IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 1, January 2016

Sierpinski Carpet Based Mushroom Shape Fractal Microstrip Antenna

Priyanka Sharma[1], Sumit Kaushik[2], Vijaya Thakur[3]

Student (M.Tech, ECE), LRIET, Solan, Himachal Pradesh[1]

Assistant Prof., ECE Department, LRIET, Solan, Himachal Pradesh[2]

H.O.D., ECE Department, LRIET, Solan, Himachal Pradesh[3]

Abstract: Microstrip antenna is the most basic types of antenna which is used now days. The reduced weight and flat profile of these antennas as compared to the parabolic reflector antennas make it attractive for a number of applications. These antennas are less bulky and are capable of resonating at different frequencies but have some disadvantages as low bandwidth and low gain. There are a number of techniques which may be used in order to improve these factors. Using fractal geometry or using DGS are some of these techniques. Design and simulation has been carried out using IE3D simulation software. Sierpinski fractal geometry has been used to form a mushroom shaped patch antenna.

Keywords: Fractal, mushroom shaped, patch antenna.

I. INTRODUCTION

A number of advancements have occurred and are being used today. However as the demands for the system performance is increasing day by day there are a lot of issue and challenges are facing us today. A good antenna design can improve the system performance. There are a number of constraints such as size, weight and cost, in high performance aircrafts, spacecrafts and satellite. In order to meet these requirements microstrip patch antennas are used. Microstrip antennas are wideband narrow beam antenna placed on FR4 glass, ceramic etc. whose dielectric constant lies between $2.2 \leq \varepsilon_r \leq 12$. Although they are less bulky and have the ability to resonate at different frequencies, there are some disadvantages of microstrip antennas such as low bandwidth, poor polarization, high Q factor and low gain. There are a number of techniques for improving on such factors. Some of them are fractal geometry and use of DGS structure or cutting slots on patch. There are a number of fractal shapes such as Minkowski, Koch curve, Sierpinski, Hilbert curve and fractal arrays. When fractal geometry is applied on the patch, the area of the patch decreases, number of frequency bands increases and resonant length also increases. Bandwidth increases with the help of using DGS. The performance of the antenna can be increased if DGS and fractal geometry are applied to an antenna

II. DESIGN AND IMPLIMENTATION

Frequency of operation is a very important aspect while designing an antenna. Before designing an antenna its frequency of operation should be known. Single band antennas support only one or two frequencies. Nowadays multiband antennas are being used. By the use of fractal geometry a single antenna can be made to work at different frequencies. This makes the device support several standards with a single antenna built within it. Sierpinski fractal technique has been used to design a multiband mushroom shaped antenna. Three iterations have been done and parametric analysis has been carried out. Initially a square patch has been analyzed. The square patch has dimension of L×W=25mm ×25mm. FR4 substrate has been used having a relative permittivity of €sub=4.4. Co-axial field has been used to provide feed to the antenna. Feeding is done at a point where impedance matching can take place. Design and simulation has been carried out using IE3D simulation software.

Table 1: Dimensions of mushroom shaped FMPA.

Variable	Value
Length of patch	25mm
Width of patch	25mm
Length of ground	30mm
Width of ground	30mm
Thickness of substrate	2.4mm
Feeding technique used	Coaxial Feeding Technique
Substrate used	FR-4
Dielectric constant	4.4
Loss Tangent	0.02
Feed point	X=-11, y=-11, z=0
First iteration cut	8mm
Second iteration cut	3mm

The different geometries corresponding to the 0^{th}, 1^{st}, and 2^{nd} iterations has been shown in figure 1(a), 1(b), 1(c). The square patch has been analyzed. It has a dimension of 23mm×25mm as shown in figure 1(a). The ground dimensions are 30mm×30mm. Coaxial feed has been applied at (-11,-11,0). Feed point is selected in such a way that impedance matching takes place

1^{st} iteration of Sierpinski carpet fractal technique is applied on the patch. As shown in the figure 1(b) a mushroom shaped cut in the center of the patch is made using this geometry. An 8 mm cut is made for this iteration.

