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Fault Location in Transmission Lines using Artificial Neural Network

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Abstract

Fault in transmission lines is common and major problem to deal with in this stream. This paper presents a technique to detect the location of the different faults on a transmission lines for quick and reliable operation of protection schemes. Fault detection, fault classification and fault location have been achieved by using artificial neural networks. Feed forward networks have been employed along with back propagation algorithm for each of the three phases in the Fault location process.

Keywords: *Artificial Neural Networks, fault, learning, Back-propagation Algorithm*.

Introduction

The main problem of this study is evaluating the sequence artificial neural networks to having the best performance to detect the foult location in transmission lines.

The main objective of this paper is to detect the location of the different faults on a transmission lines. Explaining the ways that used to detect the location of the faults on a transmission lines and making sure of its work.

The methodology that used in this study is analysis and design with using the SimPowerSystems toolbox in Simulink by The Math Works to satisfy the required result.

Transmission Line Protection

Transmission lines are a vital part of the electrical distribution system, as they provide the path to transfer power between generation and load[1].

Transmission protection systems are designed to identify the location of faults and isolate only the faulted section. The key challenge to the transmission line protection lies in reliably detecting and isolating faults compromising the security of the system.

One of the most important components of a power protection system is the relay which is a device that trips the circuit breakers when the input voltage and current signals correspond to the fault conditions designed for the relay operation [2-6] .

Artificial Neural Network

Artificial Neural Network, commonly referred to as “neural networks” has been motivated right from its inception by the recognition that the human brain computes in an entirely different way from the conventional digital computers.

The brain is a highly complex, and parallel computer (information processing system). It has the capability to organize it’s structural constituents, known as neurons, so as to perform certain computations (e.g. pattern recognition and perception) many times fasters than the fastest digital computer in existence today.

In the most general form, a neural networks is a machine that is designed to model the way in which the brain perform a particular task or function of interest, the network usually implemented by using electronic components or is simulated in software on a digital computer[7-8].

Artificial neural networks generalized by human cognition mathematical model are based on the following assumptions:

1) Information processing occurs in the simple elements called neurons.

2) These signals are sent through the synapses between neurons that serve as a liaison between the neurons
3) Each synapse has a certain weight depending on neural network architecture type
4) Each neuron enumerate input signals through output signals as activation function
The basic element building artificial neural network system is a node (unit) which serves to convert the input into an output signal. This model has the input of the N-dimensional vector (X1, X2, X3,..., XN) and the outpu[9]t. The basic model of multi layer neural network is illustrated at Figure 1 below.

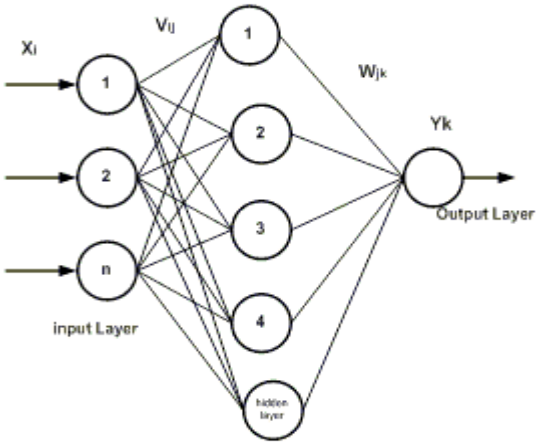

Figure 1: The Basic Model of Multi Layer Neural Network

Fault Location in Power Transmission Lines Using Neural Networks

Modeling the Power Transmission Line System

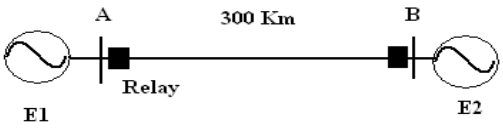

Figure 2: One-Line Diagram of the Studied System

Fig (2)shows a one-line diagram of the system that has been used . The system consists of two generators each located on either ends of the transmission line along with a three phase fault simulator used to simulate faults at various positions on the transmission line. The line has been modeled using distributed parameters so that it more accurately describes a very long transmission line.
This power system was simulated using the SimPowerSystems toolbox in Simulink by The Math Works.

