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CALCULATION OF MICROSTRIP PATCH ANTENNA PARAMETERS USING ARTIFICIAL NEURAL NETWORK

Kavita Mishra*, Rohini Saxena, Mukesh Kumar, Meenakshi Kumari, Ajay Singh
* Dept. of Electronics and communication engineering, SIET, SHUATS, INDIA

ABSTRACT

In this paper, a comparison of Microstrip patch antenna parameters returns loss, VSWR and directivity between using HFSS Software and Artificial Neural Network. In this antenna achieved four resonant frequency 3.5 GHz, 6 GHz, 6.9 GHz and 8.9GHz using substrate material Fr-4 Glass epoxy substrate with using co-axial feeding technique. An ANN has been developed for the calculation of return loss, VSWR and directivity of resonant microstrip antenna using MATLAB and compare with HFSS's antenna parameters. The resonated frequencies lies in S, C and X bands. Results of the ANN network are compared with the data obtained from HFSS software and concluded that ANN results are in good agreement as compared to HFSS.

INTRODUCTION

The significance of wireless communication has increased rapidly as per the development of wireless equipment's used for communication purposes. As due to the advancement of wireless technology there is a certain need for the contribution in the field of antennas. It is a device with unique feature that they follow the process of radiation and receive those radiation in the form of electromagnetic waves they are used widely in, WLAN, GPS, mobile phones and other means of communication devices. They are easy to develop as they are light in weight, low in cost and maintain high performances for spectrum of high frequencies. The microstrip antennas are considered best for wireless communication as they constitute coplanar configuration. The co-axial feed technique has an important feature of impedance matching which further contributes in Maximum power transmission.

This paper concentrates on the development of neural network for the circuits with highly nonlinear response. Thus, the networks are built by multi-layer perceptron (MLP) network with relatively large no. of neurons were used to achieve the results accurately.

In this paper a 40 mm × 30 mm ×1.57 mm dimension antenna has been designed for comparison of antenna parameters between HFSS and ANN. The designed antenna using co-axial feeding technique with substrate material Fr-4 glass epoxy substrate. The proposed antenna has resonated at four frequencies which lies in S, C and X bands. This antenna is used for various wireless devices like Wi-Max, Wi- Fi and microwave communication devices.

ARTIFICIAL NEURAL NETWORK

ANN is used for adaptive controllers, modeling as Active and passive devices enhancing of microwaves circuit modeling. It is a combination of electronic hardware and software similar to the interconnection of nodes in human brain composition of ANN required nonlinear function in blocks of neurons. Neurons are connected with weights can be reduced or strengthen as per the given input pattern and o/p produced as feed forward network. This ANN operates at high speed and using ANN approach the return loss, directivity and VSWR is calculated.

ANTENNA DESIGN

The Patch Antenna is a Radio Antenna in its fundamental form as radio patch .It consists of a radiating patch on one side of dielectric surface which is composed of a ground plane. The patch is made up of gold and copper. It has a rectangular sheet that formed transmission line which has a length equal to one half of the wavelength of the radiated wave of the transmitted lines. The radiated patterns of rectangular patch are photo etched and are used

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in applications such as circular polarization and high frequency multi frequency applications. The basic antenna element is composed of conducting material of dimension Length × Width on direct substrate of permittivity (ε_r) and thickness (h) is to be backed by conducting ground plane.

