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Artificial Intelligence Used for Detection of Power Quality Problems in Electrical System

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Abstract: *The artificial intelligence is the science and engineering of making intelligent machine, especially intelligent compute programs. It is related to the similar task of using computers to understand human intelligence. From quite, few years intelligent based methods are being used in electrical system. There are mainly three artificial intelligence based techniques are widely used in electrical system: expert system, artificial neural network and fuzzy logic system. Power quality defined as any power problem manifested in voltage, current or disoperation of customer equipment. This paper describes the use of artificial neural network technique for detection of power quality problems in electrical system using MATLAB.*

Keywords: *artificial intelligence, power quality, neural network, fuzzy logic.*

1. INTRODUCTION

The need of power & its protection has increased in many areas in world of technology. The demand of electric energy is an essential for development of any country. The demand for a continuity supply of electric power for the existence of the today's world in each & every area has increased without fault of operation in power system [1]. The fig 1 shows the component of the whole electric power system [2]. Power quality is defined as the study of voltage and current in power system. In this paper for detection of power quality problem in electric system artificial intelligence techniques are used. The AI consists of expert system, artificial neural network, fuzzy logic etc. In this paper we mainly used artificial neural network for detection purpose. Artificial neural network also called neuro computing, connection or parallel processing. It is the part of AI and provide as approach to be applied to problem where the expert system are well not suited [3]. Artificial neural network are mainly inspired from human brain [4].

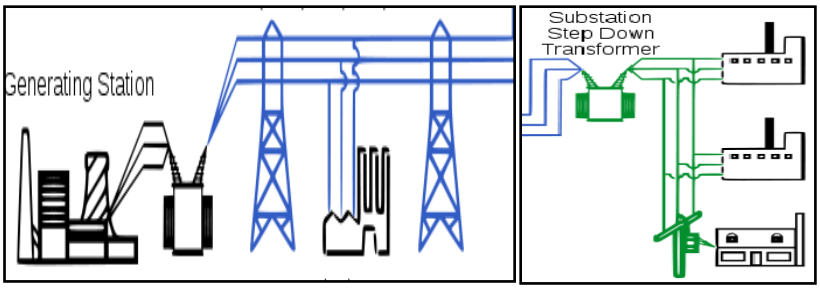

Fig1. *Components of electric power system*

2. POWER QUALITY DISTURBANCES

The duration and the frequency of the disturbances influence to loss in power system has categorised in a two ways- direct losses and indirect losses. The direct losses are defined as production environment and damage of electric equipment. Indirect losses defined as the delay in the delivery of the electrical equipment to the plant and non economic inconvenience. The main point of the power quality disturbances is to know about the behaviour of the disturbances [5]. In general power quality disturbances categorised as transients, long duration voltage interruption, short duration voltage interruption, voltage fluctuation and power frequency variations. In this paper only two power quality disturbances are detected by neural network using MATLAB. These are transmission line fault and voltage disturbances.

2.1. Transmission Line Fault

In transmission line basically there are two types of fault series fault and shunt fault. Shunt fault are further classified into two types: balanced fault & unbalanced fault [6]. The balanced fault has three phase fault in transmission line and unbalanced faults consist of single line to ground fault, line to line fault and double line to ground fault. In this paper we considered only single line to ground fault. These types of fault occur when one phase of transmission line establishes a connection with the ground either by ice, storm, or falling of tree in transmission line. Among the other transmission line fault the chances of this fault has 70% from other fault. Fig 2 shows the simulation model of transmission line fault in MATLAB.

