design and because of their universality, only shadowed by the traditional design obtained through studying the physics of the problem. At present, artificial neural networks are emerging as the technology of choice for different applications, such as pattern recognition, prediction, and control and system identification.

Neuron is modeled as follows.

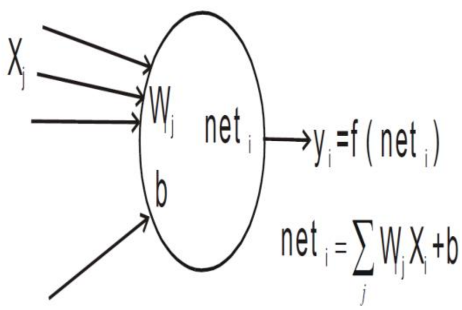

Fig: 1 Neuron Model

Each node has inputs connected to it and weights corresponding to each input data. Each node only has one output. The above neuron, based on the above notation, is called neuron i. j inputs Xj and one bias b as shown fig. 1. Each input correspond to a weight Wij, thus there are j weights in the neuron. Output of the neuron y_i is produced by a function of net_i where

$$\mathrm{net}_i = \sum_j W_{ij} X_j + b$$

III. ANN BASED FAULT DETECTION

Artificial intelligence, cognitive modeling, and neural networks are information processing paradigms inspired by the way biological neural systems process data. Artificial intelligence and cognitive modeling try to simulate some properties of biological neural networks. Artificial neural networks have been applied successfully to speech recognition, image analysis and adaptive control, in order to construct software agents (in computer and video games) or autonomous robots and specially in fault detection system [7-10]. Neural network theory has served both to better identify how the neurons in the brain function and to provide the basis for efforts to create artificial intelligence. Fig 2 shows a single neuron. The following diagram shows a simple neuron with:
Neuron consists of three basic components, namely weights, thresholds/biases and a single activation function. Values w1, w2……wn are weights to determine the strength of input vector X = [x1, x2,….., xn] T . Each input is multiplied with its associated weight of the neuron XT.W.

$$I = X^T . W = x_1 w_1 + x_2 w_2 + \dots + x_n w_n = \sum_{i=1}^{n} x_i w_i$$

$$Y = f(I) = f\left\{\sum_{i=1}^{n} x_i w_i - \varphi_k\right\}$$

To generate the final output Y, the sum is passed on to a non-linear filter f called activation function or transfer function, which releases the output Y.Most popular sigmoidal function follows the transition equation shown below.

$$Y = f(I) = \frac{1}{1 + e^{-\alpha I}}$$

where α is the slope of sigmoidal function followed.

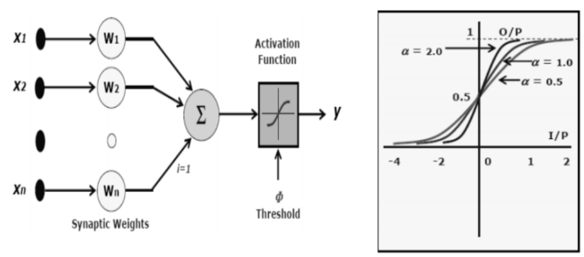

Fig: 2A single neuron and sigmoidal activation

The capability of the neural network increases as number of neurons increases. This capability multiplies as number of layers in neural network structure increases [11-13]. Figure 3 shows multilayer neural network with one hidden layer. The weights connecting neurons are varied continuously while training the neural network. In NN applications, the challenge is to find the right values for the weights and the threshold. Various algorithms are developed in neural network field depending on different problems and applications where it has been used. Back Propagation, Radial Basis Functions, Multi-Layer Perceptron algorithm.

IV. FAULT DETECTION AND CLASSIFICATION SYSTEM

The design process of proposed fault detection and classification approach is as follows:

- Training of artificial neural network and validation of the trained ANN using test patterns to check its correctness and generalization.
- Creating data acquisition of current and voltage signals in the power system.

- Application of D.W.T on the current signals and calculating in detail the coefficients of energy.
- Changing the system parameters, data acquisition of current and voltage signals and storing and analyzing results.
- Selection of suitable ANN topology for given application.

The fault resistance, fault location, and fault type are changed to generate different training patterns.

