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Application of Multi Layer Feed Forward Back Propagation Neural Network for Analysis & Modelling of Antenna

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ABSTRACT

In this article Multilayer Perceptron feed forward back propagation (MLPFFBP-ANN) is presented for the estimation of bandwidth of a microstrip antenna. The different variants of training algorithms of Multilayer Perceptron feed forward back propagation (MLPFFBP-ANN) are used to realize the neural network model. The data for training and testing the neural network are obtained by IE3D software. The results obtained by using MLPFFBP-ANN are compared with IE3D software and found quite acceptable. The results obtained from IE3D and results from MLPFFBP-ANN are in good conformity.

Keywords: MLPFFBP, Accuracy, dual Bandwidth, Artificial Neural Network.

1. INTRODUCTION

Neuro models are computationally much more efficient then EM models once they are trained with reliable learning data obtain from a fine model by either EM simulation or measurement. The Neuro models can be used for efficient accurate optimization and designed within the range of training [1-5]. The artificial neural network model has been developed for microstrip patch antenna as shown in Figure 3. The feed forward network has been utilized to calculate the bandwidth of the microstrip antenna. For the present work, the multilayer perceptron feed forward back propagation neural network (MLPFFBP) model is used as a general function approximation [6-10]. It can approximate any function with a finite number of discontinuities. In the network there are 1input neurons in the input layer, 10 hidden neurons in the hidden layer, and one output neuron in the output layer as shown in Figure 4. In order to evaluate the performance of the proposed MLPFFBP ANN based model for the design of Microstrip antenna. During the training process the neural network automatically adjusts its weights and threshold values such that the error between predicted and sampled outputs is minimized. The adjustments are computed by the back propagation algorithm.

In the present work Multilayer *Perceptron feed forward back propagation (MLPFFBP)* is developed to analyze the bandwidth of microstrip antenna. IE3D software has been used to generate training and test data for the ANN. It is a computational EM simulator based on Method of Moment. It has analyzed that a 3D and multi layer structure of general shapes feed point must be located at point on the patch where the input impedance of patch matched the feed for the specific resonant frequency. The return loss is recorded and that feed point is selected as the optimum one where the RL is most negative i.e. less than -10dB. It is easy to model and easy to match by controlling the probe feed coordinates [11-19]. The proposed antenna has been designed on glass epoxy substrate to give a wide bandwidth of 49.12%, covering the frequency range from *1.162 GHz to 2.696 GHz* which is best suitable for WLAN and UMTS application.

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2. ANN MODEL & NETWORK ARCHITECTURE

The configuration of the proposed antenna is shown in Figure 1. The microstrip antenna that has the patch length *L* and the patch width *W* has been located on the surface of a ground with glass epoxy substrate having the thickness of *h.* It is simulated the frequency domain response of the antenna for

