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# Dual Band Microstrip Antenna Design Using Artificial Neural Network

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***Abstract:** This paper presents novel coaxial probe feed, microstrip antenna with dual bandwidth design using a soft computing tool Artificial Neural Network. By varying the position of the feed, dual bandwidths of 8.08% and 8.15% is achieved which is further simulated on ANN tool. The antenna is fed by coaxial probe feeding technique. The obtained bandwidth from the IE3D is used a training set to train the feed forward network of the ANN. The proposed patch antenna is designed and simulated on the Zeland IE3D software and the results are trained and verified using Artificial Neural networks.*

***Keywords:** Artificial Neural Network, Feed Forward network, Dual Band, C Shaped MSA.*

## I - INTRODUCTION

Artificial neural networks are information processing systems with their design inspired by the studies of the ability of the human brain to learn from observations and to generalize by abstraction. As highly nonlinear structures, ANNs are able to accurately model any arbitrary nonlinear input–output relationships between different data sets giving an efficient alternative to conventional methods such as numerical modeling methods, which could be computationally expensive, or analytical methods, which could be difficult to obtain for new devices or empirical models, whose range and accuracy could be limited. ANN model can be learned from: full-wave electromagnetic simulators, physics-based models, or measurements.

Microstrip patch antennas are widely used in wireless communication due to their conformal and planar structure, compactness, low-profile, directive with high transmission efficiency, light weight, low profile, low cost and ease of integration with microwave circuit. However standard rectangular microstrip antenna has the drawback of narrow bandwidth. A few approaches can be applied to improve the microstrip antenna bandwidth. These includes increasing the substrate thickness, introducing the parasitic elements either in coplanar or stack configuration, and modifying the shape of the radiator patch by introducing the slots. In this work, we have first demonstrated the potential of neural network in antenna modeling using ANN combined with EM knowledge to develop a single neural network model for the calculation of resonant frequency and hence bandwidth of rectangular patch antenna.

## II – ANTENNA DESIGN AND LAYOUT

To design a rectangular microstrip patch antenna following parameters such as dielectric constant of substrate ($\varepsilon_r$), the resonant frequency ($f_r$) and height of the substrate (h) should be considered for calculating the length and the width of the rectangular microstrip patch.

$$W = \frac{c}{2f\sqrt{(\varepsilon_r + 1)/2}} \quad (1)$$

Where **c** is the velocity of light, $\varepsilon_r$ is the dielectric constant of substrate, ***f*** *is* the antenna working frequency,

**W** is the patch width, the effective dielectric constant and the length extension are given as,

$$\varepsilon_{eff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2}\left[1 + 10\frac{h}{W}\right]^{-\frac{1}{2}} \quad (2)$$

 

$$\frac{\Delta l}{h} = 0.412 \frac{\left(\varepsilon_{eff} + 0.300\right)\left(\frac{W}{h} + 0.262\right)}{\left(\varepsilon_{eff} - 0.258\right)\left(\frac{W}{h} + 0.813\right)} \qquad (3)$$

$$L = \frac{c}{2f\sqrt{\varepsilon_{eff}}} - 2\Delta l \qquad (4)$$

Figure 1 shows the layout of a coaxial probe-fed slotted patch antenna. The slots on the patch are shown in Figure 1, where, *L* and *W* are the length and width of the patch. The patch is fed by a coaxial probe. The resonant frequency for the proposed antenna is 5.61GHz. The substrate used for the fabrication of proposed antenna is RT Duroid 5880 substrate with dielectric 2.2. For the design of Microstrip antenna IE3D electromagnetic simulator is used. The dimension of Antenna is as follows:

**Table 1. Antenna design parameters.**

| Parameters | Value (mm) |
|---|---|
| W | 20 |
| L | 17 |
| $L_1$ | 9.8 |
| $W_1$ | 7.6 |
| $W_2$ | 6.2 |

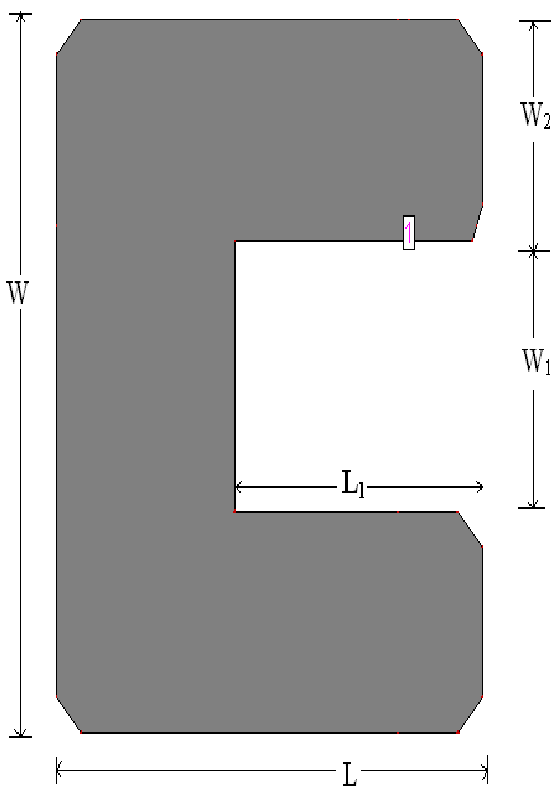


Figure 1. Geometry of C shaped microstrip antenna.

