

Design of Hexagonal Fractal Antenna Array for Multiband Wireless Application

Jyoti Ananda Jadhav

Electronic and Telecommunication
Amrutvahini College of Engineering
Sangamner, India

Prof. Ramesh Pawase

Electronic and telecommunication
Amrutvahini College of Engineering
Sangamner, India

Abstract—In this paper describes the concept of new fractal multi-band antenna based on the hexagonal shape. Three iterations of the hexagonal fractal &array multiband antenna arranged are examined. With this structure it is possible to configure the multi-band frequency and radiation patterns with high directivity and gain. Antenna is simulated using CAD FEKO suite (6.2) using method of moment .The fractal antenna is fabricated using FR4 dielectric constant of 4.4 and loss tangent of 0.02.The software is used to design and analyze the antenna array for application at 1.2, 1.8 GHz, 2.7 GHz & 2.9 GHz.

Index Terms— Fractal multiband antenna, hexagonal fractal multiband antenna, iteration function system, sierpinski gasket, sierpinski gasket antenna.

I. INTRODUCTION

In modern wireless communication systems and applications, wider bandwidth, multiband and low profile antennas are in great demand for both commercial and military applications. The rapid increase of wireless communications leads to a large demand in designing of a multiband antenna. Traditionally, each antenna operates at single or dual frequency bands, where different antenna is used for different applications. There are different configurations used for multiband antenna. The fractal antenna geometry concept is a special technique used to design multiband antenna. The name “fractal” from the latin “fractus” meaning broken, was given to highly irregular sets by benoit Mandelbrot in his foundational essay in 1975 [1].fractal is recursively generated structure having self-similar shape, which means that some of the parts have same shape as whole object but at the different scale. Due to self-similarity property of the fractal they are especially suitable for the design of multiband frequency antenna. Due to the concept self-similarity and infinite complexities, the proposed geometry of the antenna is very versatile is in term of polarization radiation pattern, gain and bandwidth. In this paper the self-similarity property of hexagonal is used to achieve the multiband operation.

II. HEXAGONAL FRACTAL ANTENNA

The geometry of fractal is important because effective length of fractal antenna can be increased while keeping total area same.

Most of the fractal geometries have the following characteristic features: infinite complexity and detail, fractional dimension and self-similarity. These characteristic features of fractal can be utilized in antenna design to get the following advantage:

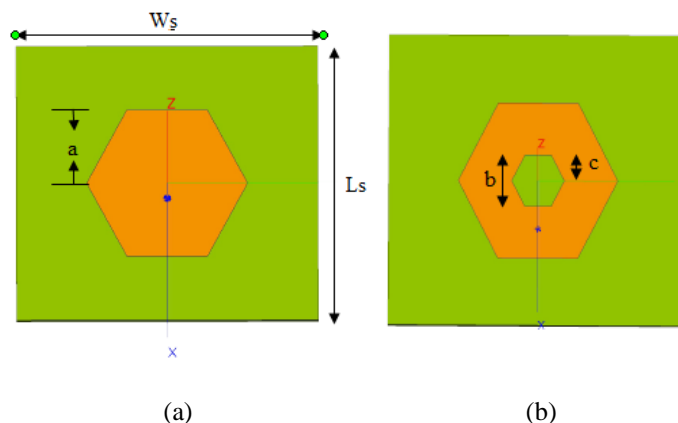
Better Efficiency: fractals have sharp corners and edges that cause abrupt changes in the direction of current and hence enhance radiation. Therefore fractals are efficient radiator of electromagnetic energy [2].

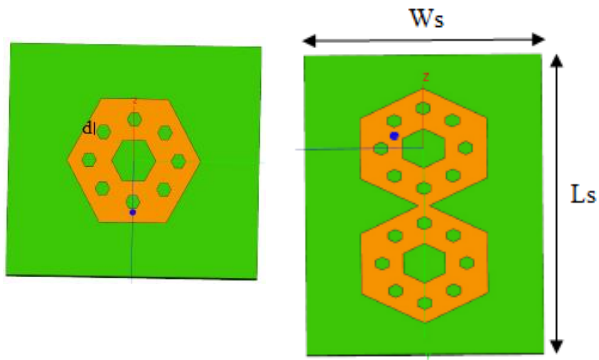
Multiband antenna: due to the self-similarity property of fractals there are multiple copies of the geometry in a fractal object and hence they can be utilized for multiband antennas [2].

