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Fault Analysis on Transmission Lines Using Artificial Neural Network

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Abstract
The transmission and distribution lines are vital links between generating units and consumers. This project focuses on detecting Fault detection on electric power transmission lines using artificial neural networks (ANN). The developed neural network is capable of detecting single line to ground and double line to ground for all the three phases Simulation results have been provided to demonstrate that artificial neural network based methods are efficient in faults detection on transmission lines and achieve satisfactory performances.
Keywords: Fault Detection, ANN, Transmission Line, etc.

Introduction

Transmission line is the most likely element in the power scheme to be exposed especially when its physical dimension is taken into consideration. Transmission line is used to transfer power or voltage to long distance destination. Power or voltage generated from source is supplied to the load through the Transmission Line. While transmitting, Transmission Line encounters various faults due to momentary tree contact, a bird or an animal contact or due to other natural reasons such as thunderstorms or lightning.

The objective of this work is to study and employ neural network (NN) method as a reliable tool to identify or detect faults in a transmission line scheme Artificial neural network (ANN) is a powerful method to be used in transmission line fault identification, isolation and classification. The parallelism inherent in neural networks (NN) enables them with faster computational time than the traditional techniques. Using this technology in transmission line fault diagnosis validates its utility and encourages engineers to use this technique in other power systems. The main objective of this paper is to develop neural network based autonomous learning scheme that acquire knowledge incrementally in real time, with as little supervision as possible and to deploy effective strategies for practical application of such scheme for fault identification and diagnosis. In protection of transmission line the fault identification, classification and location plays an important role.

The number of neurons in the layers is selected to be sufficient for the provision of required problem solving quality. 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 for solving particular problems which are difficult to solve through the human beings or the conventional computational algorithms. 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 neural network approach to problem solving than conventional computational method. 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.

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.

This operating procedure should be contrasted with the traditional engineering design

model, made of exhaustive subsystem specifications and intercommunication protocols. In Artificial neural networks, the designer chooses the network topology, the performance function, the learning rule, the criterion to stop the training phase, but the system automatically adjusts the parameters. So, it is difficult to bring a priori information into the design process, and when the system does not work properly, it is also hard to incrementally refine the solution. ANN-based solutions are extremely efficient in terms of development time and resources. 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.

A. Neuron System

Neuron is modeled as follows.

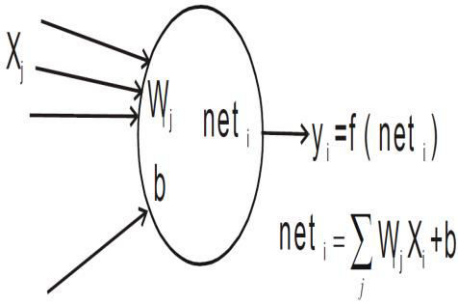

Fig: 1 Neuron Model

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. 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

$$\text{net}_i = \sum_j W_{ij}X_i + b$$

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. 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.

$$I = X^T.W = x_1w_1 + x_2w_2 + \ldots + x_nw_n = \sum_{i=1}^{n} x_iw_i$$

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

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.

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

where α is the slope of sigmoidal function followed.

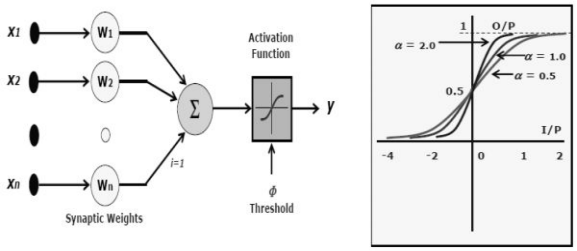

Fig: 3 A single neuron and sigmoidal activation

The capability of the neural network increases as number of neurons increases. This capability multiplies as number of layers in neural network structure increases. 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

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.