The proposed rectangular microstrip patch antenna having dimension $40 \times 30 \times 1.57$ mm^3. The coaxial feed line is used with substrate permittivity $\varepsilon_r = 4.4$, substrate thickness h = 1.57 mm at operating frequency f = 5 GHz. The designed antenna shown in Figure 1.
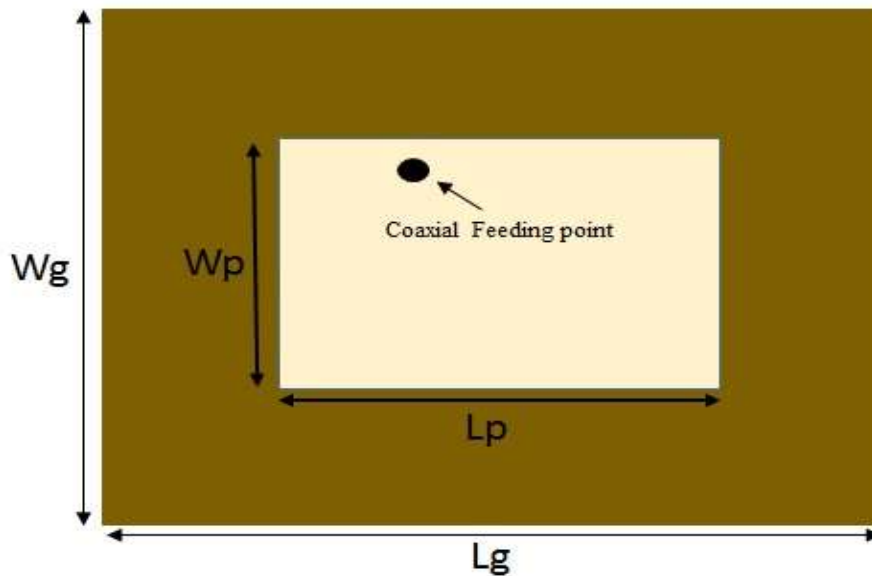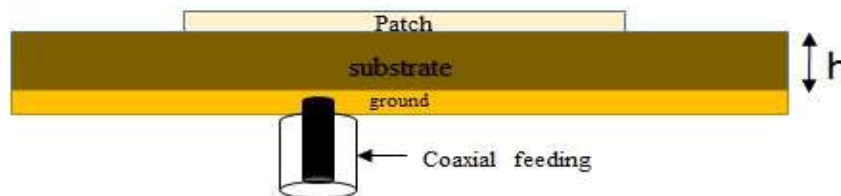

Fig. 1. Top view of micro strip patch antenna

Fig. 2. side view of micro strip patch antenna

Table. I Dimensions of Proposed Microstrip multiband antenna.

S. N.	Parameters	Dimension
1.	Ground Length Lg	40 mm
2.	Ground Width Wg	30 mm
3.	Patch Length Lp	20 mm
4.	Patch Width Wp	15 mm
5.	Substrate thickness h	1.57mm
6.	Operating frequency	5 GHz