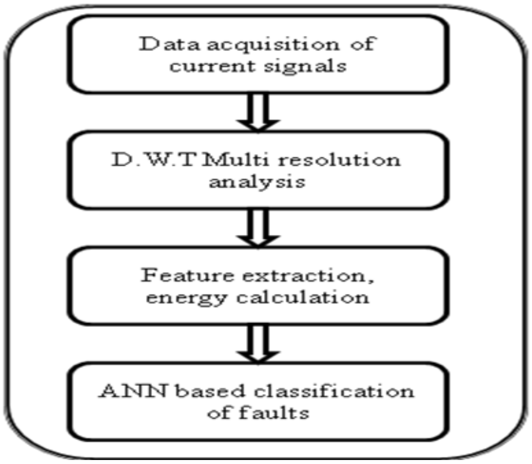

Fig: 3 Process of fault detection and classification.

V. RESULTS AND DISCUSSION

The proposed power system was simulation model using the SimPower toolbox in Simulink by The MathWorks shown in fig. 4. The three-phase fault simulator is used to simulate various types of faults at varying locations along the transmission line with different fault resistances as shown fig. 5-6.

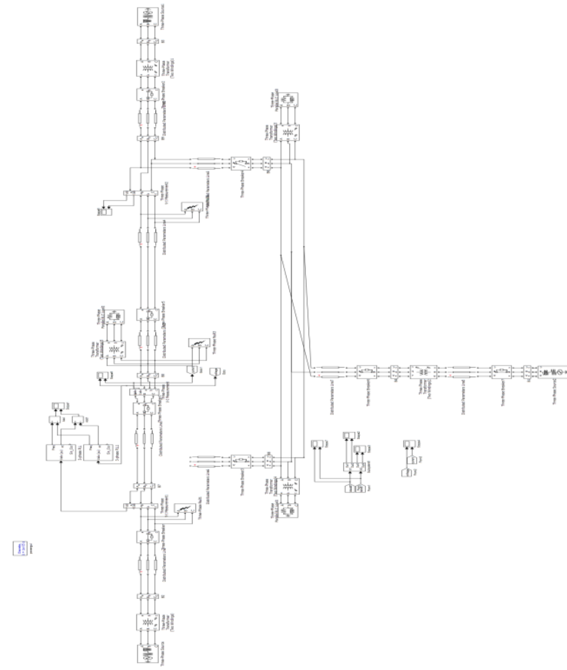

Fig: 4Simulink Block

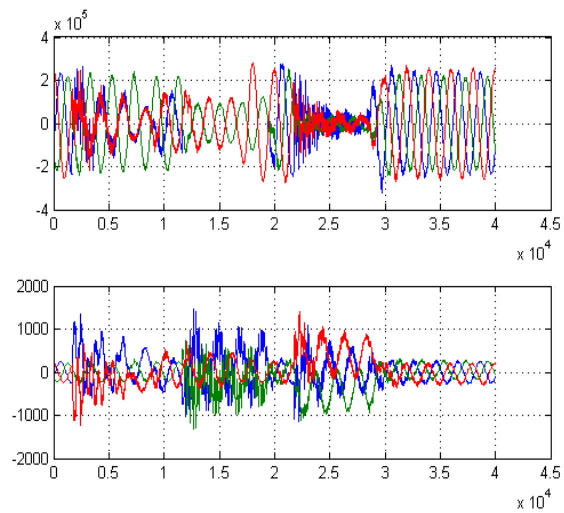

Fig:5 Shows the current waveform of a Phase A and B

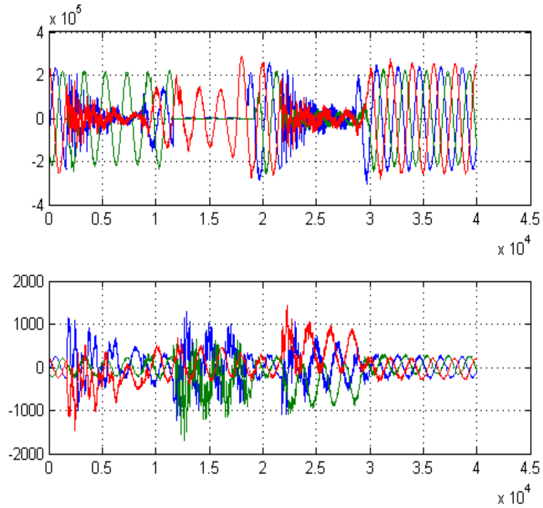

Fig:6 Shows the current waveform of Ground to Line

The different cases of single line to ground and double line to ground fault is tested for the developed fault detection technique. Each figure has four sub plots. Fault in one phase disturbs other phase current as shown fig. 7-11 in all the result given blow.

