Design & Analysis of Multiband Fractal Antenna Based on the Koch Curve Geometry

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Abstract- **Fractals have very unique properties, therefore in recent years, antenna designers use fractal geometry for broad-band antennas designing.A fractal monopole antenna based on the Koch curve is studied in this paper. Modelling and simulation is performed via CST Microwave Studio electromagnetic simulator .The antenna has been fed with probe feed. This microstrip fractal antenna has been designed on substrate with dielectric constant £r= 4.3 and thickness h=1.6 mm. We got two resonant frequencies like 31.65 GHz &35.4 GHz which shows multiband characteristics. Simulated results indicates that the return loss is better than 10 dB, the VSWR is less than 1.3,the directivity is greater than 6dBi & the gain is more than 6dB in each band. So this fractal antenna can be suitable for the radio astronomy & space research applications.**

Keywords- Fractal, Koch curve, Self-similarity, Multiband, Wideband, probe feed .

1. INTRODUCTION

There has been an ever-growing demand, in All fields of communication applications for antenna design that possess the small size, ease of fabrication, conformal, low cost and multibandcapabilities [1]. Microstrip antenna is one of them to fulfill these requirements. The microstrip antenna is efficient radiator around half wavelength. As the size of the antenna becomes less than **λ/2**, the radiation of the antenna along with other antenna parameters deteriorates[2].

There are various approaches to reduce the size of the antenna without much affecting the antenna performance[9]. The application of the fractal geometry is one of the techniques to reduce the size of the antenna as well as to provide multiband properties [3].

Recently, the fractal engineering has attracted a lot of attention to the re searchers due to the major advantages like multiband performance, Wide band / Broadband application, Self similarity, Self filling, Frequency independent [4].

The term fractal which means broken or irregular fragments was originally coined by Mandelbrot in 1983 to describe a family of complex shapes that possesses inherent self-similarity or self-affinity in their geometrical structure [5].

The recent developments in the wireless technology functional at multiple frequency demands multiband or multifunctionalantennas with broader bandwidth. could be possible toachieve these objectives with the help of incorporation of fractal technology in microstrip antennas [7]. This paper presents the novel antenna design based on self similarity of fractal geometry to achieve the multiband as well as size reduction of the antenna[8].

2.ANTENNA DESIGN

This fractal antenna is an iterative model to a normal square loop with a generator of the shape shown in figure 1.

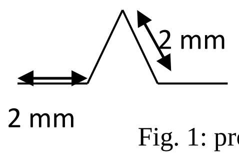

Fig. 1: proposed generator

Figure 2.a shows a normal wire square loop in which the length of each side is 6mm. By replacing each straight wire with the proposed generator shape, I get a new shape as shown in figure2.b.

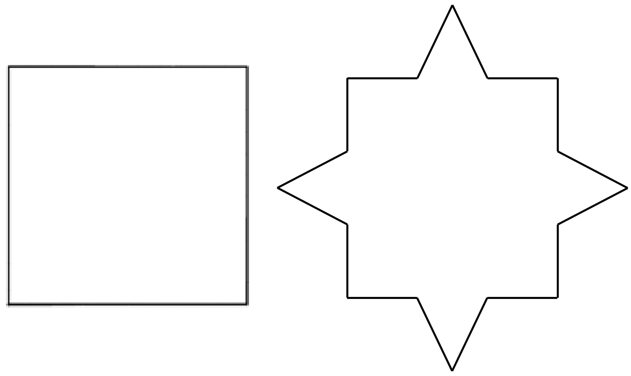

Fig. 2.a: Iteration 0 Fig. 2.b: Iteration 1

3.SIMULATION RESULTS

CST Microwave Studio electromagnetic simulator software is used for design & simulation.Antenna is fed with probe feed.Results like Reflection coefficient(return loss),VSWR(voltage standing wave ratio),Variation of Impedance Z(real & Imaginary part),2D radiation patterns,3D radiation patterns are simulated. Simulation results of iteration1 & iteration2 are summerised in table 1 & table 2respectively.