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RESULTS AND DISCUSSION

The Return loss verse frequency are obtained by HFSS is shown in Figure 3. The VSWR verse frequency is shown in Figure 4. The Directivity is shown in Figure 5. The radiation pattern for the frequency band 3.5 GHz, 6 GHz, 6.9 GHz and 8.9GHz is shown in Figure 6. These results are obtained with the help of HFSS. Table (II) depicts for Directivity, VSWR and Return loss using HFSS.
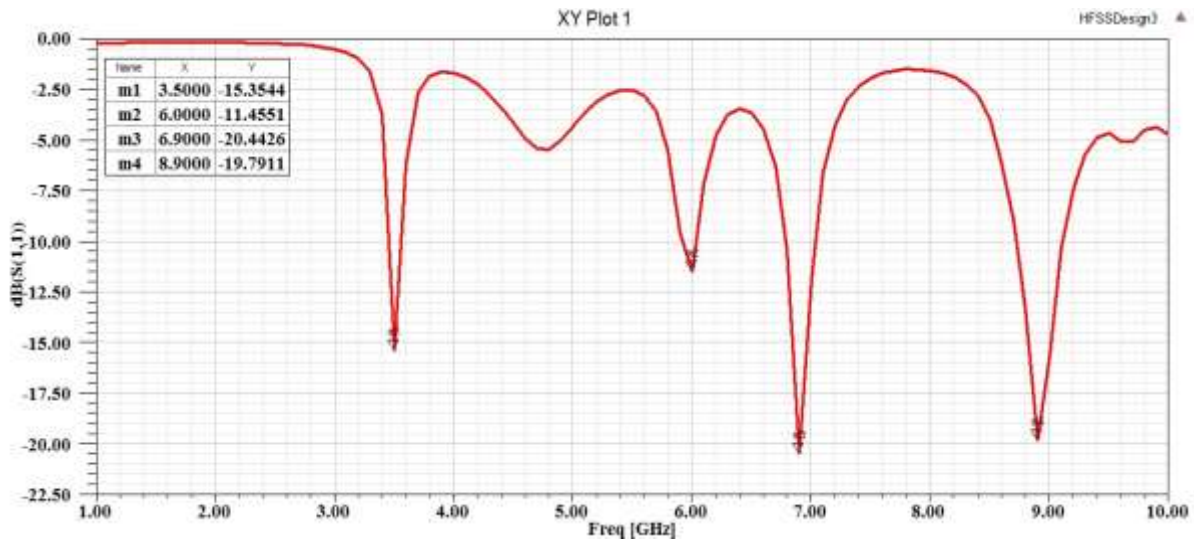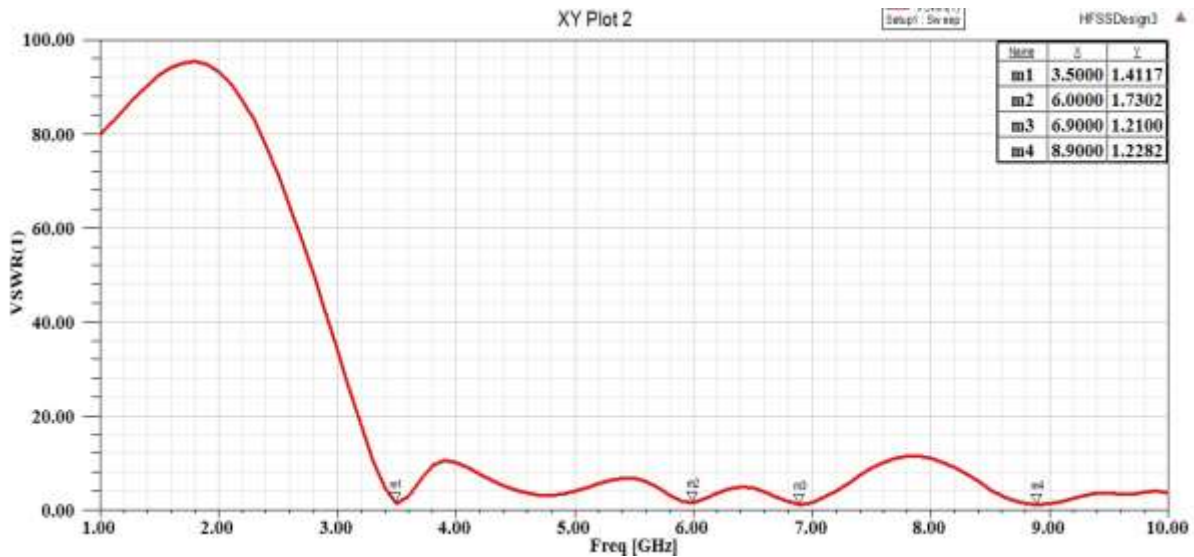