Size: Compact size compared to antennas of conventional designs, while maintaining good to excellent efficiencies and gains. The first three iteration of hexagonal fractal antenna is shown in figure 1 which shows that the area remains same but length of antenna get increase due to iteration.

III. ANTENNA GEOMETRY

The hexagonal fractal microstrip antenna for three iterations has shown in fig.1 the hexagonal fractal antenna is mounted on FR4-printed circuit board (PCB) with dielectric constant of 4.4 and thickness of $h=1.6\text{mm}$, $a=24$, substrate length= 110mm , width= 110mm . Third iteration geometry of an antenna consist of eight small shaped hexagonal which are constructed by reducing and grouping these hexagon generator shape to one third its first iteration.





(c) (d)
Figure 1: first three iteration of hexagonal fractal antenna.

IV. SIMULATED RESULT

The first three iteration of corner fed hexagonal fractal dipole measured and have been examined using finite element method.

The hexagonal fractal antenna is design for four iterations i.e. 0th iteration, 1st iteration, 2nd iteration and 3rd iteration and the result are noted for different parameter as shown in table.

Iteration	Frequency	Reflection Coefficient	VSWR	Gain (dBi)	Bandwidth
0 th iteration	1.56966	-17.2216	1.3193	4.581	10
1 st iteration	1.50124	-15.3327	1.44	5.220	11
2 nd iteration	1.50628	-30.92	1.0585		29
	2.57822	-25.5933	1.1087		
3 rd iteration	1.12	-13.1	1.57		72
	1.8645	-26.56	1.1		53
	2.786	-18.15	1.28	2.612	147
	2.98869	-18.6797	1.27		108

A. RETURN LOSS:

The return loss for the 3rd iteration of the hexagonal fractal antenna is plotted in figure 2. The hexagonal fractal produced a high return loss compared to the sierpinski carpet fractal antenna.

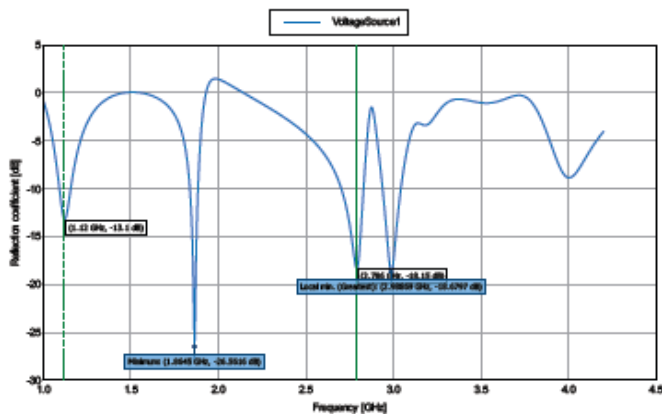


Figure 2: reflection coefficient magnitude [dB]- fractal_3rd iteration array.

B.VSWR:

Voltage Standing Wave Ratio (VSWR) is a ratio between maximum voltage and minimum voltage along transmission line. VSWR is increase if there is mismatch between the antenna and transmission line and it is increases if there are good matching [6]. The VSWR is given by

$$VSWR = Z_0 (1 + |S_{11}|) / (1 - |S_{11}|)$$

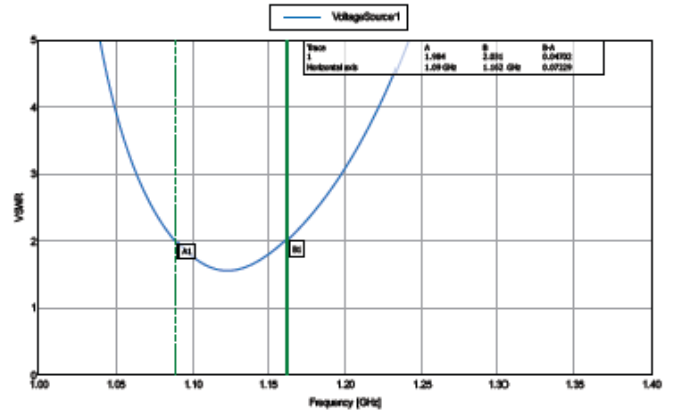


Figure 3: VSWR-Fractal_3rd iteration array.