3.1 Simulated Results of Iteration 0

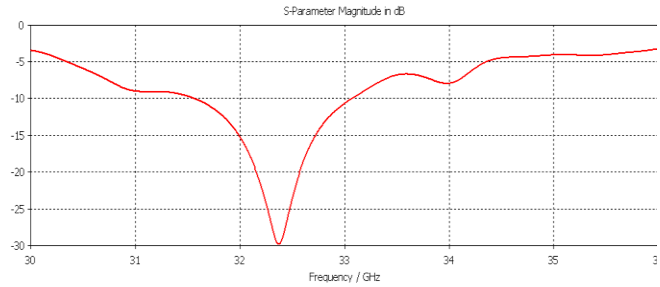

Fig.3.1:Variation of simulated reflection coefficient(S11)with frequency

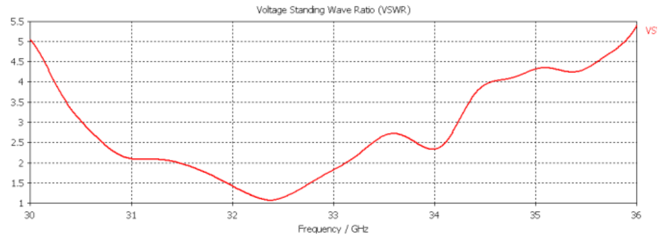

Fig.3.2: Variation of VSWR with frequency

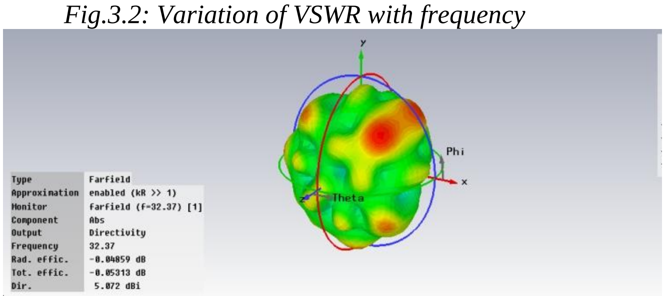

Fig.3.3: 3D Radiation pattern(Directivity) at Fr=32.37 GHz

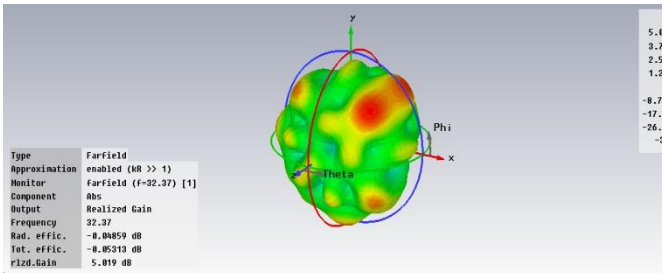

Fig .3.4: 3D Radiation pattern(Gain) at Fr=32.37 GHz

Table 1: The different results of iteration 0 are given below

fr (GHz)	RL (dB)	VSWR	Directivity (dBi)	Gain (dB)
32.37	-29.814	1.006	5.072	5.019

