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Microcontroller shaped fractal Antenna using IE3D

Shweta Goyal, Yogendra Kumar Katiyar

***Abstract*— This paper describes the design of self similar microcontroller shape fractal patch antenna using IE3D electromagnetic simulation. Fractal geometry is a methodology through which size reduction is achieved. The fractal geometry generates multiple or enhancing bandwidth[5]. This paper describes the simulation of three iterations of antennas and performs the characteristics of these antennas. In this paper we designed on substrate with ϵ_r=4.4 & h=1.6mm.**

***Index Terms*— fractal, ie3d,microcontroller shape.**

I. INTRODUCTION

An antenna is an device which converts electric power into the radio waves, and its vice versa. Antennas are usually used with a radio transmitter or radio receiver. In the, recent telecommunication systems require antenna with wider bandwidth and with smaller dimension than formally possible antennas. This has initiated antenna research in various directions, one of which is by using fractal shaped antenna elements. Fractal geometry is used to reduce the size of patch antenna as they are self similar designs[1]. There is significant relation between antenna dimension and wavelength.

The aforesaid relation tells that if antenna size is less than $\lambda/4$ then antenna is not high-octane because radiation resistance, gain and bandwidth is reduced and to get overcome from these limitations the antenna size is increased, which again is a problem for hand held devices. Fractal geometry is a very good solution for this problem. A fractal is a recursively generated object having a fractional dimension. Now a day's, the geometrical properties of self-similar and space filling nature has prompted antenna design engineers to adopt the geometries a viable alternative to meet the target of multiband operation. The aforesaid structures that are analyzed as antenna are not the ones that we prevailed after infinite iteration but those after finite iterations as desired by the designer. The use of fractal antennas for multiband antennas is discussed in [3,4,5].Most of the fractal design have the following characterstics:infinite complexity, fractional dimension, self-similarity and space filling. These characteristics of fractal antennas can be utilized in antenna design to achieve the following advantages: miniaturization, multiband/wideband antennas and better efficiency[2,6]. In this paper microcontroller shape fractal patch antenna is presented. In this work, for the designing of microcontroller shape fractal patch antenna, rectangular patch is taken of the size of length and width 7mm & 9.8mm respectively. Microcontroller shape patch has taken inside the geometry and the other parts are removed from the geometry. In this paper we designed on substrate with ϵ_r=4.4 & h=1.6mm and loss tangent=0.02[3].

Shweta Goyal, M.tech Scholar, Regional College for Education research & Technology

Yogendra Kumar Katiyar, Associate Professor, Regional College for Education research & Technology

II. ANTENNA DESIGN

Size reduction is one of the vital advantages of fractal antenna [7,8]. Minkowski fractal geometry algorithm is used as shown in figure 1.

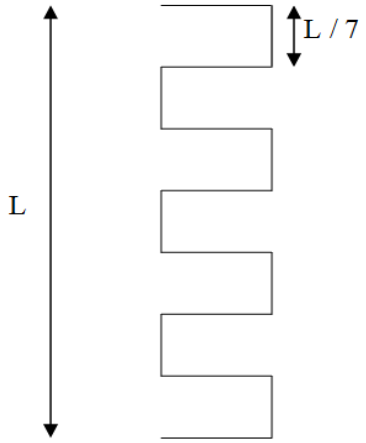

Fig 1:Minkowski fractal geometry

Minkowski algorithm has been applied to the rectangle as shown in figure 2. By dividing length into 7 parts and removing three squares from right side of the patch, this microcontroller Shape patch is formed. By applying further iterations self similar structures can be made. Initially rectangle patch is taken having dimensions of 7 mm by 9.8 mm using FR-4 as substrate of thickness 1.6 mm as shown in table 1. By applying different iterations of fractal geometry self-similar structures as shown in figure 3 and 4 are obtained.

Table I Antenna dimensions

Parameter	Value
Length of patch	7mm
Width of patch	9.8mm
Thickness of substrate	1.6mm
Dielectric constant of substrate	4.4
Loss tangent of substrate	0.02
Feed to patch	Coaxial feed

The rectangular patch having dimension 7 mm by 9.8 mm is taken as shown in figure 2 and coaxial feed has been given. Feed point has been chosen in such a way that impedance matching take place at that point.

