HEXAGONAL CARPET ANTENNA FOR WLAN/ WiMAX & BLUETOOTH APPLICATIONS

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Abstract

In this paper, carpet of hexagon structure is investigated for wide band applications. The proposed antenna is made by repetitions of hexagon shape. Modified line feed is used for designing the antenna to achieve wide bandwidth ranging from 2.325Ghz to 4.613Ghz with a bandwidth 65.96%.In the present work size reduction has been achieved. It offers gain of 3.65dBi, directivity of 4.13dBi and antenna efficiency of 89.59% at 2.96Ghz resonant frequency. This antenna is suitable for WLAN, WiMAX and Bluetooth applications. The proposed antenna is simulated by IE3D Zeland simulation software based on method of moments.

Keywords: *Microstrip antenna, fractal, hexagonal carpet, bandwidth, line feed.*

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1. INTRODUCTION

Microstrip antennas are a class of miniaturized antennas with numerous advantages like light weight, low cost and compatibility with monolithic microwave integrated circuits (MMICs) [1-3] but the major drawback of microstrip antenna is its narrow bandwidth and lower gain. There are many approaches to reduce the size of the antenna without much affecting the antenna performance. The application of the fractal geometry is one of the techniques.

The term fractal has originated from the Latin word fractus which is related to the verb fangere (means : to break) [4-5]. Fractal antenna uses self similar design to maximize the length or increase the perimeter on inside sections or the outer structure of the material that can receive or transmit electromagnetic radiations within a given total surface area or volume[6]. Certain fractals represent the self-similarity properties as multiband behavior and space-filling properties as reduction in antenna size[7-11].

In the present work, the bandwidth of microstrip antenna is enhanced to 65.96% .The second iterated antenna is shown in Figure 1.The frequency band of this antenna is between 2.325Ghz to 4.613Ghz which is suitable for WLAN, WiMAX and Bluetooth applications[9-12].

This antenna has been designed on glass epoxy substrate (ε_r=4.4) [13].The substrate material has large influence in determining the size and bandwidth of an antenna. Increasing the dielectric constant decreases the size but lowers the bandwidth and efficiency of the antenna while decreasing the dielectric constant increases the bandwidth but with an increase in size.

2. ANTENNA DESIGN SPECIFICATIONS

The design of second iterated antenna is shown in figure1. This antenna is designed by using glass epoxy substrate which has a dielectric constant 4.4. The ground plane length and width are taken 40 mm and 47 mm respectively. A regular hexagon of side 8mm is taken and three such hexagons are arranged in the manner as shown in figure1, so as to obtain carpet of hexagonal structure.Height of the dielectric substrate is 1.6 mm and loss tangent tan δ is 0.0013.Line feed is applied. Antenna is fed through 0.3 mm probe. Simulation work is done by using IE3D simulation software. All the specifications are given in table 1(all lengths in mm and frequency in GHz).

3. ANTENNA DESIGN PROCEDURE

The primary hexagonal shaped patch is having side length 'f' of 8mm.From that patch, six equilateral triangles of side length 4mm has been taken out to obtain a regular hexagon having side 4mm and this geometry is referred as the first iteration. Then six equilateral triangles of side length 2mm has been taken out to obtain a regular hexagon having side 2mm, which results in 2^{nd} iteration. Three hexagons as obtained in second iteration are joined at the vertex to frame the desired carpet as shown in figure 1. Figure 2 shows the design procedure of the proposed Fractal structure geometry, depicting 0th iteration, 1^{st} iteration and 2^{nd} iteration. The proposed antenna can also be called as hexagonal carpet fractal antenna, as it is obtained after two iterations of structure. Line feed is used. The probe feed is placed at point (X =21.8125, Y =2.5). During the designing of proposed antenna on IE3D ground plane is starting from (0,0) at lower left corner. The geometry of proposed antenna is shown in figure1.

Table1: Antenna design specifications.

