Volume 5, Issue 8, August 2015 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

A Novel Miniaturized, Multiband "F" Shape Fractal Antenna

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Abstract— The fractal structure has two properties i.e. self similarity and the space filling properties that makes it different from other patch antenna and lead to many improved parameters. The result of these properties are size reduction, multiband and enhanced gain of antenna etc. which has attracted the attention of researchers. This paper presents a new miniaturized "F" shape fractal antenna to achieve multiband characteristics using HFSS 13.0. .

Keywords— Fractal antenna, multiband characteristics, size reduction, HFSS.

I. INTRODUCTION

The modern wireless technology require antennas of smaller size and multiple bands to allow several frequency applications [1][2]. Fractal antennas are a viable solution to meet these requirements. Therefore several researches are taken up at various organizations to develop new fractal antennas [3]-[5]. The self similarity properties [6][7] of fractal geometry results in multiband characteristics. Whereas the space filling properties increase the electrical length; hence allow it to work at lower frequencies. The scaling of the geometry in the fractal structure is done using a scaling factor given by [8]:

$$\xi = \frac{h_n}{h_{n+1}} \quad (1)$$

Where ξ= Scaling factor of the geometry,
h= height of antenna,
n= whole number representing the number of iterations.

II. THE PROPOSED ANTENNA

The fractal geometry has been designed using an alphabet "F" by rotating with 900 anticlockwise. This Rotated F structure is used to form an antenna using scaling factor 0.5. The "F" shape is formed by using three rectangles. The generated "F" structure or 0th iteration is used as the building block for the successive iterations. The purpose of using "F" shape is to achieve multiband characteristics in the lower frequency region and also to control the characteristic gain of antenna with the selection of number of F shapes used. FR-4 epoxy substrate of relative permittivity (εr) 4.4 with a loss tangent 0.02 and thickness d = 1.5676 mm is used to design the antenna. Fig.1 shows the generation stages of the proposed antenna, where colour implies copper material and gray area represents slots.

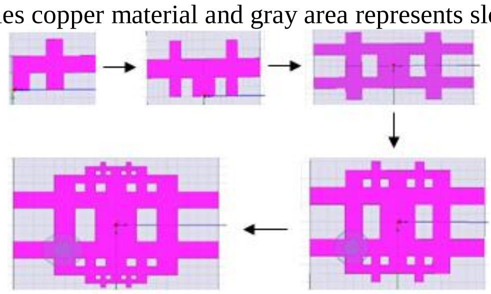

Fig.1Generation Stages for fractal antenna

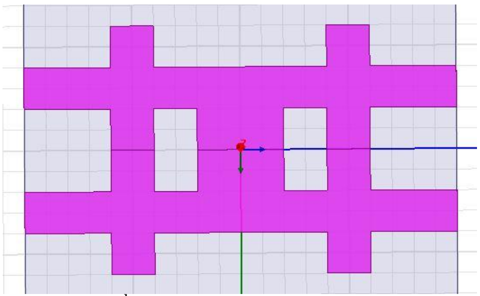

Fig.2 0th Iteration of Fractal Antenna

The overall dimensions of the antenna are L = 20 mm and W = 20 mm. The dimensions of F shape, L = 10mm and W = 6 mm, For 0th Iteration, L = 20mm and W = 6mm. which is scaled down by a factor 0.5 for first iteration i.e. L = 10 mm and W = 3 mm.

The coaxial probe SMA connector is used to feed the antenna at x = 3 mm & y = -5.2 mm. Fig. 3 depicts the first iteration of fractal antenna using FR4 epoxy substrate.

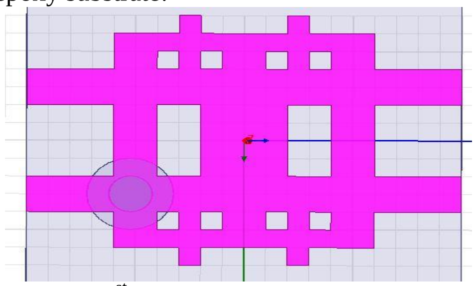

Fig. 3 1st Iteration of Fractal Antenna

III. RESULTS AND DISCUSSION

Ansoft HFSS simulator is used to simulate the antenna. Fig. 4 shows the simulated S11 result for 0th iteration of the proposed "F" shaped fractal antenna. The only resonant frequency is 6.7 GHz having reflection coefficient -17.57 dB.