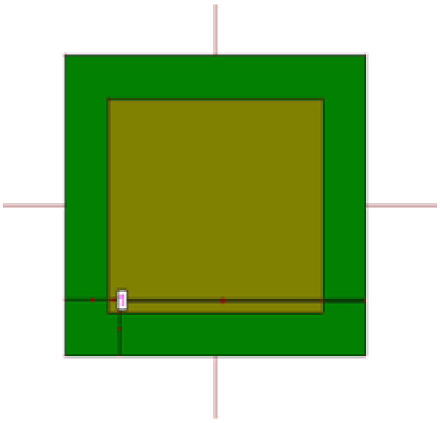


Figure 1(a)

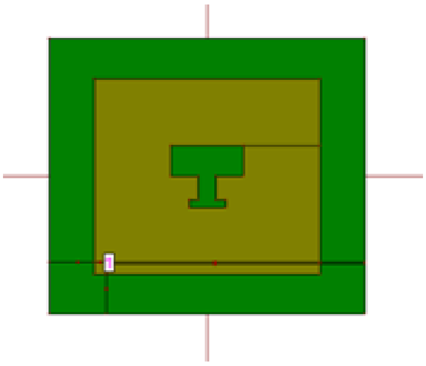


Figure 1(b)

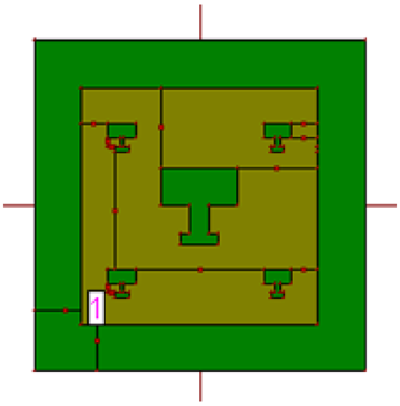


Figure 1(c)

Now to make mushroom shaped fractal, cuts of 3mm are made on all four sides of the mushroom made in the 1st iteration. As IE3D has been used hence one has to consider the center of the square for making cuts. Hence the figure is obtained as shown in figure 1(c). These geometries show self repeated structures. From the figures 1(a) and 1(b) it is clear that the shape of mushroom goes in decreasing and the area of the patch also keep decreasing with each iteration.

III. RESULTS AND DISCUSSIONS

Dimensions of the proposed antenna are optimized by IE3D simulation software and the final dimensions are listed in table II. Antenna characteristics are defined on the basis of resonant frequency, bandwidth, gain, return loss and directivity. S_{11} parameter defines the return loss. It is defined as the maximum reflection of power from the given antenna. The designed antenna is simulated and shows the different frequencies which can be used for multiband applications. The return loss v/s frequency curve for different iterations is shown in figure.2 and the radiation patterns of radiation antenna for some particular frequencies have been shown in figure 3.

Table II: Comparison of the results of different iterations

Iter No.	Resonance Freq. (GHz)	Return Loss (dB)	Gain (dBi)	Directivity (dBi)	Band Width (MHz)
0th	5.4	-30	0.936	4.348	
	8.1	-18	3.111	9.136	
	10.2	-20	0.072	8.945	450MHz
1st	5.94	-10.34	2.558	7.37	50MHz
	8.3	-11.66	2.324	8.4	
	8.7	-15.76	1.777	7.87	
	9.7	-39.9	2.283	7.6	1800Mhz
2nd	5.5	-13	2.29	5.82	200MHz
	8.2		1.33	7.62	
	9.4		2.65	8	
	9.7	-28.26	1.93	6.8	2GHz

From figure 2 it is clear that fractal geometry helps in improving the characteristics of an antenna. The antenna at 0^{th} iteration resonates at 5.4 GHz, 8.1 GHz and 10.2 GHz with return loss of -30dB,-18dB and -20dB, gain of 0.9dBi, 3.1dBi and 0.7dB, directivity of 4.3dBi, 9.1dBiand 8.9dBi with a bandwidth of 450Mb. On applying 1^{st} iteration the antenna resonates at 5.9 GHz, 8.3 GHz, 8.7 GHz, and 0.7 GHz, with return loss of -10.3dB, -11.6dB, 15.7dB, and 39.9dB, gain of 2.5dBi, 2.3dBi, 1.7dBi, and 2.2dBi, directivity of 7.3dBi, 8.4dBi, 7.8dBi, 7.6dBi with a bandwidth of 1 GHz.

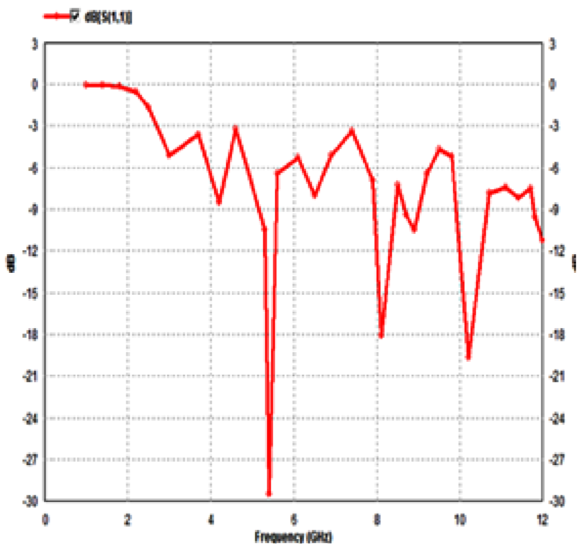


Figure 2(a)

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 1, January 2016

With the 2nd iteration improvement in the characteristics is observed, with the antenna resonating at 5.5 GHz, 8.2 GHz, 9.4 GHz, and 9.7GHz, and the return loss observed is -13dB and -28.2dB, gain is 2.2dBi, 1.3dBi, 2.6dBi, and 1.9dBi, directivity of 5.8dBi, 7.6dBi, 8dBi, and 6.8dBi, with a bandwidth of 2GHz.