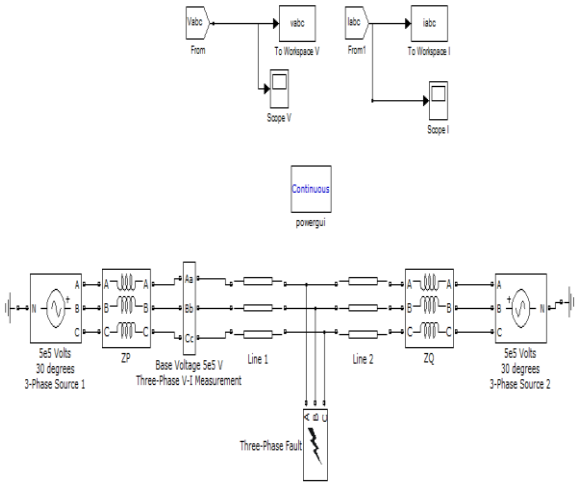

Figure 3: Snapshot of the Studied Model in SimPowerSystems

Three Phase Faults

Training the Neural Network for Three Phase Fault

Location

The learning methods in neural networks are classified into two basic types:

(a) Supervised Learning: An essential ingredient of supervised is the availability of an external teacher, which is able to provide the neural network with a desired or target response. The network parameters are adjusted under the combined influence of the training vector and the error signal.
This adjustment is carried out iteratively in a step-by-step fashion with the aim of eventually making the neural network emulate the teacher.
This form of supervised learning is in fact an error-correction learning, which was already described.
(b) Unsupervised Learning: In unsupervised or self-organized learning there is no external teacher to oversee the learning process. In other words, there are no specific samples of the

function to be learned by the network. Rather, provision is made for a task-independent measure of the quality of representation that the network is required to learn and the free parameters of the network are optimized with respect to that measure. Once the network has become tuned to the statistical regularities of the input data, it develops the ability to form internal representations for encoding features of the input and thereby creates new classes automatically [11-12].

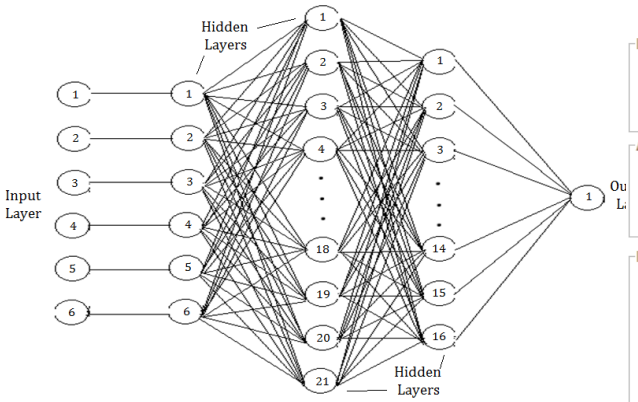

Figure 4: Structure of the chosen ANN (6 – 21 – 11 – 1)

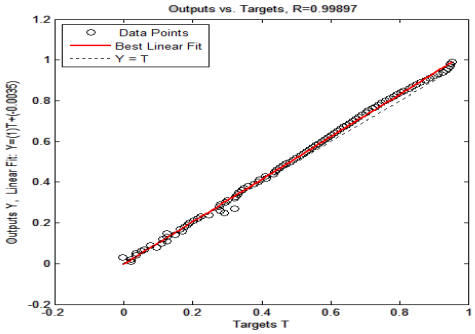

Figure 5: Regression fit of the outputs versus targets of ANN (6-6-21-16-1).

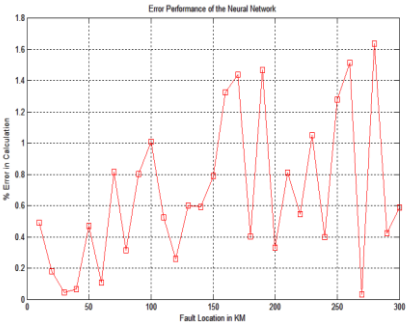

Figure 6: Test Phase performance of the ANN (6-6-21-16-1).