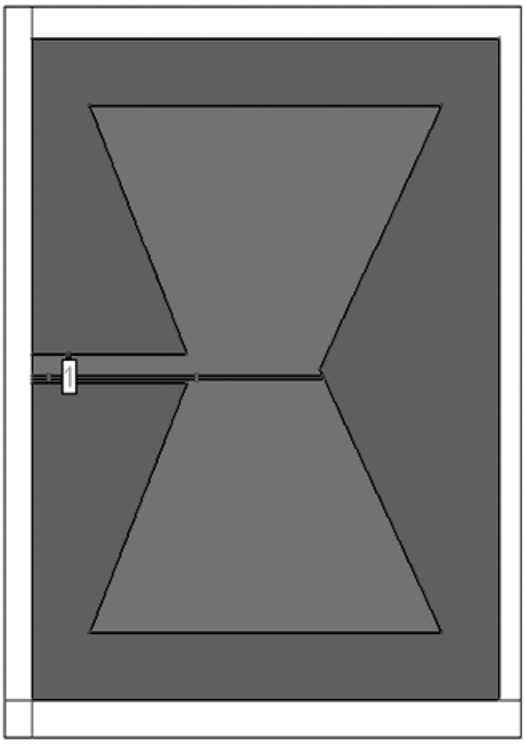

Figure 1: Geometry of proposed Microstrip antenna

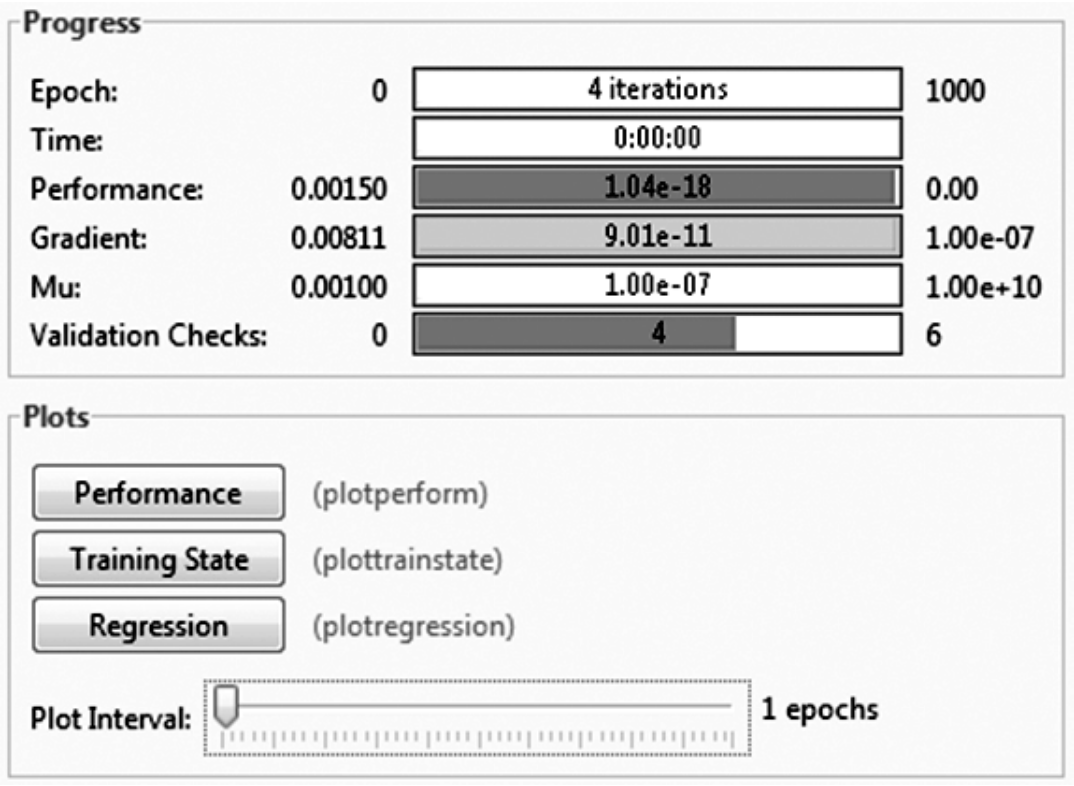

Figure 2: Performance & Training with Levenberg Marquardt Technique

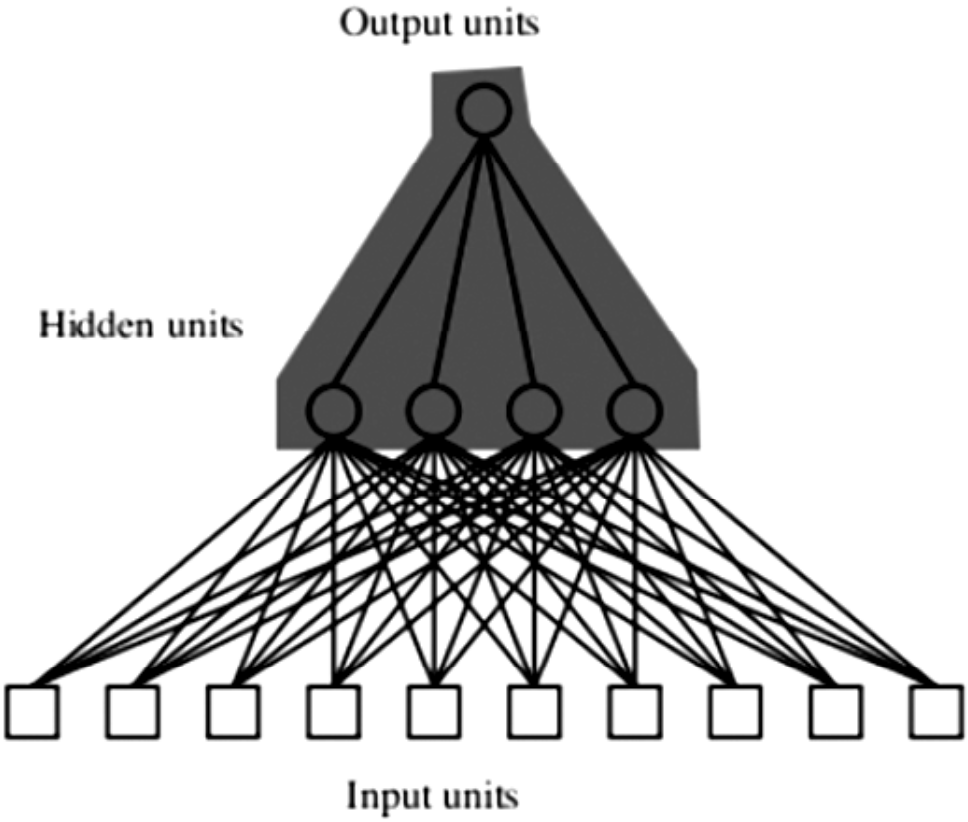

Figure 3: Three Layer MLFFBP Network Architecture

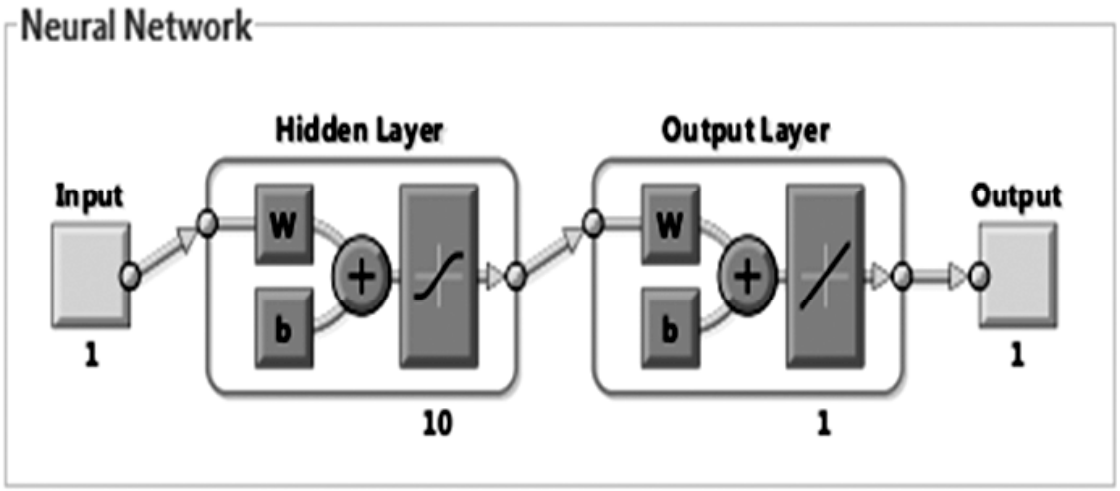

Figure 4: Three Layer Multi Layer Perceptron
Feed Forward Back Propagation Network Architecture

various patch dimensions using IE3D software for generation of data. For training and testing of the ANN, data sets are generated by using IE3D software. Figure1 shows the layout of a coaxial probe feed microstrip antenna. By varying the length of feed of proposed geometry the training data and test data for *MLPFFBP* has been generated. Figure 2 shows the performance & training with Levenberg Marquardt technique. The Multilayer *Perceptron feed forward back propagation* model has been developed for microstrip antenna as shown in Figure 3. The *MLPFFBP* Artificial Neural Network has been utilized to calculate the bandwidth of microstrip antenna. These networks can be used as a general function approximation. It can approximate any function with a finite number of discontinuities, arbitrarily well given sufficient neurons in the hidden layer.