S. No.	Parameters	Value (mm)
1.	dielectric constant ε_r	4.4
2.	substrate height	1.6
3.	ground plane width (W)	47
4.	ground plane length (L)	40
5.	a	14
6.	b	2
7.	c	4
8.	d	2
9.	e	2
10.	f	8

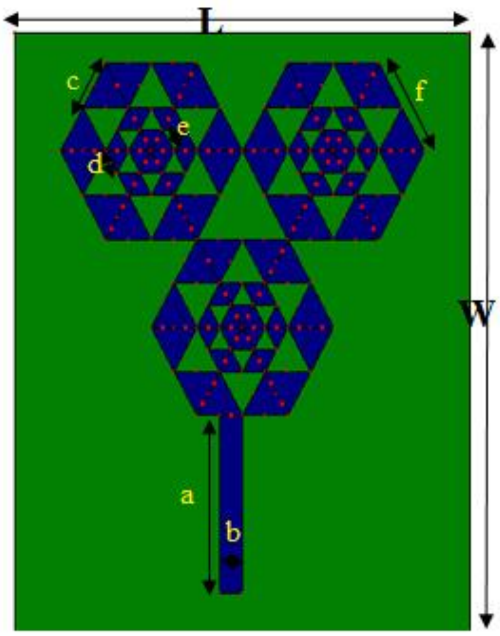

Fig.1. Geometry of proposed Microstrip antenna

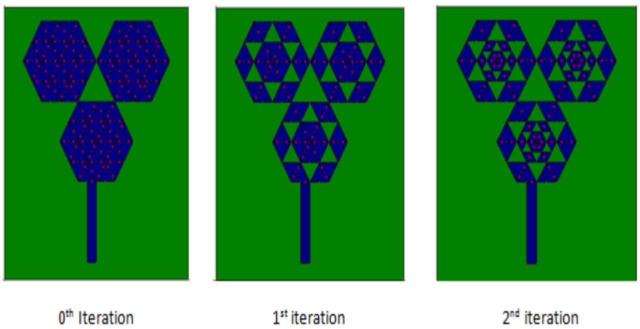

Fig. 2 Two iterations of hexagonal-shaped fractal antenna

4. SIMULATION RESULT AND DISCUSSION

The simulated return losses of 0th iteration, 1st iteration and 2nd iteration are shown in figure 3,4and 5 respectively. It is clearly observed that size reduction has been achieved in 1st and 2nd iteration. It is due to the fact that as the order of iteration increases, electrical path length increases which leads to the lowering of resonance frequency. Thus, this property can be utilized for size reduction.