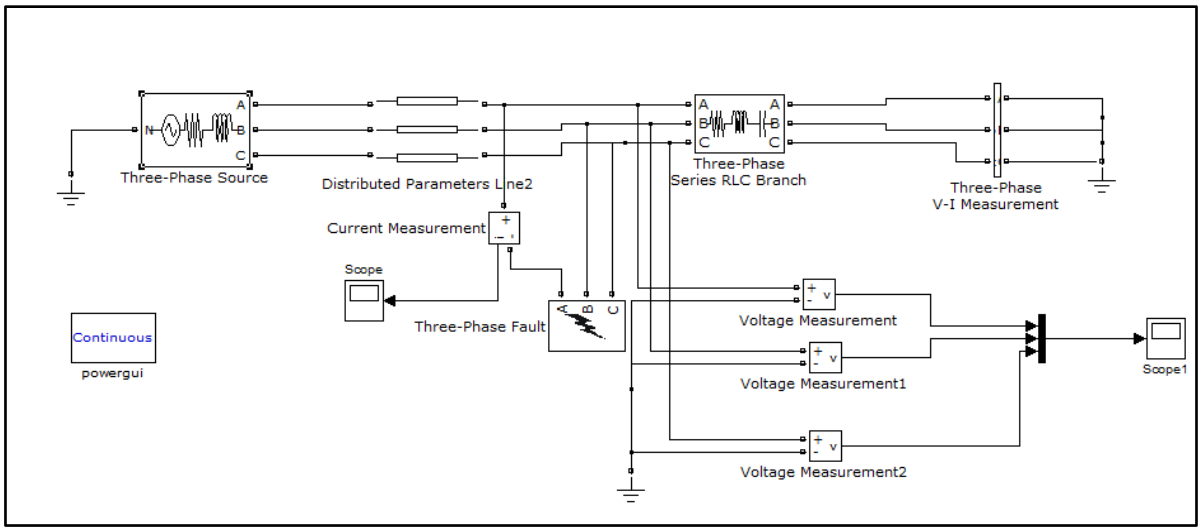

Fig2. *Simulation model of transmission line fault*

Fig 3 and fig 4 shows the scope output of current.

Fig3. *Scope output of current at without fault condition*

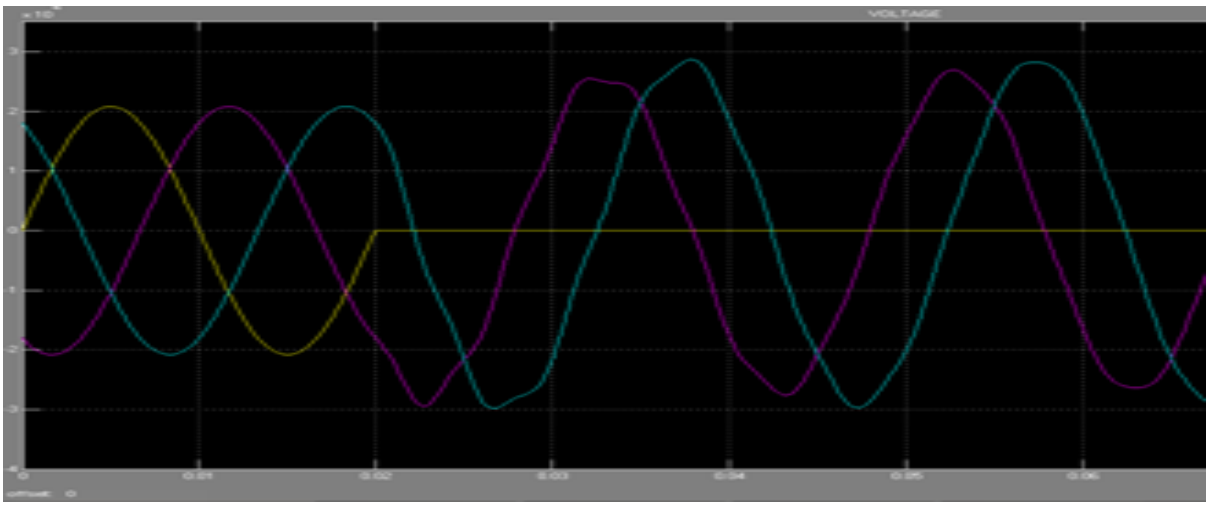

Fig4. *Scope output of current at with fault condition*

2.2. Voltage Interruption

Voltage interruptions has classified as short duration interruption and long duration interruption. The short duration interruption is total interruption of electric supply for duration from few milliseconds to one or two second. The causes of this interruption are mainly due to the opening and automatic reclosed of protection devices, insulation failure, lightning & flashover. The long duration is defined as total interruption of electric supply for greater than 1 or 2 second. The causes are storms, falling a tree, fire, human error etc.

Consequences of both the voltage interruption are tripping of devices, loss of information and mal function of data and stoppage of all the electric equipments. The fig 5 shows the simulation model for voltage interruption in MATLAB.