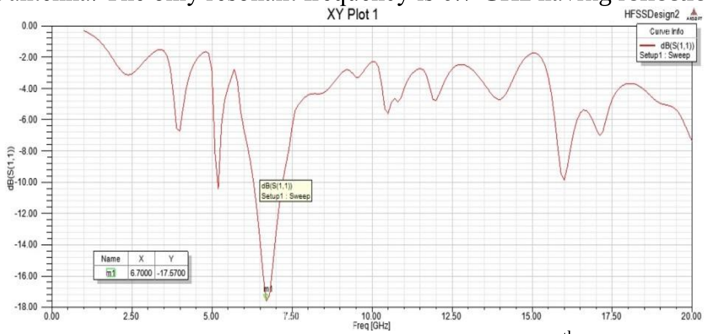

Fig. 4 Simulated Return Loss (S11 parameter) of 0th Iteration

The 0th iteration of proposed antenna has gain 4.68 dBi, at 6.7 GHz for ϕ= 00 as shown in the total radiation pattern Fig.5.Further fractal iterations would result resonance at multiple frequencies. Fig. 6 and 7 shows the simulated S11 and total gain for 1st iteration of the proposed "F" shaped fractal antenna. The four resonant frequencies are 4.3GHz, 4.8GHz, 6.8GHz and 16.2GHz having reflection coefficients -19.68 dB, -17.82dB, -18.44dB, -10.92dB and gain -1.20dBi, -1.21dBi, 0.45dBi, 4.77dBi respectively. Fig. 8 depicts the simulated S11 result for 2nd iteration. The four resonant frequencies obtained are 4.3GHz, 4.7GHz, 6.8GHz and 13.8GHz.