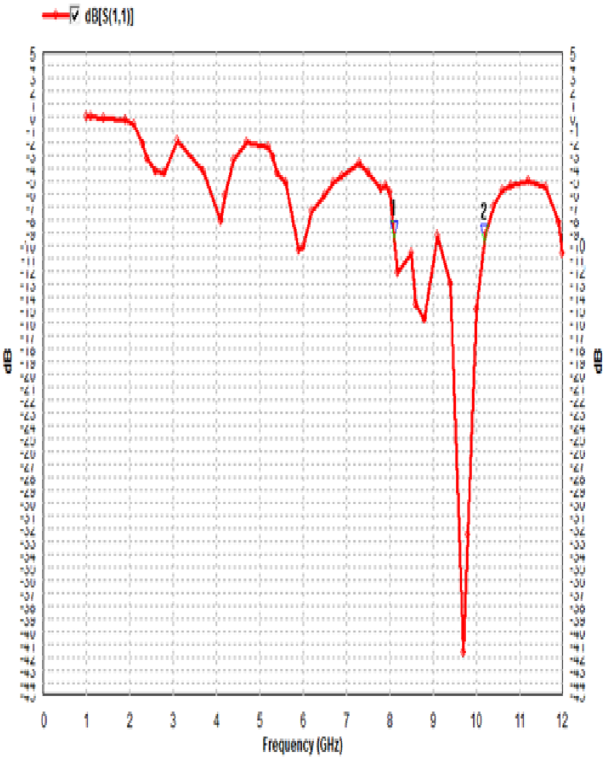


Figure 2(b)

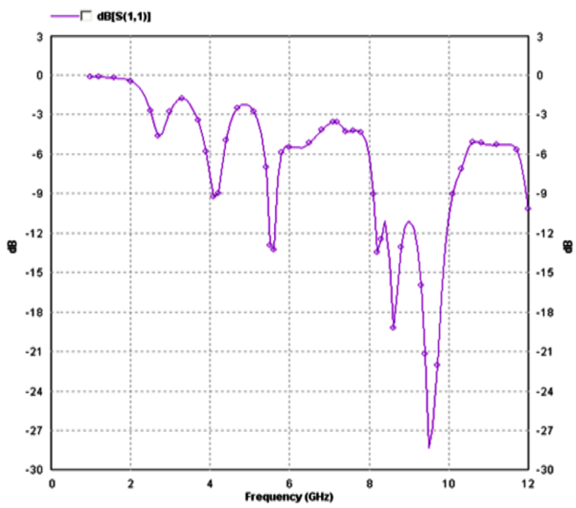
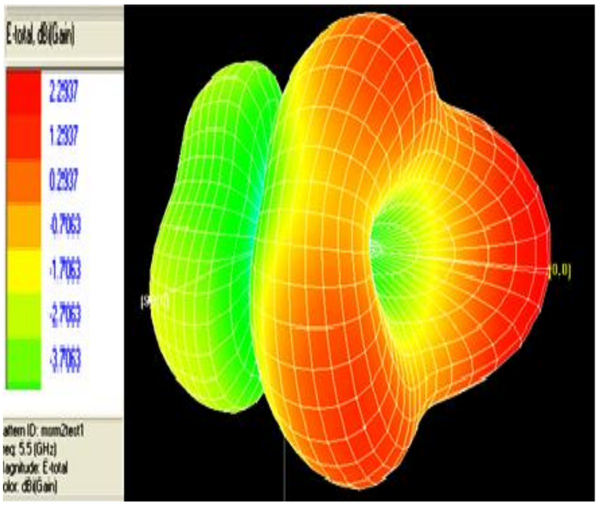


Figure 2(c)

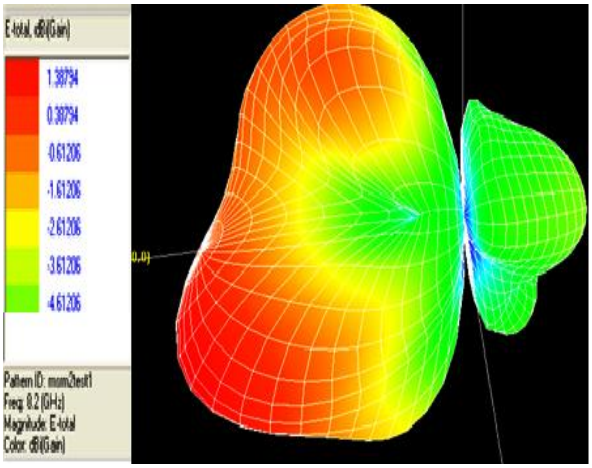
Figure 2: Return loss v/s Frequency curve (a) 0th iteration (b) 1st iteration (c) 3rd iteration