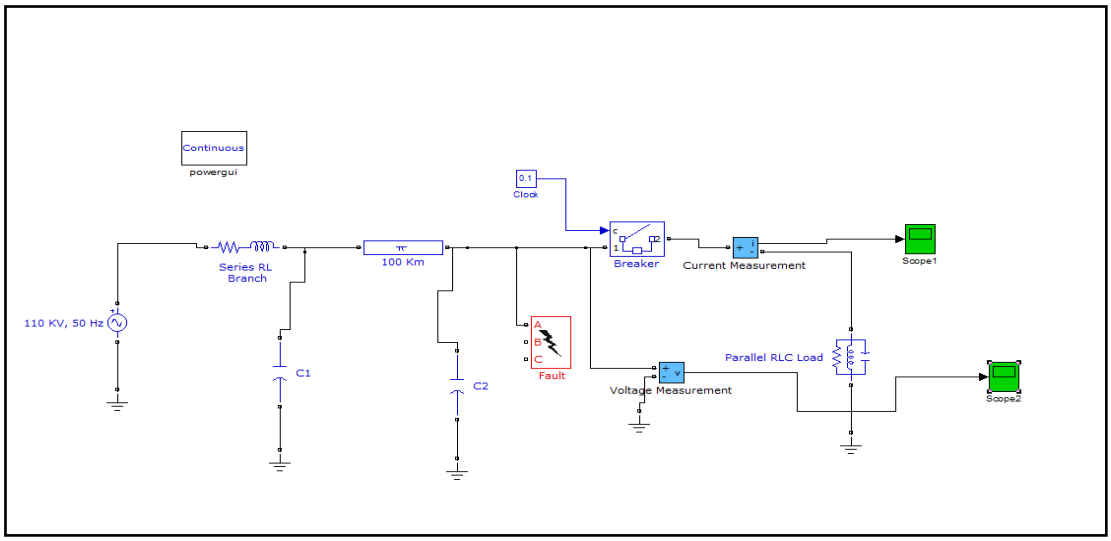

Fig5. *Simulation model for voltage interruption*

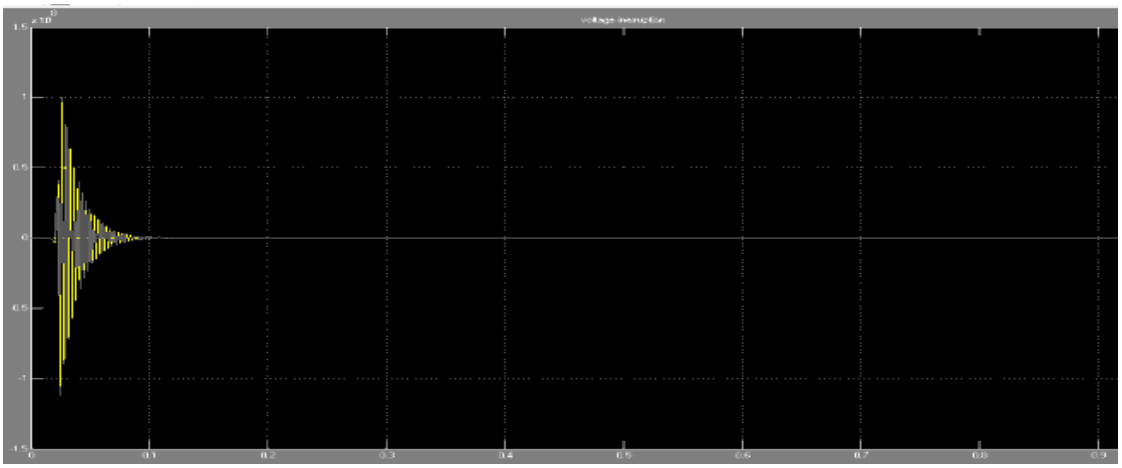

Fig6. *Scope output of long duration voltage interruption*

3. ARTIFICIAL NEURAL NETWORK

When model of any artificial neural network, basically there should be three components kept in mind. . First, the synapses of the biological neuron are modelled as weights. Let's remember that the synapse of the biological neuron is the one which interconnects the neural network and gives the strength of the connection. For an artificial neuron, the weight is a number, and represents the synapse. A negative weight reflects an inhibitory connection, while positive values designate excitatory connections [5].