3.2 Simulated Results of Iteration 1

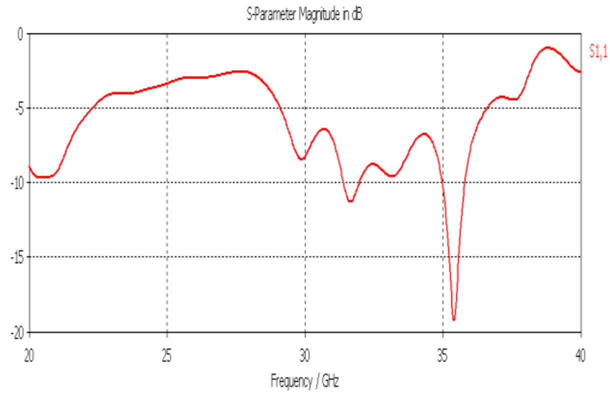

Fig.3.5: Variation of simulated reflection coefficient (S11) with frequency

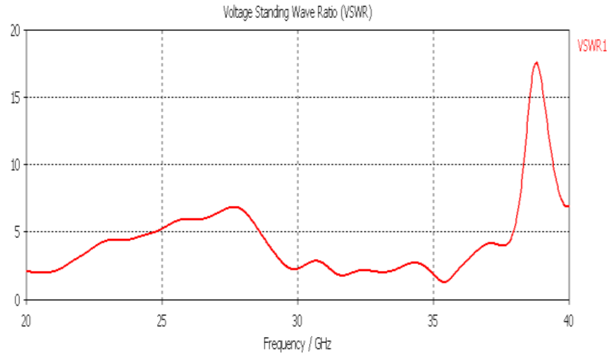

Fig.3.7: Variation of VSWR with frequency

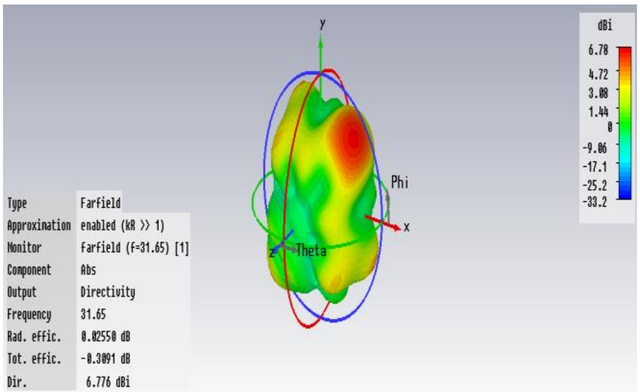

Fig 3.8: 3D Radiation pattern(Directivity) at Fr=31.65 GHz

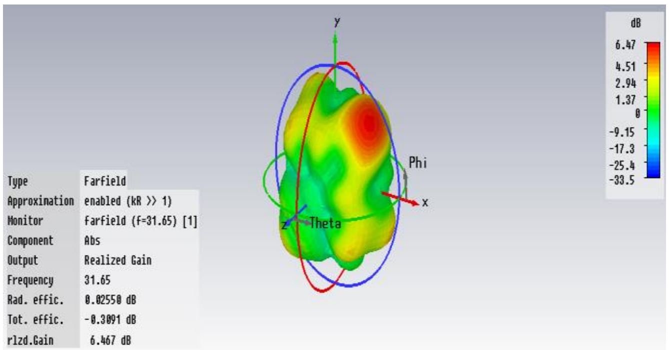

Fig 3.9: 3D Radiation pattern(Gain) at Fr=31.65 GHz

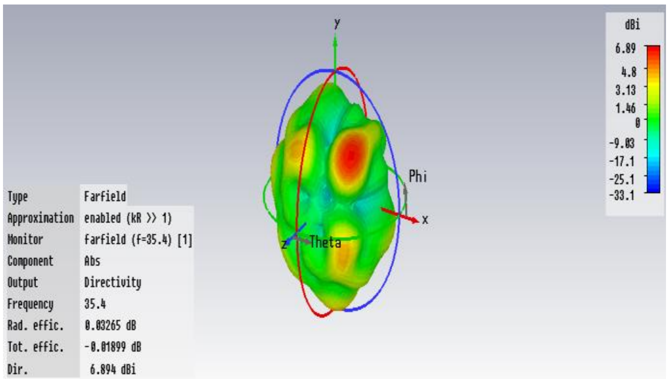

Fig 3.10: 3D Radiation pattern(Directivity) at Fr=35.4 GHz

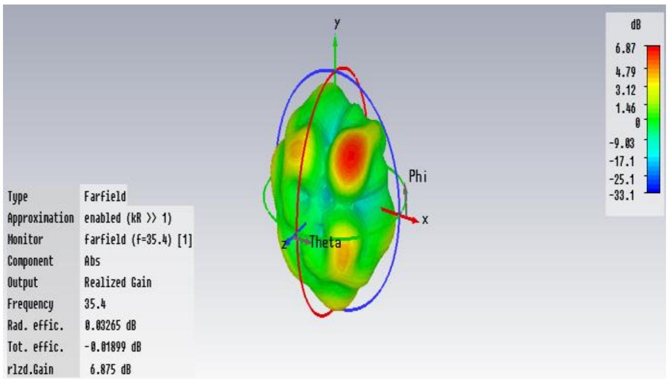

Fig 3.11: 3D Radiation pattern(Gain) at Fr=35.4 GHz

Table 2: The different results (3)are given below

fr (GHz)	RL (dB)	VSWR	Directivity (dBi)	Gain (dB)
31.65	-11.42	1.74	6.087	6.115
35.4	-19.27	1.24	6.894	6.875

Table 3:Comparision of different major parameters for multiple iterations

	0^{th} iteration	1^{st} iteration
Resonant freq.	32.37 GHz	31.65 GHz 35.4 GHz
Return loss	-29.814 dB	-11.42 dB -19.27 dB
VSWR	1.006	1.74 1.24
Directivity	5.072 dBi	6.087 dBi 6.894 dBi
Gain	5.019 dB	6.115 dB 6.875 dB
Presence of multiband	Nil	Yes

4. CONCLUSION

It is concluded that incorporation of fractal geometry in conventional antenna reduces the size of antenna by shifting the first resonant frequency towards lower side.
Main parameters such as the return loss, VSWR, and far-field characteristics at operating bands have been studied. The radiation pattern is isotropic like. Therefore, the proposed antenna has satisfactory characteristics for use as a broadband communication antenna.
Due to the better simulation results as indexed in the table 3, the proposed antenna can be suggested for the radio astronomy & space research applications.

5. ACKNOWLEDGEMENT

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