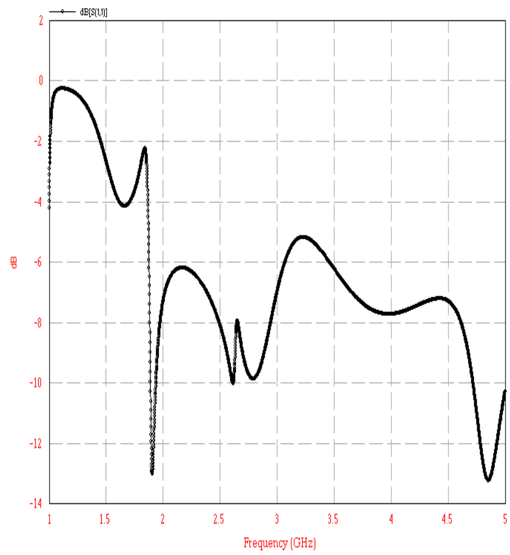

Fig.3. Return loss for 0th iteration

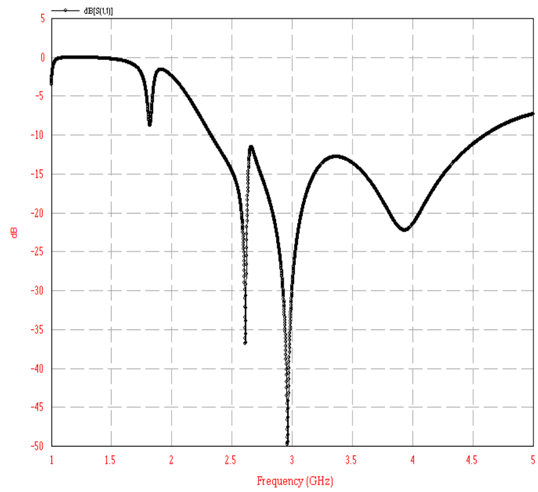

Fig.4. Return loss for 1st iteration

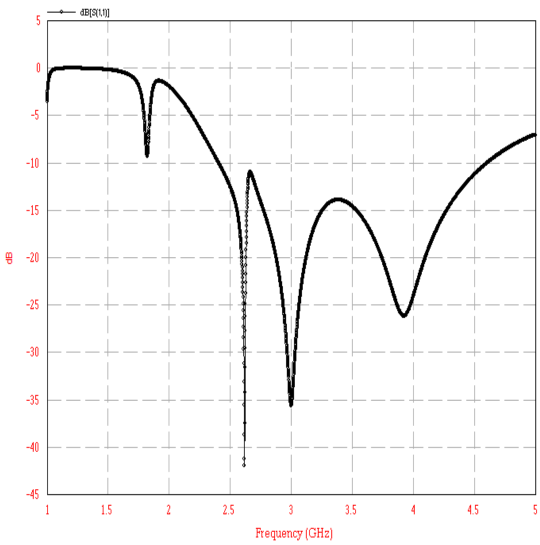

Fig.5. Return loss for 2nd iteration

Table 2, summarizes the simulated results of zeroth, first and second iterated antenna. The first iterated antenna is the proposed antenna which shows quiet a good return loss, bandwidth, VSWR and size reduction.

The fractional bandwidth of proposed antenna is 65.96%. The efficiency of proposed antenna is found to be 89.59%.The gain of antenna is 3.65dBi and the directivity is found to be 4.13dBi. VSWR of the antenna is in between 1 to 2 over the entire frequency band.

Table 2: Comparison of various parameters of different iterations

ITERATION	BANDWIDTH	RETURN LOSS	GAIN	DIRECTIVITY	ANTENNA EFFICIENCY	AREA
	(%)	(dB)	(dBi)	(dBi)	(%)	(mm^2)
0^{th}	30.34%	-13.04	2.2	3.34	77.01	498.96
1^{st}	65.96%	-50.5	3.65	4.13	89.56	374.22
2^{nd}	62.92%	-42.42	2.23	3.35	77.37	342.9

The simulation performance of proposed microstrip patch antenna is analyzed by using IE3D version 9.0software.The performance specifications like radiation pattern etc of proposed antenna is shown in the figures 6 to 10.