 

## III. NEURAL NETWORK ARCHITECTURE AND TRAINING

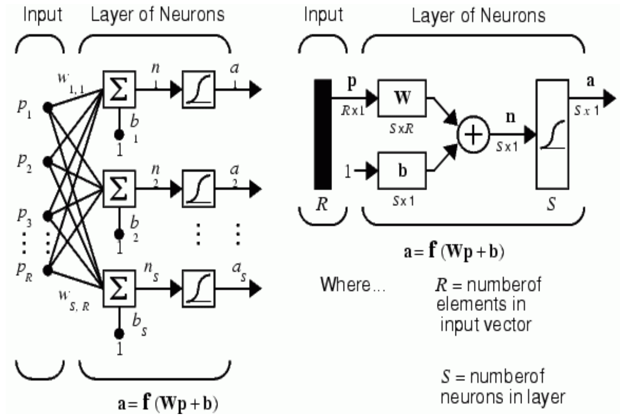

Figure 2. Feed Forward Network

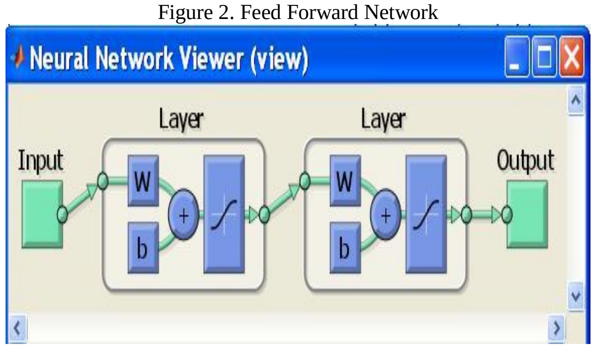


Figure 3. Neural Network Viewer as obatined from MATLAB

## IV. TRAINING DATA AND GENERATION WITH EM AND ANN

The data has been obtained from the Zeland IE3D simulator based on methods of moments. The width and length of the patch is kept constant and postion of the feed is varied to obtain the resonant frequency and simultaneously bandwidth of the microstrip antenna is calculated. MLP networks are feed forward networks trained with the standard back propagation algorithm. The training function used is TRANLM and the adaption learning function used is TRAINGDM they are supervised networks and also they required a desired response to be trained. With one or two hidden layers they can approximate virtually any input output map. The weights of the network are usually computed by training the network.

**Table 2 Comparison of results of IE3D and ANN**

| SLOT LENGTH ($L_1$) | SLOT WIDTH ($W_1$) | PROBE ($X_1$,$Y_1$) | BW IE3D (GHz) | BW FFBPN (GHz) | BW WITHOUT SLOT(GHz) |
|---|---|---|---|---|---|
| 10 | 7.6 | 16,17.5 | 0.591, 0.850 | 0.591 0.852 | 0.536, 0. 531 |
| 10 | 7.6 | 16,18 | 0.592, 0.891 | 0591 0.892 | 0.536, 0. 531 |
| 10 | 7.6 | 16,18.5 | 0.592, 0.899 | 0.593 0.896 | 0.536, 0. 531 |
| 10 | 7.6 | 16,19 | 0.566, 0.799 | 0.565 0.799 | 0.536, 0. 531 |
| 10 | 7.6 | 16,19.5 | 0.563, 0.763 | 0.561 0.762 | 0.536, 0. 531 |
| 10 | 7.6 | 16,20 | 0.523, 0.633 | 0.522 0.631 | 0.536, 0. 531 |

## IV. RESULTS AND DISCUSSIONS

Figure 4 shows the return loss graph of microstrip antenna. The slotted antenna resonanates at 5.61 GHz and 6.84 GHz frequency giving dual bandwidths of 8.08% and 8.15% hence it is suitable for dual band operations.

Results obtained from the electromagnetic simulator IE3D has been used as an input to the soft computing tool Artificial Neural Network and bandwidth is calculated from the ANN as well as IE3D simulator and it is observed that in both cases the results are satisfactory as depicted in table 2.

 

Figure 5 shows the smith chart; figure 6 shows the radiation pattern and figure 7 shows the VSWR curve which is of c shaped microstrip antenna obtained from IE3D.The proposed microstrip antenna have better gain and good radiation efficiency.