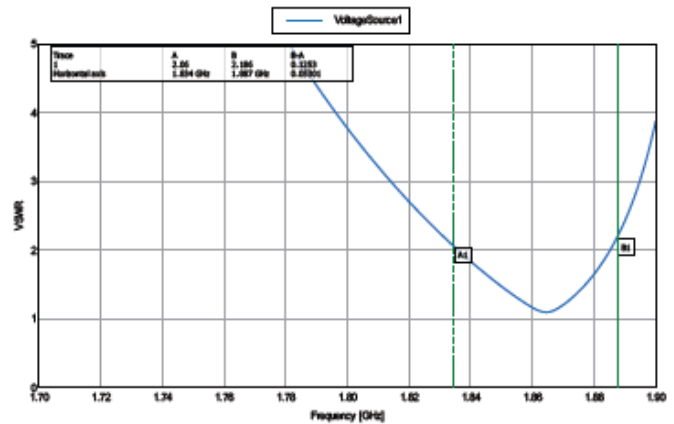


Figure 4: VSWR-Fractal_3rd iteration array.

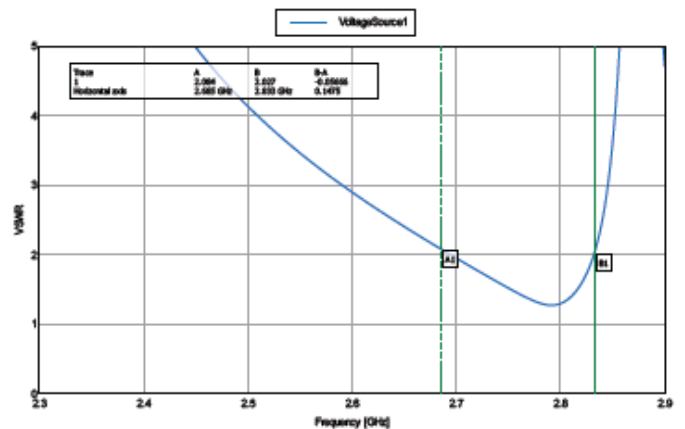


Figure 5: VSWR-Fractal_3rd iteration array.

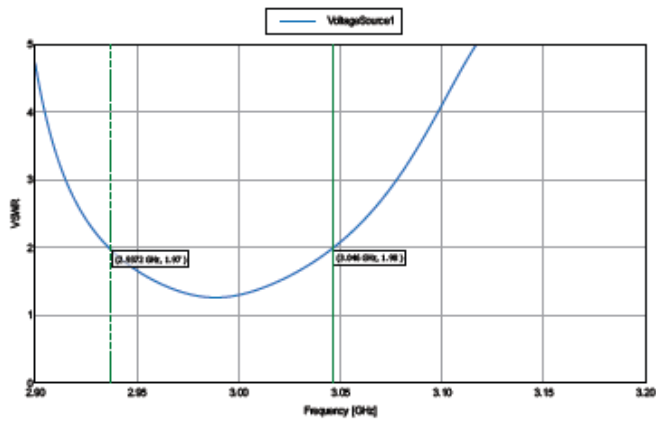


Figure 6: VSWR-Fractal_3rd iteration array.