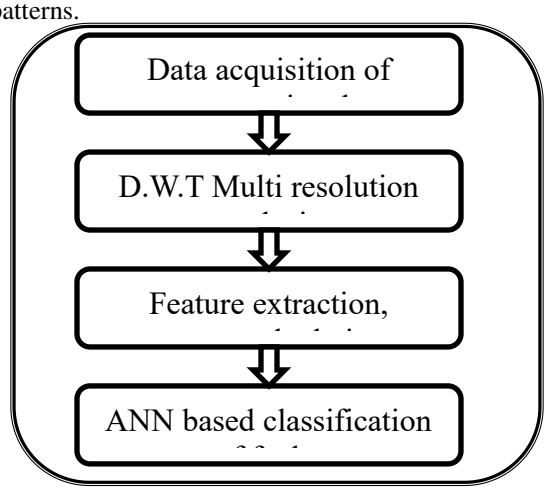

Fig: 4 Process of fault detection and classification.

Results and discussion

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

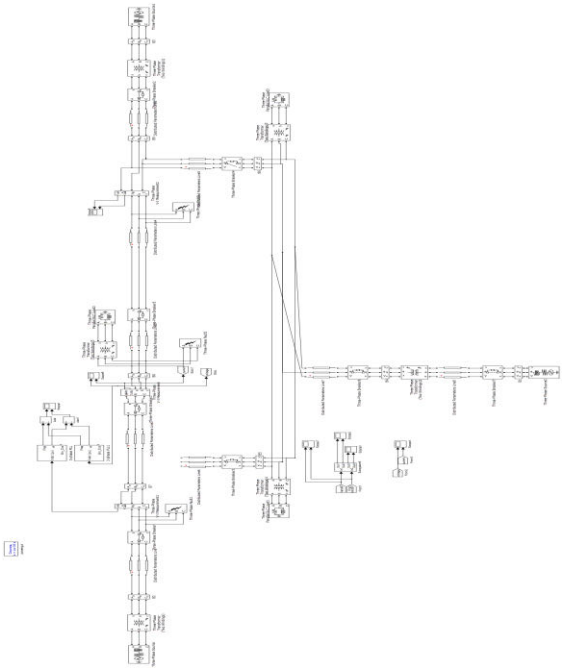

Fig: 5 Simulink Block

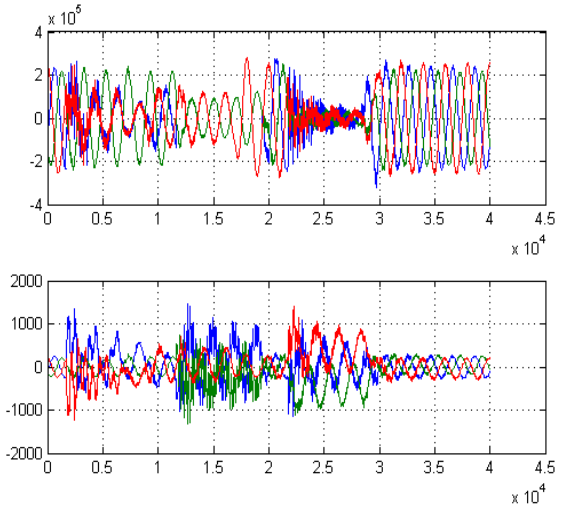

Fig: 6 Shows the current waveform of a Phase A and B

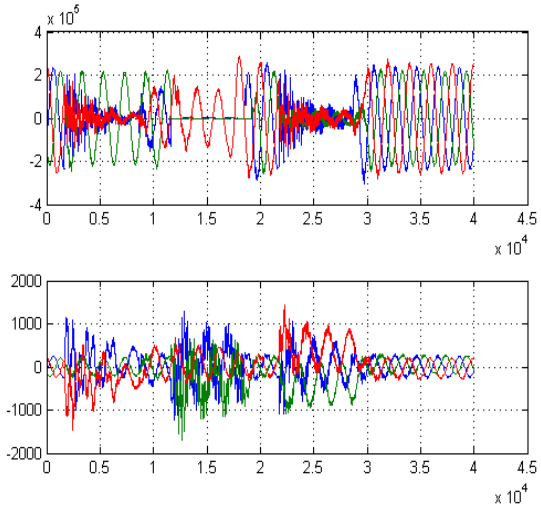

Fig: 7 Shows the current waveform of Ground to Line

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 in all the result given blow.

