Analysis the behavior of Sierpinski Carpet Fractal and Patch Antennas

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Abstract : **In this paper we design and analysis the result of the Sierpinski carpet fractal antenna and patch antennas. The proposed antenna is designed on FR4 epoxy substrate with dielectric constant of 4.4 and fed with 50 ohms micro strip line. In our work there is a comparison between patch and sierpinski carpet fractal antenna. The Dimensions for the sierpinski Carpet and patch antenna are 16mm*18mm*1.6mm. The antenna structure is simulated using An Soft HFSS software. The antennas characteristics such as return loss, radiation pattern and VSWR of the antenna are analyzed and presented. The proposed fractal antenna can be used in the frequency range from 2-20 GHz. In our purposed work the simulated result of sierpinski carpet fractal antenna is much better than the patch antenna.**

IndexTerms **- Micro strip Antenna, Fractal, Sierpinski Carpet Fractal Antenna (SCFA)**

I. INTRODUCTION

Wireless communication has been developed widely in recent years. Future communication devices will aim to provide video, images, data communication, anytime anywhere around the world. This indicates that the future communication devices must meet the requirements of multiband or wideband in order to cover all possible operating bands, at the same time they should be small enough to be placed inside the communication systems or communication devices. Fractal antennas [1] can be used for this purpose. Fractal antennas can be used to find the best distribution of current within a given volume in order to meet a particular design goal. There are several advantages as in [2] of these fractal devices including reduction of resonant frequencies, smaller size and broadband width as well as low profile, low weight, conformal to the surface of objects and they have easy production.

II. PROPOSED ANTENNAS CONFIGURATION

The square patch was selected for initial design. Fig1 shows the sirpinski carpet fractal antenna and patch antennas with ground and substrate slotting.

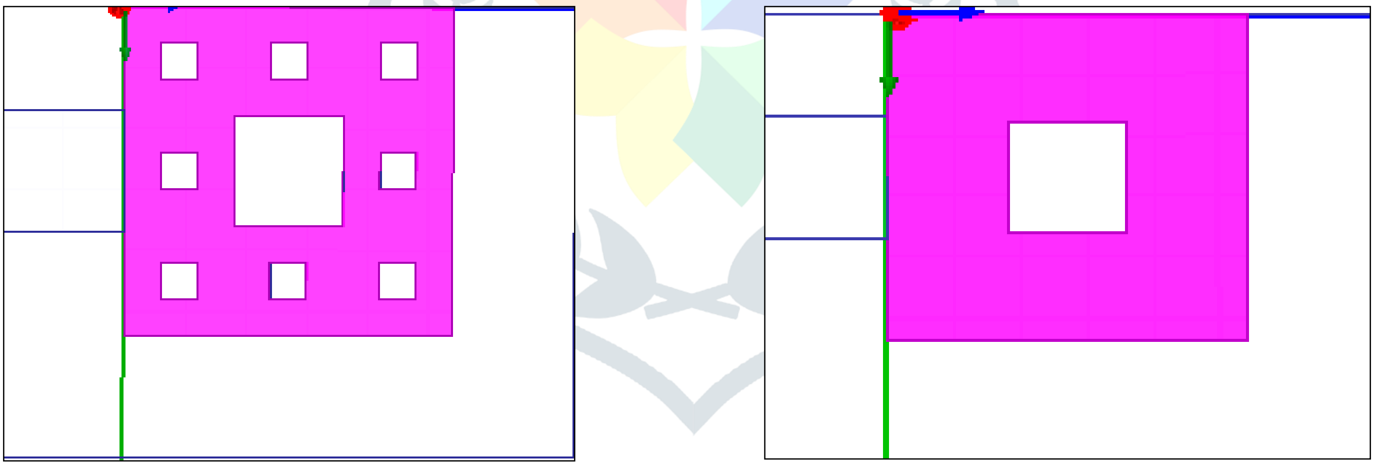

Fig 1 (a) Fig 1 (b)

Fig 1 (a) shows sierpinski carpet fractal antenna and fig 1 (b) shows that the designed patch antenna

III. ANTENNA DESIGN

A. SIERPINSKI CARPET FRACTAL GEOMETRY

The design starts with Sierpinski Carpet Planar Antenna. The first basic rectangular patch is designed. In the first iteration the basic square patch is segmented by removing the middle square from it, by taking scale factor 1/3. For second iteration segments are done on remaining eight squares following the scale factor of 1/3. The same procedure is used for further iterations with same scale factor. By using this method we have designed four iterations as shown in Figure 1(a). This basic rectangular patch is designed on a FR4 substrate of thickness 1.6 mm and relative permittivity of 4.4.