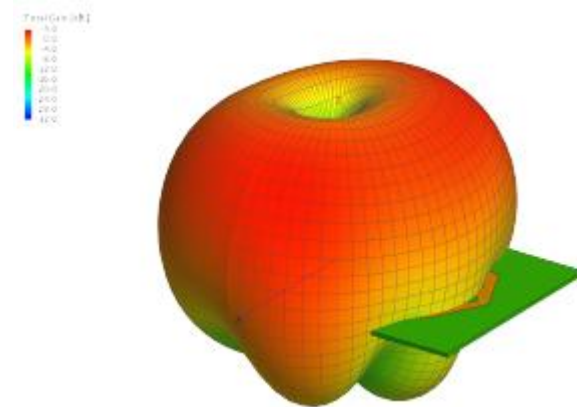


Figure8:3D VIEW

C.DIRECTIVITY:

Directivity, d is an important parameter that shows the ability of the antenna focusing radiated energy. Directivity is a ratio of maximum radiated to radiate by reference antenna. Reference antenna is an isotropic radiator where the radiated energy is same in all the direction and has directivity of 1. Directivity can be definition as [4].

$$D = F_{max} / F_0$$

Where,

F_{max}= Maximum radiated energy

F₀= Isotropic radiator radiate energy

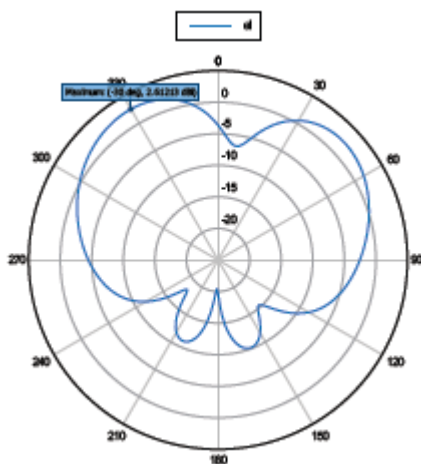


Figure 7: phi gain [dBi] (frequency =2.81818GHz; phi= 90 deg) – fractal_3rd iteration array.

V. CONCLUSION

The hexagonal fractal antenna has designed and simulated on CAD FEKO suit (6.2). by which can improve antenna parameter with different iteration methods, by changing the structure and keeping the size constant. The simulated results have shown a good radiation structure, which has high directivity and gain, when compared to a simple patch antenna. The return loss measurements show an excellent dip and suitable bandwidth. The directivity and gain are directly proportional to the number of fed array element which can be used for multiband application. Thus , designed antenna can be used for various application GPS at 1.2 GHz, application of mobile operating at 1.9 GHz, USB Dongle operating at 2.7 GHz and 2.9 GHz for satellite system.

REFERENCES

- [1] C.Puente.J.Romeu, R.Pous, And A.Cardama, “On the behavior of the Sierpinski multiband fractal antenna,” *IEEE trans. Antennas propagate.* vol. 46, pp. 517-524, apr. 1998.
- [2] Manas Jena, B.B. Mangaraj And Debases Mishra, “Bandwidth and gain enhancement of multiband fractal antenna based on the sierpinski carpet geometry,” *ICTACT Journal On Communication Technology*, March 2013, vol. 04, issue:01
- [3] C.Puente ,J.Romeu.R. Pous X.Garcia , And F. Benitez , “fractal multiband antenna baesd on the sierpinski gasket,” *electron. Let.* vol.32, no.1. pp .517
- [4] Prashant More, Sanjay V. Khobragade, “A hexagonal–shaped fractal antenna array for multiband applications.
- [5] Dethalia Manjibhai, Prof.Jayeshkumar Parjapati, Dipakkumar Barasara., “An Overview Of Fractal Geometries And Antenna.” *International Journal Of Engineering And Science*, ISSN 2278-4721, Vlo.1,Issue2(Sept 2012), PP 01-04
- [6] Rahul Batra, P.L.Zade, Dipika Sagne, “design and implementation of sierpinski carpet fractal antenna for wireless communication.” *International journal of scientific research engg & technology (IJSRET)* vol.1.,issue3.pp.043-047, july 2012
- [7] C.A. Balanis, *Antenna Theory: Analysis And Design*, 3rd rd., wiley,2005