Case-1, Single Line Fault detection

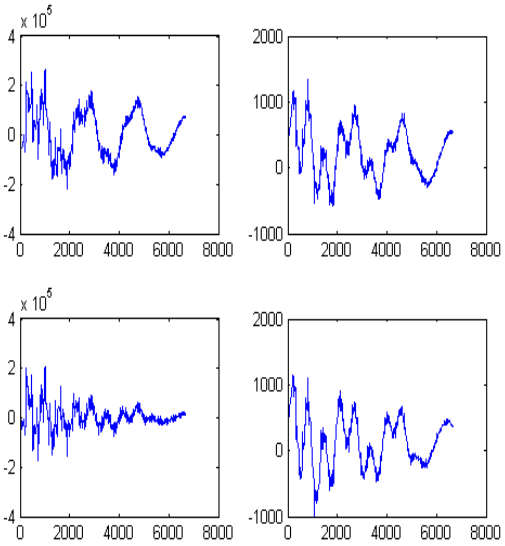

Fig: 8 Single Line Phase A and B fault detection

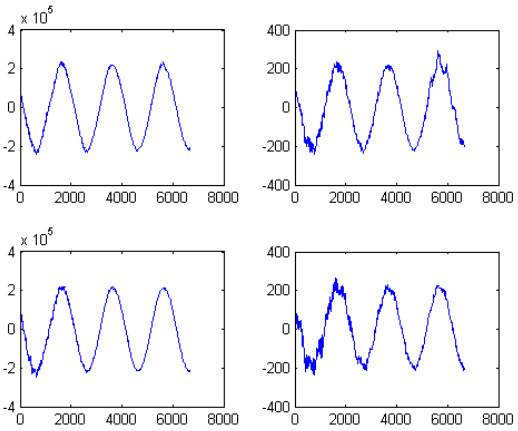

Fig: 9 Single Line Phase B and C fault detection

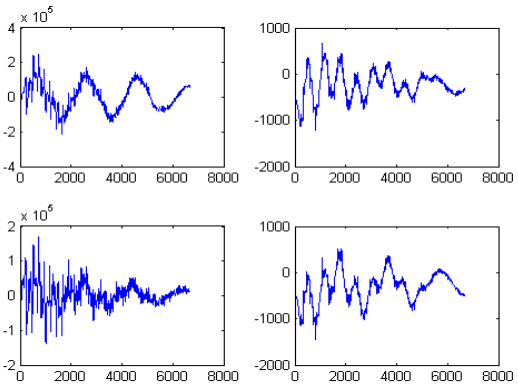

Fig: 10 ingle Line Phase B and C fault detection

Case-2, Ground to Line Fault Detection

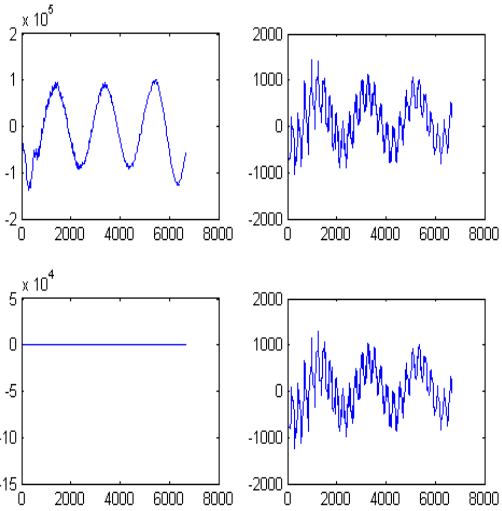

Fig. 5.*Fehler! Kein Text mit angegebener Formatvorlage im Dokument..****7 Fault detection for Single line to ground fault in phase A***

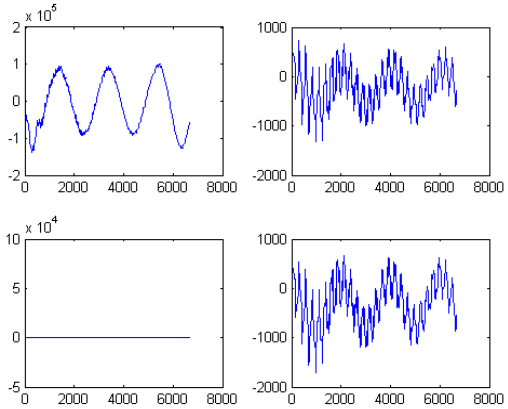

Fig. 5 Fault detection for Single line to ground fault in phase C

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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