B. PATCH ANTENNAS GEOMETRY

In this section the steps under taken for designing the antenna are discussed. The first practical step in antenna design is substrate selection. For our design FR4 substrate is selected. It is one of the most commonly available as well as cheap substrate. It has a dielectric constant of 4.4 and a loss tangent of 0.02.

The geometry of the proposed antenna is shown in figure 1(a). The antenna is designed on 27×27×1.6 mm3 substrate. The dimensions of the antenna are shown in table 1. All the dimensions are obtained after optimization using HFSS software. The antenna structure is shown in figures 1(a) and 1(b).

IV. REUSULT AND DISCUSSIONS

A. RETURN LOSS

The return loss for the sierpinski carpet fractal antenna is given in fig 2(a).

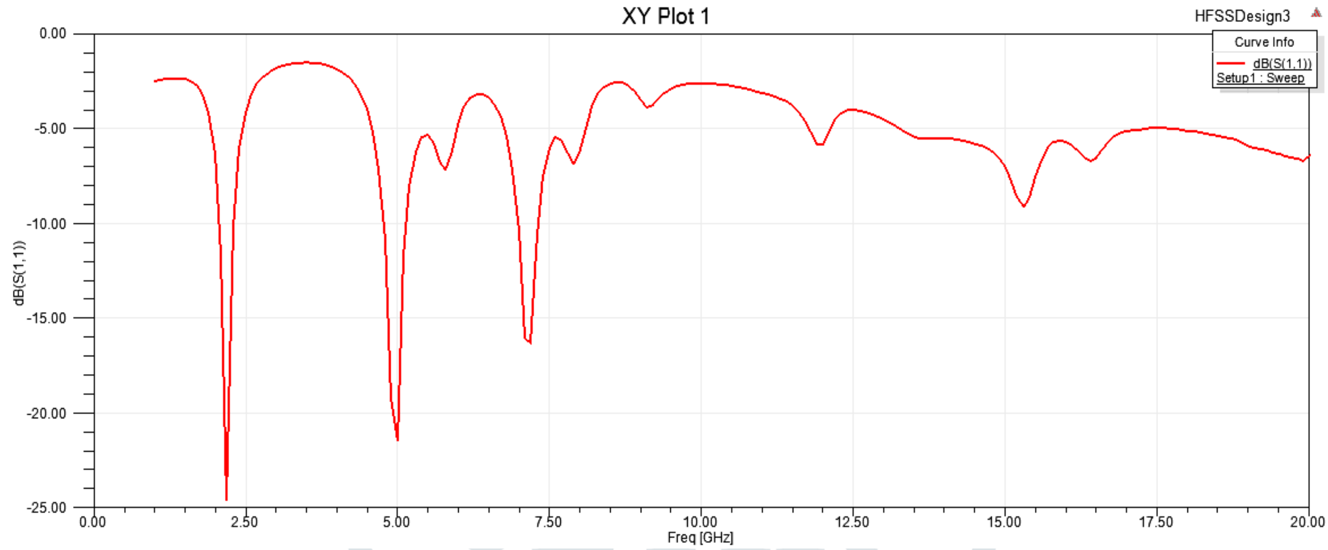

Fig 2(a) return loss for sierpinski carpet fractal antenna

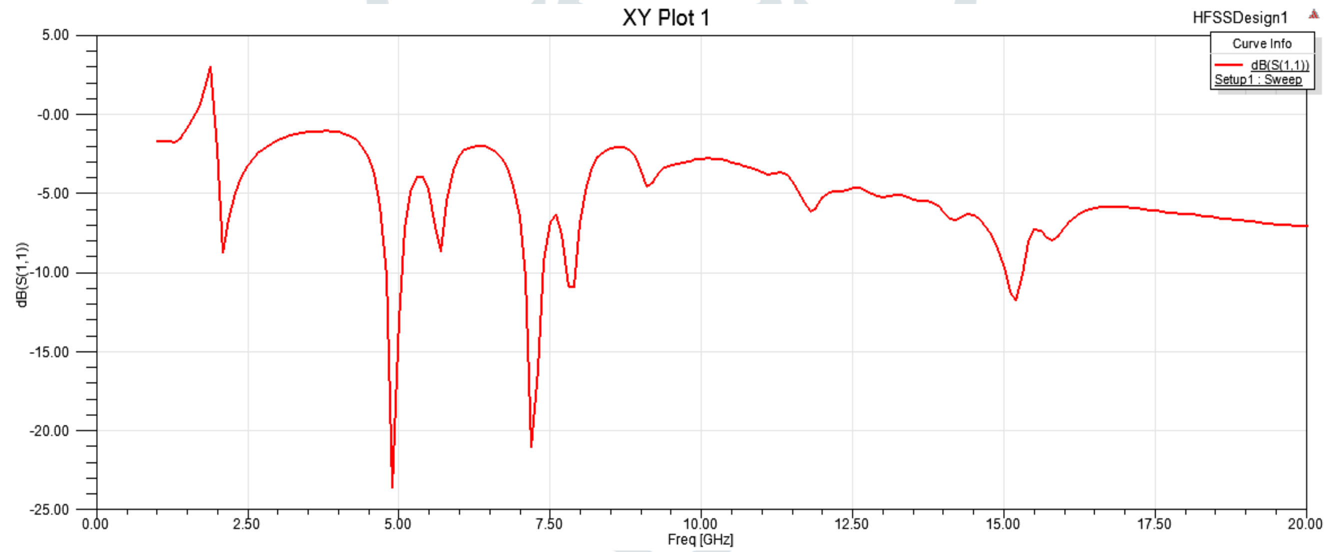

Fig2 (b) return loss for patch antenna

B. **VSWR**

The VSWR is the measure of impedance mismatch between the feed line and the antenna. The mismatch increases the value of VSWR. The minimum value of VSWR is unity and the maximum VSWR is 2 for the perfect impedance matching. The VSWR for the sierpinski carpet fractal antenna is given in fig 3(a).

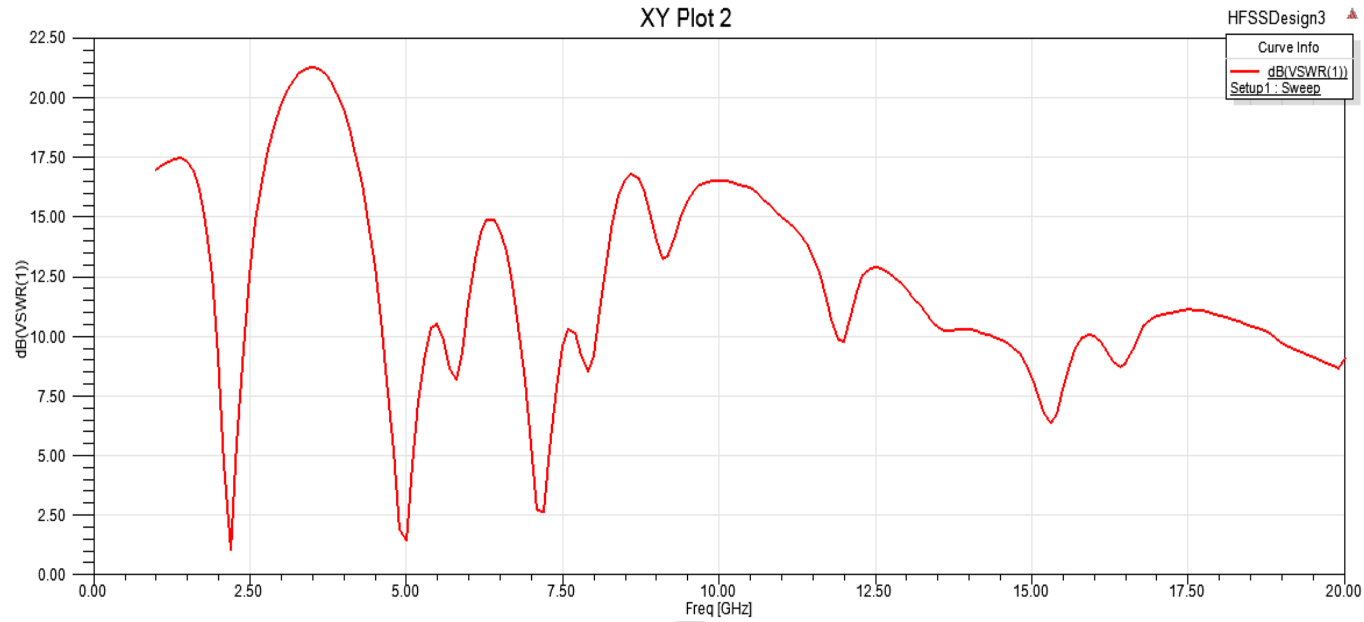

Fig3 (a) VSWR for sierpinski carpet antenna

The VSWR for patch antenna is given in fig3 (b).