Figure2: Return loss against frequency curve using HFSS

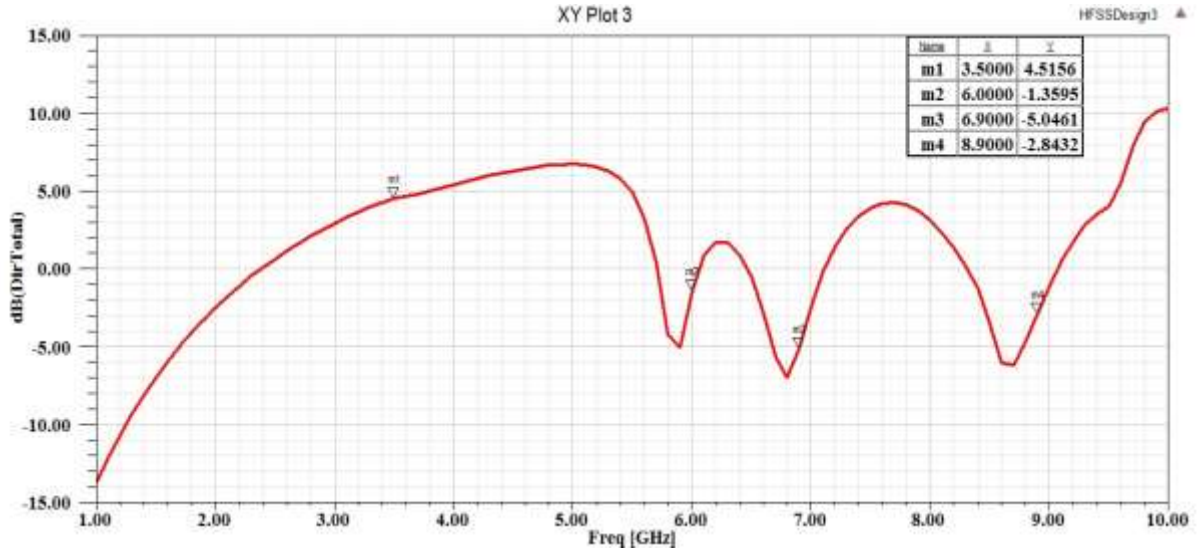*Figure 3: VSWR against frequency curve using HFSS*

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Figure 4: Directivity against frequency curve using HFSS

Table II: HFSS Data for return loss, VSWR and directivity

S. No.	Frequency	Return loss	VSWR	Directivity
1	3.5 GHZ	-15.3544	1.4117	4.5156
2	6 GHZ	-11.4551	1.7302	-1.3595
3	6.9 GHZ	-20.4426	1.2100	-5.0461
4	8.9 GHZ	-19.7911	1.2282	-2.8432