The results show that as the number of iterations is increased there is a significant change in the characteristics of the antenna. Results are analyzed in terms of return loss, gain, directivity and bandwidth. From the table II it is found that as the number of iterations increases, resonant length increases, the area decreases but the number of frequency bands increases.

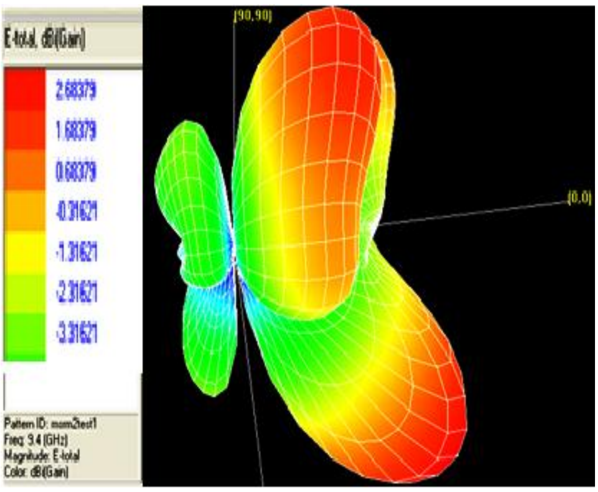


(a)

Here the antenna is having a bandwidth of 2GHz in S-band which can be further improved



(b)



(c)

Figure 3: Radiation patterns of reference antenna at (a) 5.5 GHz (b) 8.2 GHz (c) 9.4 GHz

DOI 10.17148/IJARCCE.2016.5161

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 5, Issue 1, January 2016

IV. CONCLUSION

In this paper a mushroom shaped fractal microstrip antenna has been designed by the use of Sierpinski carpet fractal technique and is iterated up to three iterations to exhibit multiband behavior. As the iteration increase the gain of the antenna increases. The proposed antenna has a bandwidth of 2GHz and can be used for secure communication purpose and in Wi-Max and Wi-Fi applications.

REFERENCES

[1]. Yogesh Kumar Choukiker, Satish k Sharma and Santanu K Behera, 2014. "Hybrid Fractal Planer Monopole Antenna Covering Multiple Wireless Communication with (MIMO) Implementation for Handheld Devices", IEEE transactions on antenna and propagation, Vol 62, No. 3, March 2014.

[2] V.V Reddy and R.S.V.N Sarma, 2014." Compact Circularly Polarized Asymmetrical Fractal Boundary Microstrip Antenna for Wireless Application", IEEE antenna and wireless communication letters, Vol. 13.

[3] Rahul Batra, P.L. Zade, and dipika Sagne, 2012. "Design And Implementation of Sierpinski Carpet Fractal Antenna for Wireless Communication", international journal of scientific research engineering and technology, Vol 1, Issue 3, pp 043-047.

[4] C. A. Balanis, Antenna Theory, second edition, New York: John Wiley and sons, Inc 1997.

[5] Rowdra Ghatak, Anirban karmakar, D.R. Podder, 2012. "Hexagonal Boundary Sierpinski carpet fractal shaped compact ultra-wideband antenna with band rejection functionality", international journal for electronics and ommunication, Vol 67, pp 250-255.

[6]. Feng Wai Yao, Xiao-Bo Xuan, Yuan-Yun Liu, Yuan-Bo Shang, 2012. " A noval compact microstrip slot antenna with spirals".

[7] D.H. Werner and S. Ganguly, 2003. "An overview of fractal antenna engineering research", IEEE antennas and propagation magazine, Vol. 45, No. 1, pp 38-57.

[8] T.P. Wong, C.K.L. Luk, Kwai-Man, Kai-Fong, 2007. "IEEE letters on Antenna and Wireless Propagation, Vol. 6, pp 5-6.

[9] Amit Kumar, Jaspreet Kaur, Rajinder Singh, 2013. "Performance Analysis of Different Feeding Techniques", International Journal of Emerging Technology and Advanced Engineering, Vol. 3, Issue 3.

[10] Wei-Chung Weng and Chia Liang Hung, 2014. "An H-Fractal Antenna for Multiband Operations", IEEE antenna and wireless communication letters, Vol 13.

DOI 10.17148/IJARCCE.2016.5161