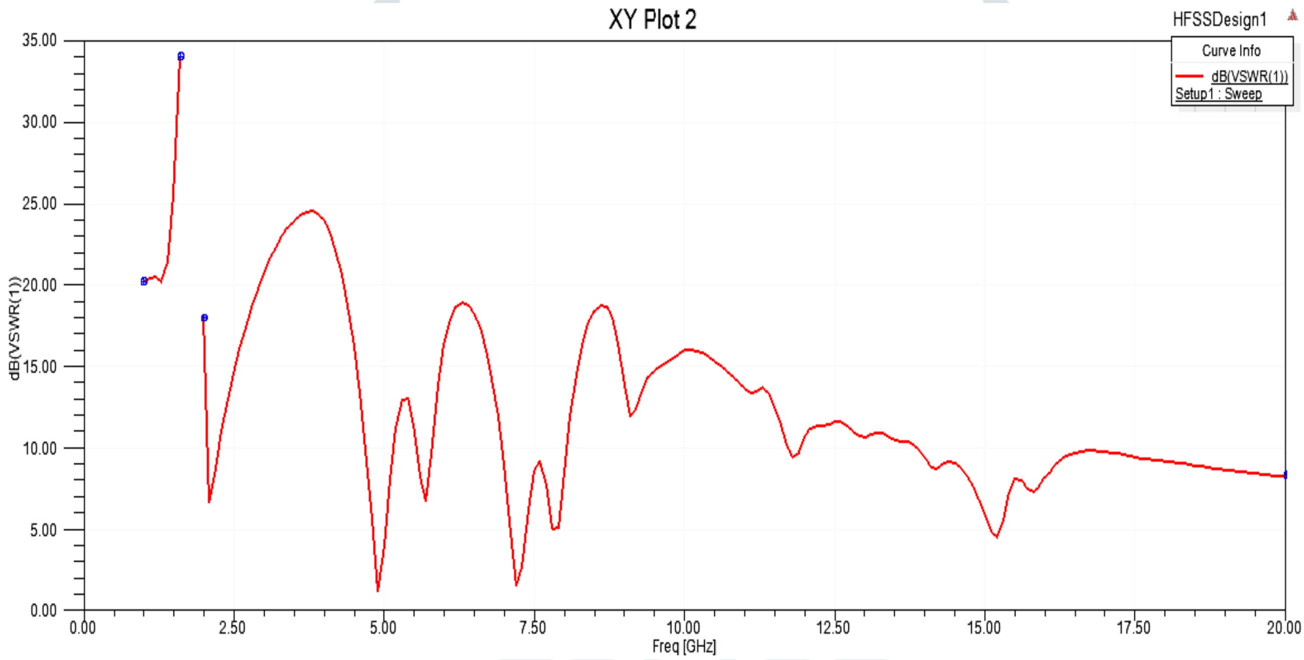

Fig 3 (b) VSWR for patch antennas

The measured values of the return loss and the VSWR are given in table 1 and 2 which are given below

Table 1 for sierpinski carpet fractal (proposed) antenna

Ref. no.	Resonating Frequency(GHz)	Return Loss(db)	VSWR(db)	Gain(db)
1	2.4	-25	0.9	7
2	4.9	-22	1	4
3	7	-17	1.1	2
4	14	-19	1.8	2

Table 2 for patch (reference) antenna

Ref. no.	Resonating Frequency(GHz)	Return Loss(db)	VSWR(db)	Gain(db)
1	2.4	-9	4	4
2	4.9	-21	1	1
3	7	-24	1.1	2
4	14	-10	4.8	-2

C. RADIATION PATTERN

The radiation pattern for sierpinski carpet antenna is given in fig4 (a).