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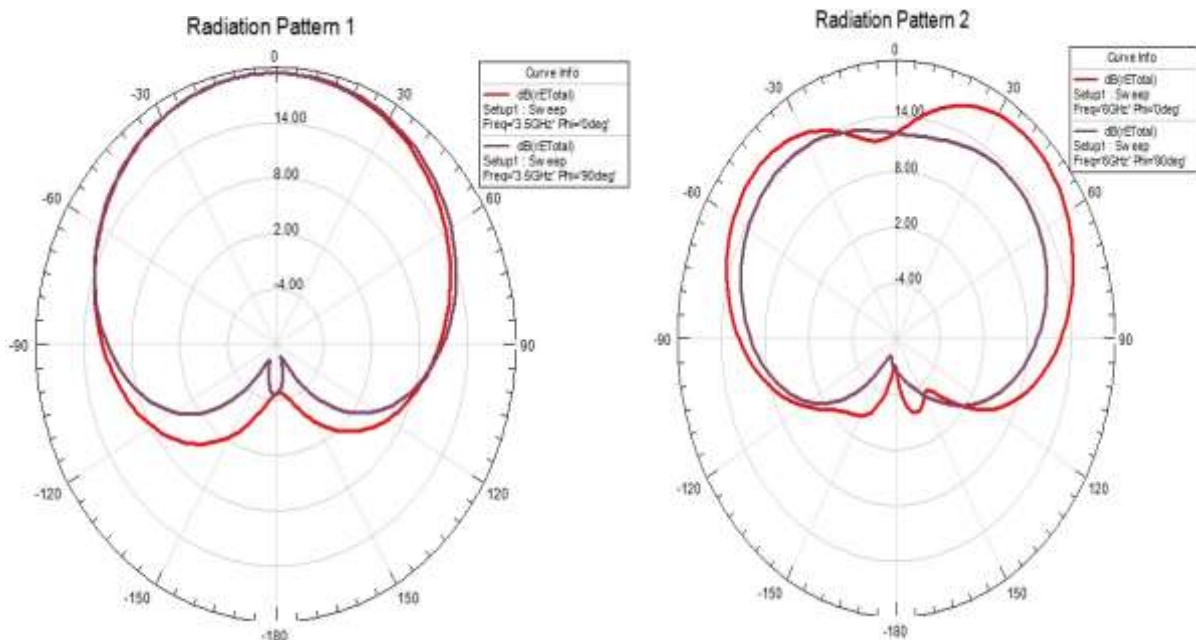
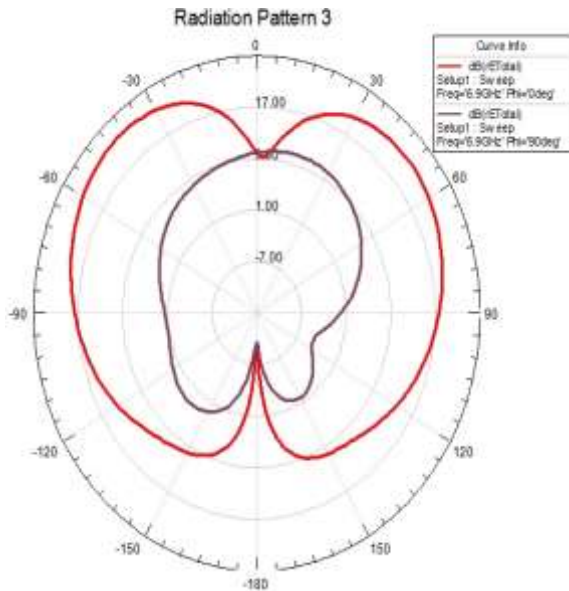*Figure 5(a): Radiation Pattern for 3.5 GHz*   *Figure 5(b): Radiation Pattern for 6 GHz*
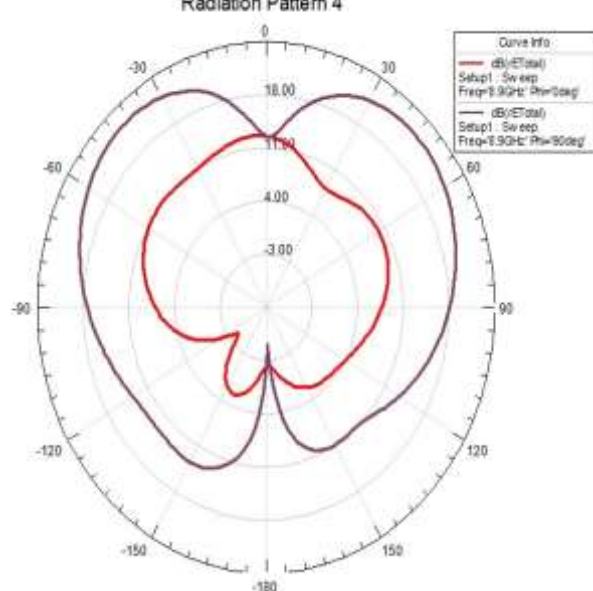

Figure 5(c): Radiation Pattern for 6.9 GHz   *Figure 5(d): Radiation Pattern for 8.9 GHz*

Table III: Results of ANN Output; ε_r =4.4, h= 1.57 mm, where ε_r is substrate and h is thickness of antenna.

S. No.	Frequency	Directivity	VSWR	Return loss
1	3.5 GHZ	5.8576	1.4273	-34.7395
2	6 GHZ	-1.9190	1.7248	-26.4846
3	6.9 GHZ	2.8838	1.4232	-34.9001
4	8.9 GHZ	3.2781	1.3766	-35.2816

ANN is calculating patch dimensions very efficiently and accurately. The feed forward back propagation gives the target value table III. That depict the results of Artificial Neural Network. Return loss values, VSWR and directivity of microstrip patch antennas are calculated. The values obtained from ANN are better than the HFSS simulation readings.

CONCLUSIONS

This Paper adapts a new method MATLAB using Artificial Neural Network for solution of different Parameters of Microstrip Patch Antenna. Artificial Neural Network has been used because it provides a higher degree of interconnections of different weights within the same network. The neural network is used in multiple applications in field of science and technology. It concluded that we discuss the forward feeding techniques of ANN and the ANN results of directivity, VSWR and return Loss of microstrip patch antenna are better than HFSS results.

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