Now we can divided the distance to 100 different case (incremented by 10 Km in each case), to test the performance of ANN

Fig 5-6 shows the results of this test conducted on the neural network (6-6-21-16-1).

The next fig shows an overview of the chosen ANN and it can be seen that the training algorithm used is Levenberg - Marquardt algorithm. The performance function chosen for the training process is mean square error [10].

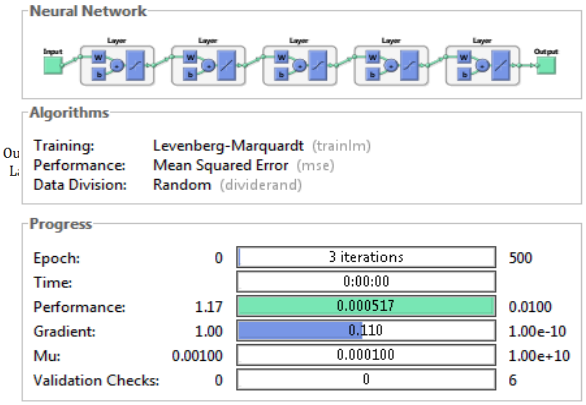

Figure 7: Overview of the chosen neural network for three phase fault location

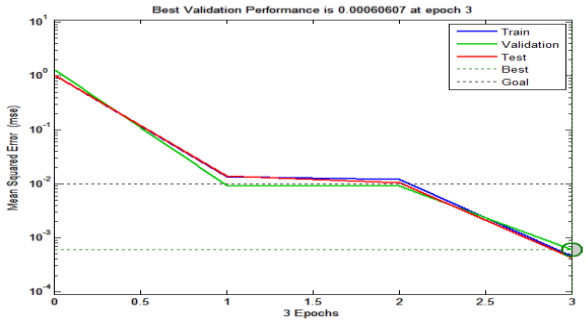

Figure 8: Mean Square Error performance of the neural network (6-6-21-16-1).

Testing the Neural Network for Three Phase Fault Location

The test performance is one important factor that helps test the network, Fig 9 shown that.

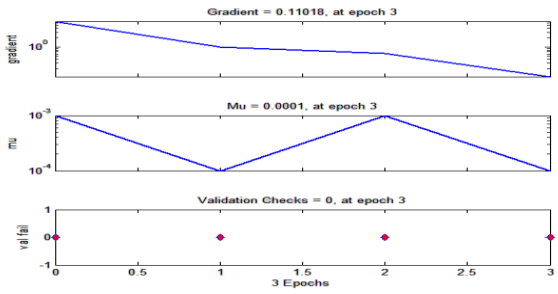

Figure 9: Gradient and validation performance plots of the ANN (6-6-21-16-1).

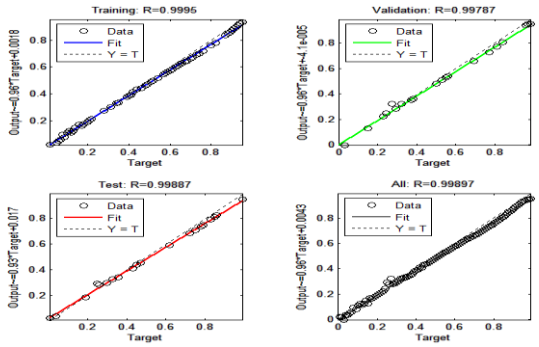

Figure 10: Regression plots of the various phases of learning of the ANN (6-6-21-16-1).

Conclusion

This paper studies detect and locate faults on electric power transmission lines.
All the neural networks investigated in this paper belong to the back-propagation neural network architecture. the detection of faults on the line to the fault location stage has been designed successfully by using artificial neural networks.
The simulation results obtained prove that satisfactory performance has been achieved by all of the proposed neural networks in general.

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