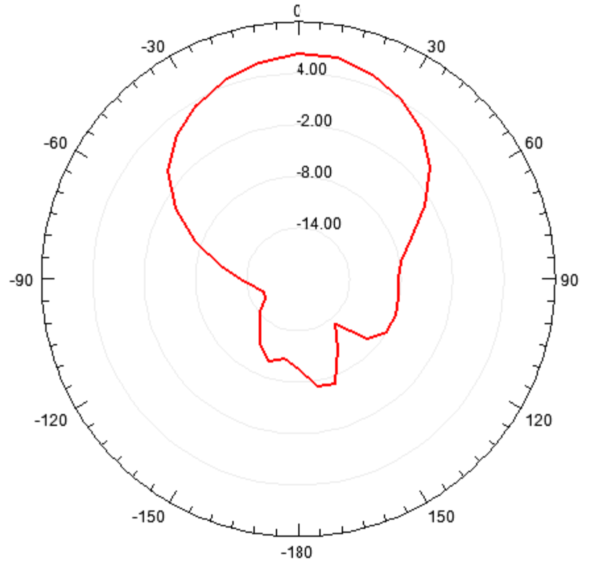

Fig 4(a) simulated radiation pattern for sierpinski carpet antenna

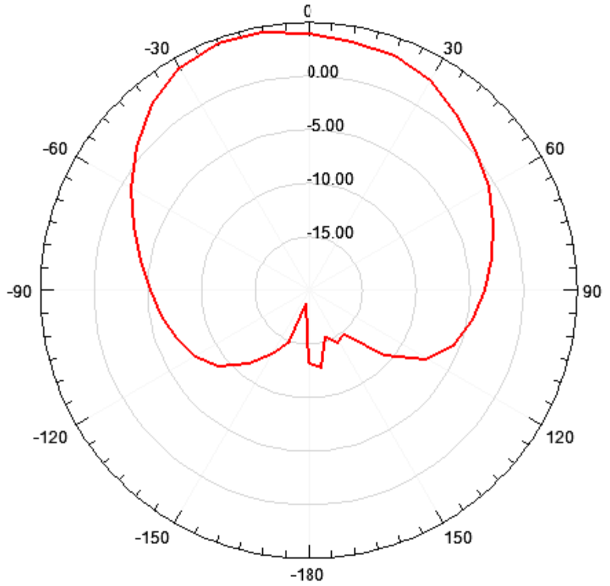

Fig4 (b) simulated radiation pattern for patch antenna

Fig4 (a) and 4(b) shows radiation patterns of sierpinski carpet fractal antenna and patch antenna. It is observed that the E-field pattern is Omni directional with low cross polarization level less than -25db for sierpinski carpet and for patch antenna E-field pattern is near Omni directional with polarization level less than -21db

V. CONCLUSION

The sierpinski carpet and patch antennas are designed and its performance characterstics are analysed. The minimum return loss for proposed antenna is -25db at VSWR is 0.9 which is bettere than that the reference antenna. The simulated result of the sierpinski carpet fractal antenna exhibit minimum return loss,omini directional radiation pattern, wide impedence bandwidth, VSWR<2, which is much better then the simulated result of the patch antenna.

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REFERENCES

[1] B.A. Floyad, C. Hung, and K.K.O," Intra-chip wireless interconnect for clock distribution implemented with integrated antennas, receivers and transmitters," IEEE j solid- state circuits,pp.543-552, may 2002

[2] A.B.M.H. Rashid,W. watanabe and T. Kikkawa," High transmission gain integrated antenna on extremely high resistivity on Si for USI wireless inter connect,"IEEE Electron device Lett.,pp. 731-733,nov 2002

[3] J. Gianvittorio and Y. R. Samii,"Fractal patch antenna,"Deprtment of electrical engineering, university of caalifornia, Los Angeles,2001.

[4]K.J. Vinoy, Fractal shaped antenna elements for wide and multiband wireless applications,PhD Thesis,Pennsylvania State University,2002.

[5] M. K. A .M. Z. A. Rahim , A. Aziz, and N. Abdullah,"Wideband sierpinski carpet monopole antenna,"2005 Asia-pacific Conference on Applied Electromagnetics Proceedings, IEEE, 2005.

[6] T.W. Hee , P.S. Hall, and K.Y. Liew," Wideband stacked sierpinski dipole antenna,"IEEE Transaction on Antenna and propagation , pp. 242-245, 2003.

7. Leon, G., R. R. Boix, and F. Medina, "A comparison among different reduced-size resonant microstrip patches," *Microwave and Optical Technology Letters*, Vol. 29, No. 3, 143 – 146, 2001.

8. Kim, I.-K., J.-G. Yook, and H.-K. Park, "Fractal-shape small size micro strip antenna," *Microwave and Optical Technology Letters,*
Vol. 34, No. 1, 15 – 17, 2002.

9. Guterman, J., A. A. Moreira, and C. Peixeiro, "Microstrip fractal antennas for multistandard terminals," *IEEE Antennas and Wireless Propagation Letters*, Vol. 3, 351 – 354, 2004.

10. Gianviffwb, J. P. and R.-S. Yahya, "Fractal antennas: A novel antenna miniaturization technique and applications," *IEEE Antennas and Propagation Magazine*, Vol. 44, No. 1, 20 – 36, 2002.

11. Rahim, M. K. A., N. Abdullah, and M. Z. A. Aziz, "Micro strip Sierpinski carpet antenna design," *2005 Asia-Pacific Conference on Applied Electromagnetics Proceedings*, 58 – 61, 2005.

12. Ooi, B.-L., "A modified contour integral analysis for Sierpinski fractal carpet antennas with and without electromagnetic band gap ground plane," *IEEE Trans. Antennas and Propagation*, Vol. 52, No. 5, 1286 – 1293, 2004.