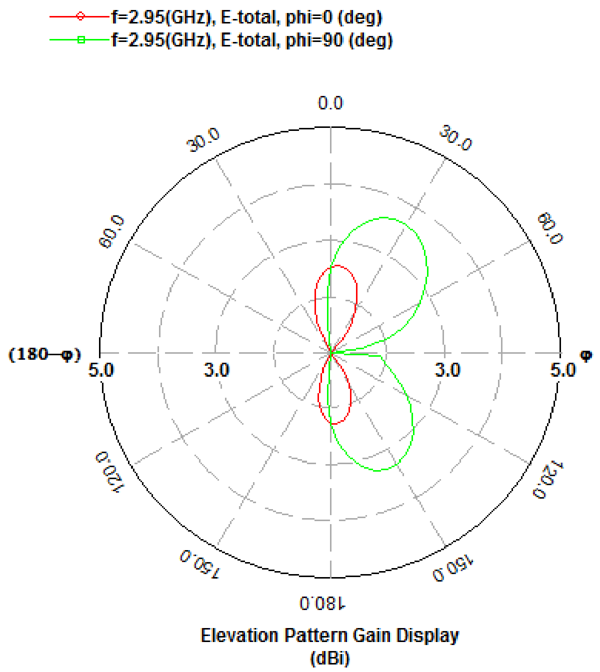

Fig.6. 2D Radiation pattern of proposed antenna

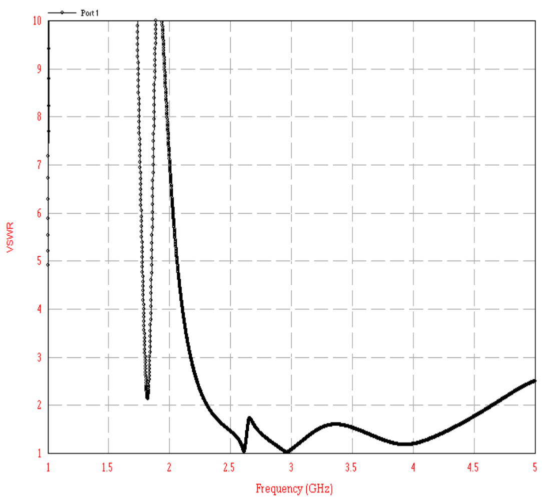

Fig.7. VSWR of proposed antenna

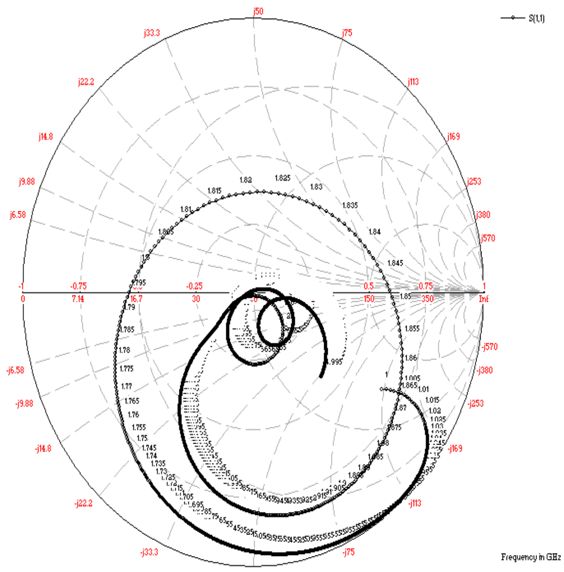

Fig.8. Smith chart of proposed antenna

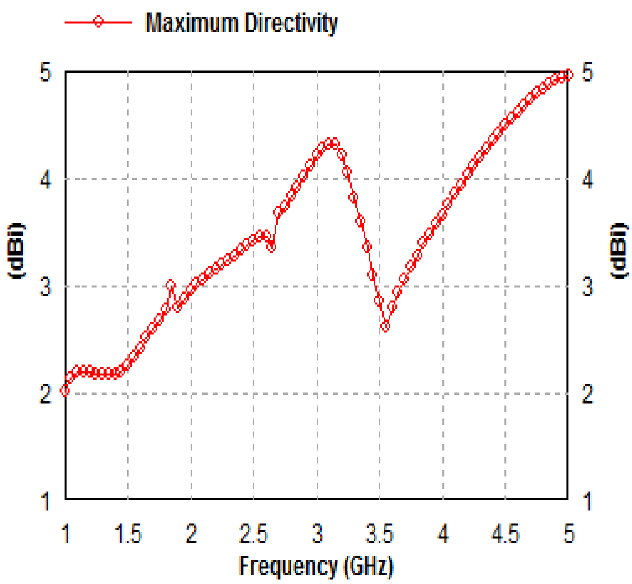

Fig.9. Directivity of proposed antenna

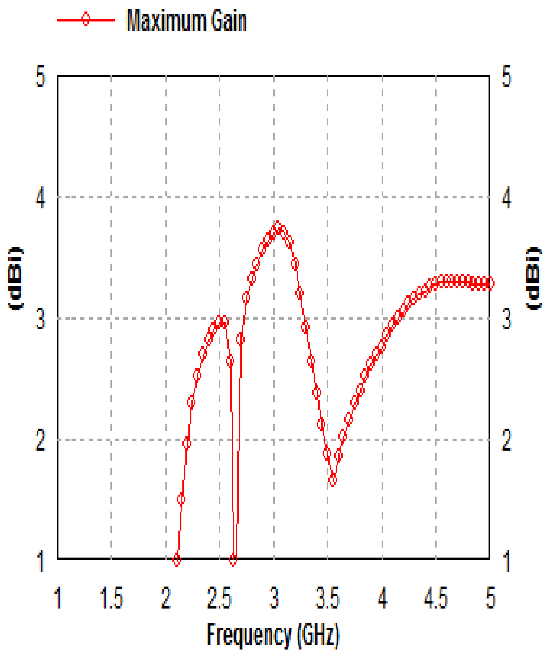

Fig.10 Gain of proposed antenna

5. CONCLUSION

Microstrip patch antenna size reduction has been achieved. The characteristics of proposed antenna are studied. Proposed antenna improved the fractional bandwidth upto 65.96%. The proposed antenna has been designed on glass epoxy substrate to give a maximum radiating efficiency of about 89.59%, gain of about 3.65dBi and directivity of 4.13 dBi. The proposed antenna is suitable for WLAN, WiMAX and Bluetooth applications.

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