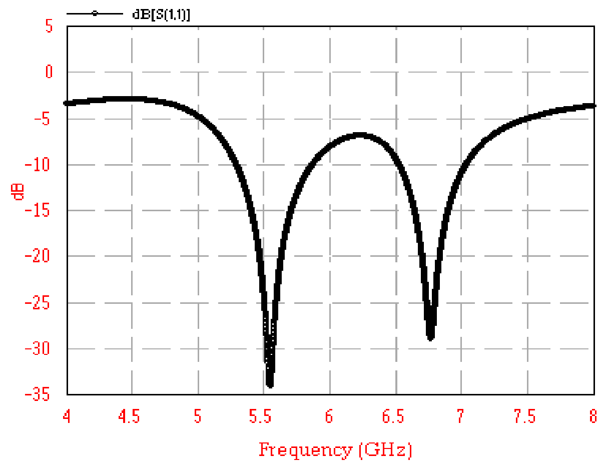


Figure 4. Return lossVs frequency plot of C shaped microstrip antenna

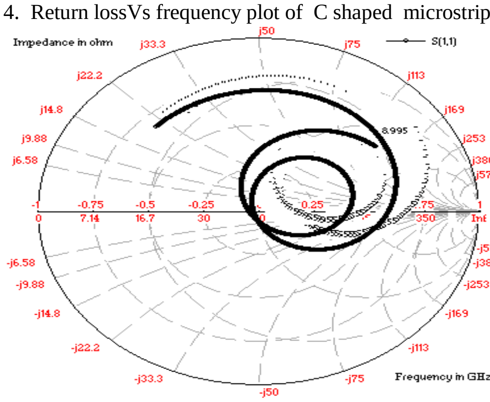


Figure 5. Smith Chart plot of C shaped microstrip antenna.

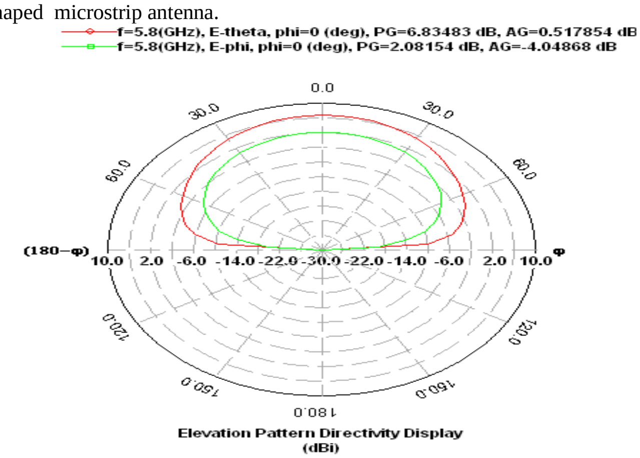


Figure 6. Radiation Pattern of the C shaped micostrip Antenna.

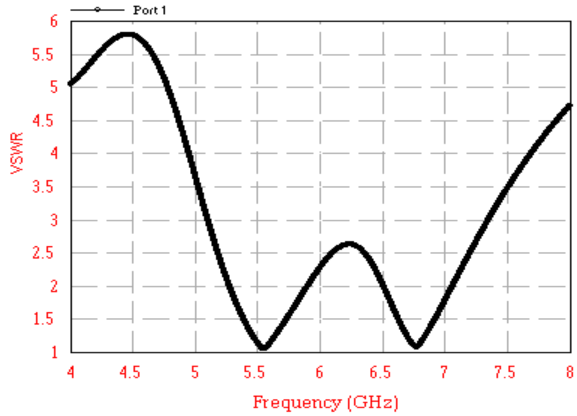


Figure 7. VSWR Vs frequency of C shaped microstrip antenna.

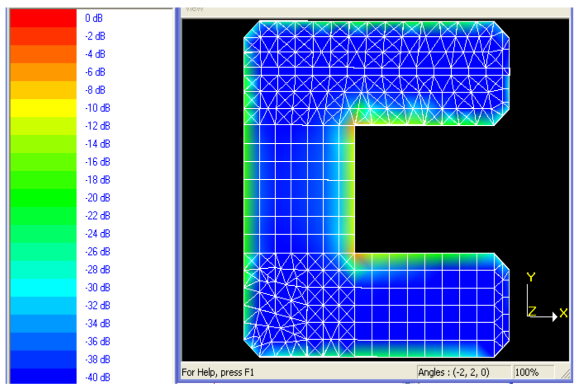


Figure 8. Current Distribution of C shaped microstrip antenna.

## V. CONCLUSION

In this paper, bandwidth of the rectangular microstrip c shaped antenna is computed accurately by using the ANN model. The advantage of ANN model is simplicity and accuracy.

The ANN allows us to provide very fast, results of analysis.

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