The following components of the model represent the actual activity of the neuron cell. All inputs are summed altogether and modified by the weights. This activity is referred as a linear combination. Finally, an activation function controls the amplitude of the output. For example, an acceptable range of output is usually between 0 and 1, or it could be -1 and 1 [6]. Mathematically, this process is described in the figure7 [7]:

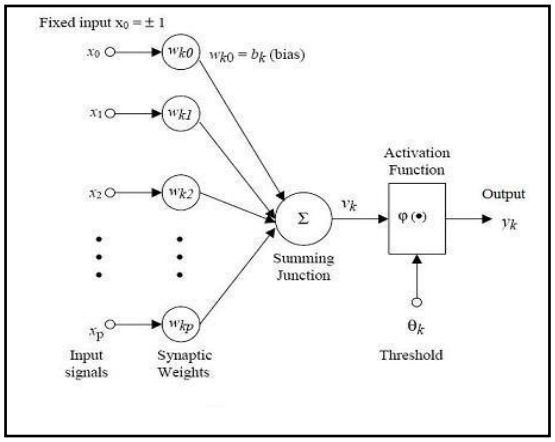

Fig7. *Mathematical model of neuron*

From this model the interval activity of the neuron can be shown to be:

$$v_k = \sum_{j=1}^{p} w_{kj} x_j$$

In equation 1, the output of the neuron, yk would therefore be the outcome of some activation function on the value of vk.

4. DESIGN OF NEURAL NETWORK FOR DETECTION OF POWER QUALITY DISTURBANCES

For design of neural network for addressing the detection of power quality disturbances many topologies of multi layer perceptron are studied. The criteria used to implement & select an appropriate MLP in neural network for the problem of detection of power quality disturbance does take into consideration the factors such as the network size, suitable learning rule and the size of the training data.

4.1. Training Procedure & Learning Rule

In neural network the back propagation learning rule used the most. However the standard back propagation network training algorithm is slow.

Since it is generating small learning rate for stable learning process so that change in network weight using the steepest descent algorithm remain small.

For training the simulation result of fig.3 and fig 5, the scope output of current is used as input to the neural network. The configuration in neural network is 1-6-1-1, 1 neuron in input layer, 6 neuron in hidden layer and 1 neuron in output layer. Selecting the right size of the network reduced the training time. The no. Of hidden layer and neuron are also important for determining the optimal size and structure of the network.

4.2. Testing The Neural Network for Fault Detection

After trained the neural network performance has been tested by plotting the best linear regression that relates the target to the output as shown in fig. 8. Fig.8 shows the regression fit of the output vs target at no fault case. Fig.9 shows the regression fit of the output vs. Target at fault condition.

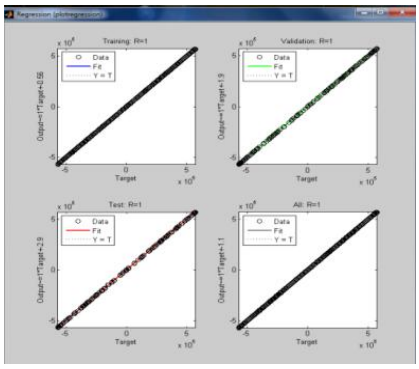

Fig8. *Shows the regression fit of the output vs target at no fault case*

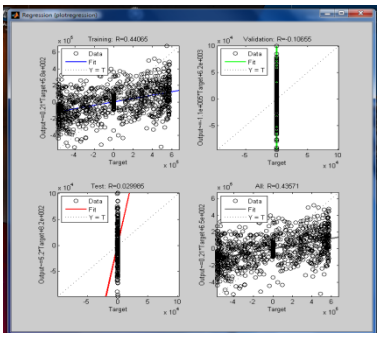

Fig9. *Shows the regression fit of the output vs target at fault case*

5. CONCLUSION

This paper presents a simulation model using MATLAB 2009, for showing the power quality disturbances in power system. For creating disturbances in power system SIMPOWER toolbox, neural network toolbox is used. This paper shows the graphical user interface result for detection of power quality disturbances in power system using neural network.

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