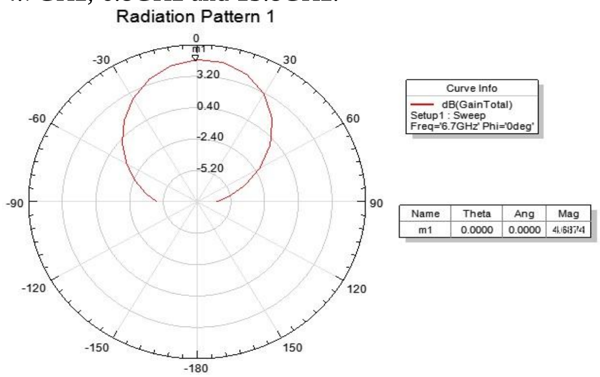

Fig. 5 Total Gain of proposed antenna for 0th Iteration

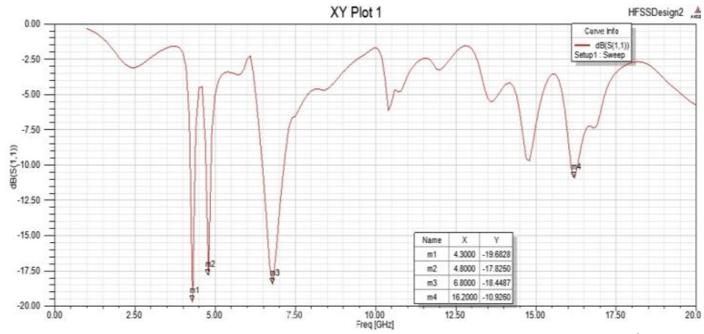

Fig. 6 Simulated Return Loss (S11) of proposed antenna for 1st Iteration

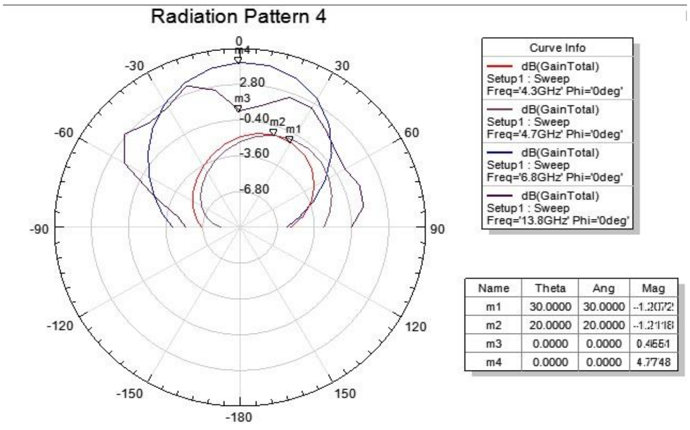

Fig. 7 Total Gain of proposed antenna for 1st Iteration

The antenna has 4.76dBi, 2.32dBi, -0.77dBi and -1.49dBi gains at 4.3 GHz, 4.7 GHz, 6.8 GHz and 13.8 GHz for ϕ= 00 respectively as shown in the Fig.9.

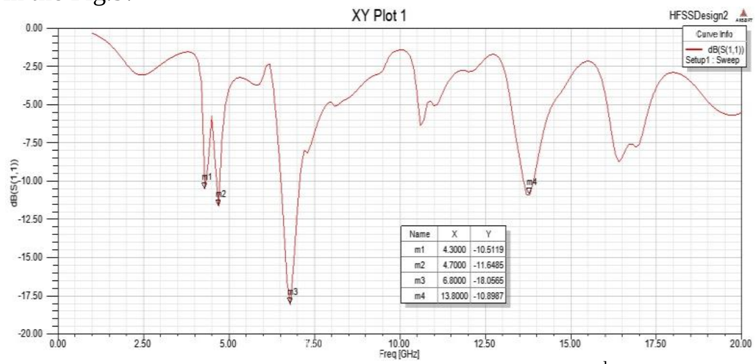

Fig. 8 Simulated Return Loss (S11 parameter) of 2nd Iteration

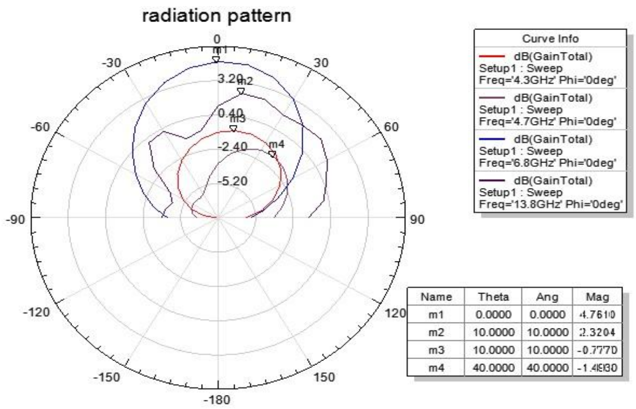

Fig. 9 Simulated Gain Total of the Proposed Antenna

Table 1 presents the return loss and gain at different resonant frequencies of the proposed antenna for 0th, 1st and 2nd iteration.

TABLE 1 RESONANT FREQUENCIES, S11 AND GAIN FOR 0TH, 1ST & 2ND ITERATION

Iteration No.	**Resonant Frequency (GHz)**	**S11 (dB)**	**Gain (dBi)**
0th	**6.7**	**-17.57**	**4.68**
1st	**4.3**	**-19.68**	**-1.20**
	4.8	**-17.82**	**-1.21**
	6.8	**-18.44**	**0.45**
	16.2	**-10.92**	**4.77**
2nd	**4.3**	**-10.51**	**4.76**
	4.7	**-11.64**	**2.32**
	6.8	**-18.05**	**-0.77**
	13.8	**-10.89**	**-1.49**

To analyse the impact of "F" shape, further simulations can be carried out.

IV. CONCLUSION

This paper describes a new "F" shaped miniaturized fractal antenna having multiband and high gain. The antenna is designed using HFSS 13.0. The selection of number of "F" shapes and their placement gives an extra freedom to play with the multiband characteristics and also in altering the gain. The presented antenna can be used in mobile, satellite and Radio location. Further changes in substrate material, feeding techniques and location of f in different style can lead to meet the requirements of various applications.

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