3. RESULT AND DISCUSSION

Figure 5 shows the No. of epochs to achieve min. mean square error level in case of MLPFFBP with LM as training algorithm. Figure 6 shows the return loss (S_{11}) verses frequency plot of proposed microstrip antenna. The results are also depicted in table 1. From the table it is evident that the results obtained from IE3D and ANN tool have good agreement and hence given accurate result after several trainings the length and width of the patch is kept constant and the probe position of the patch is being changed and the network is trained for the same adjustment. It has been observed that 20 epochs are needed to for the simulation with RBF Neural Network. The neuron hidden in the layer contains Gaussian transfer function whose outputs are

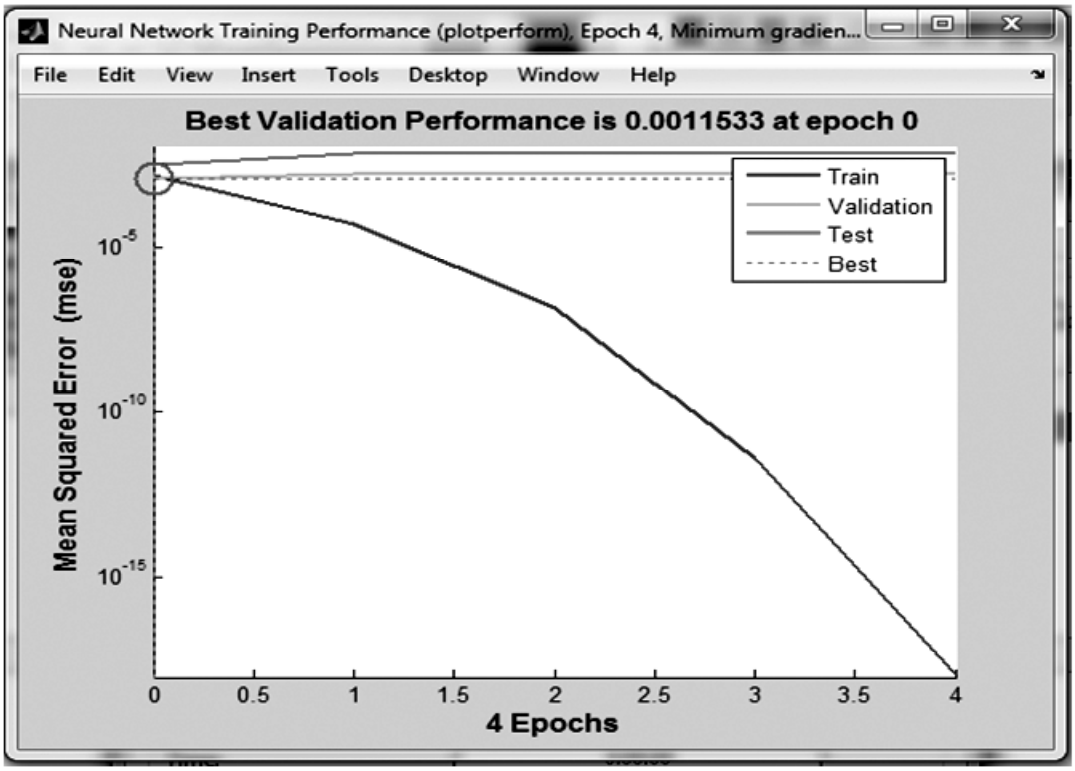

Figure 5: No. of epochs to achieve min. mean square error level in case of MLPFFBP with LM as training algorithm