Case-1, Single Line Fault detection

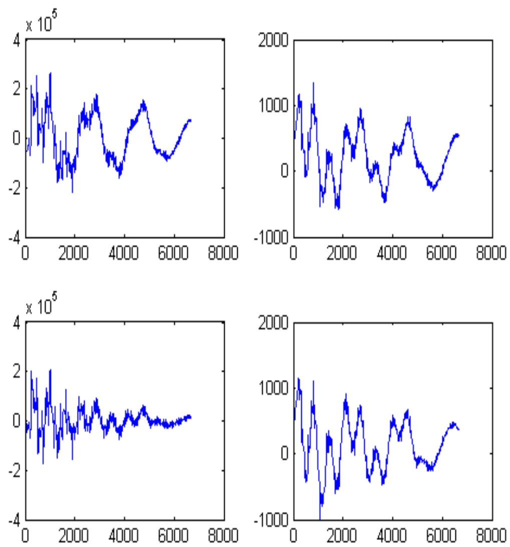

Fig: 7 Single Line Phase A and B fault detection

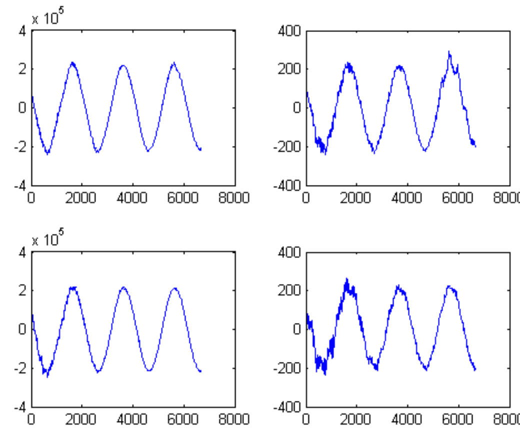

Fig: 8 Single Line Phase B and C fault detection

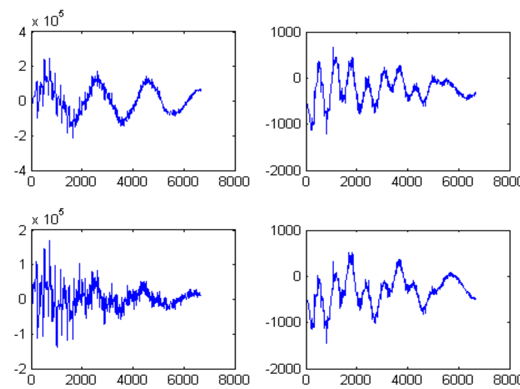

Fig: 9 Single Line Phase B and C fault detection

Case-2, Ground to Line Fault Detection

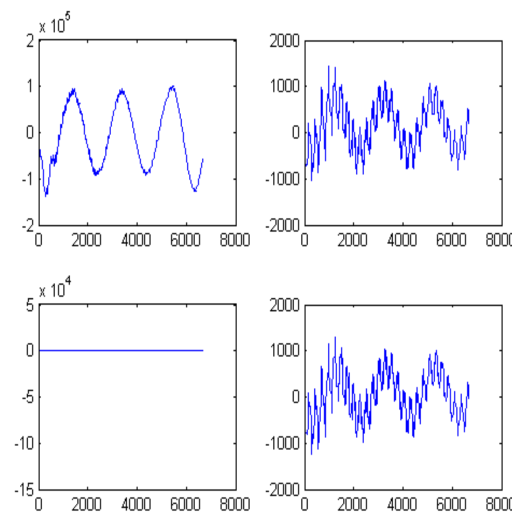

Fig. 10 Fault detection for Single line to ground fault in phase A

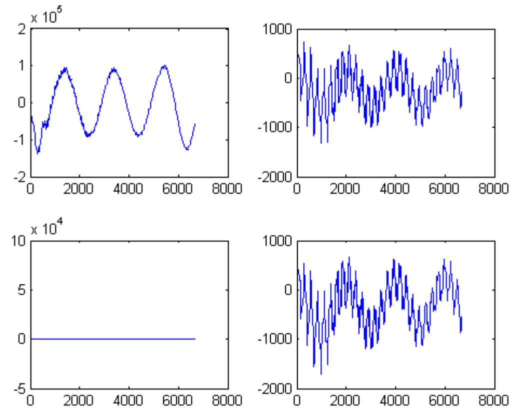

Fig. 11 Fault detection for Single line to ground fault in phase C

VI. CONCLUSION

The proposed method, fault detection using artificial neural network (ANN). The fault detection in a transmission line technique have been investigated using neural network technique. The data generated is used for single phase to ground faults, double phase faults and double phase to ground faults. The results obtained for transmission line fault detection.

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