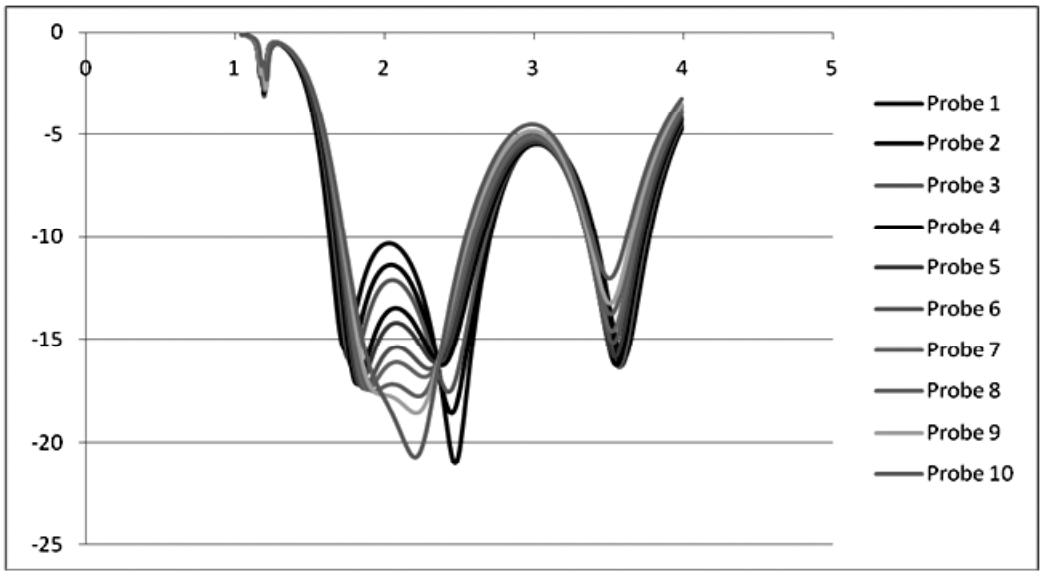

Figure 6: Return loss (S_{11}) Vs Frequency of Proposed Microstrip Patch Antenna

inversely proportional to the distance from the center of the neuron. The proposed antenna has frequency range from *1.162 GHz to 2.696 GHz* giving a wide band width of 49.12%. Multilayer *Perceptron feed forward back propagation (*MLPFFBP) model is used to model the coaxial probe feed microstrip antenna and the results are shown table 1.

Table 1
Comparison of result of IE3D and MLPFFBP-ANN using Levenberg-Marquardt algorithm

Dimension	*Probe (x, y)*	f_1	f_2	*Band Width IE3D GHz*	*Band Width MLPFFBP GHz*
29.42 × 38.01	0.0, 22.4	1.632	2.696	1.064	1.1422
	0.3, 22.4	1.652	2.686	1.034	0.883
	0.5, 22.4	1.662	2.676	1.014	1.0821
	0.8, 22.4	1.682	2.645	0.963	0.852
	1.0, 22.4	1.682	2.625	0.943	1.0141
	1.30, 22.4	1.702	2.605	0.903	0.783
	1.5, 22.4	1.702	2.585	0.883	0.962
	1.8, 22.4	1.712	2.565	0.853	0.883
	2.0, 22.4	1.722	2.555	0.833	0.943
	2.5, 22.4	1.732	2.535	0.803	0.902

4. CONCLUSIONS

In this work *Multilayer Perceptron feed forward back propagation (MLPFFBP-ANN)* is used as a tool to study the frequency of bandwidth of proposed Microstrip Antenna. The results obtained from IE3D and from *MLPFFBP-ANN* are in good agreement. The training and test set has been considered with the data obtained from IE3D software. The proposed antenna has frequency range from *1.162 GHz to 2.696 GHz* giving a wide band width of 49.12%. Multilayer *Perceptron feed forward back propagation (*MLPFFBP) model is used to model the coaxial probe feed microstrip antenna.

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