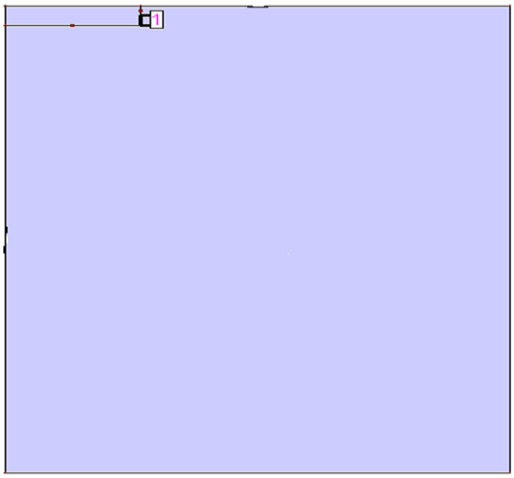

Figure 2: Basic Rectangular Geometry

Now patch as shown in figure 3 can be obtained by using concept of fractal geometry. Vertical length of 9.8 mm is divided into 7 parts, each of length 1.4 mm. Square cuts of 1.4 mm length to right sides and left sides of the rectangle shown in figure 3.

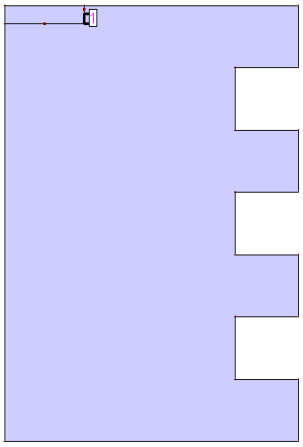

Fig 3

Similarly, same algorithm is applied to obtain the next iteration. Two squares of 1 mm on the remaining three parts of the both side patch are removed. Feed point is being taken as x= -1.5, y= 4.6 and z=0. The results so obtained are self similar in shape as shown in figure 4. From figure 4, it is obvious that the shape repeats itself[9].

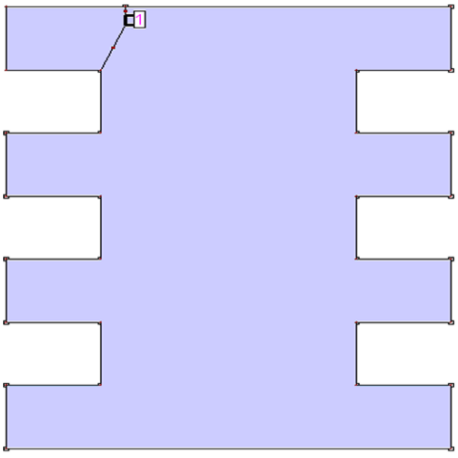

Figure 4

III. Results and Discussion

Fractal geometry consists of self-similar structures. Generally the utilization of fractal geometries in antenna tends to miniaturize their physical sizes and produce multiband response in their resonating characteristics [4]. FR-4 has been used as substrate with a thickness 1.6 mm. By taking rectangle patch dimension of 7 mm by 9.8 mm antenna resonates at 8.77 GHz, 12.24 GHz and 13.35 GHz with return loss of -16.66 dB,-8.24 dB and -14.84 dB respectively. Different iterations of fractal geometries have been applied one by one on rectangle patch and results are analyzed as shown in table 2. Various figures 5,6,7,8,9,10 shows return loss Vs frequency graphs and radiation patterns for different fractal iterations.

Table II Comparisons of results of different iterations

Iteration no	Resonant freq. (Ghz)	Return Loss (dB)	VSWR
Base iteration	8.75	-16.66	1.345
	13.35	-14.84	1.442
1st iteration	12.43	-29.5	1.069
2nd iteration	12.43	-18.17	1.28
	14.63	-14.58	1.45

In first iteration, two squares of length 1.4 mm have been cut to form E-Shape patch which was shown in figure 3. This cause antenna to resonates at 8.94 GHz with -9.37 dB return loss and at 12.43 GHz with -29.5 dB. In the 2nd iteration of E-Shape patch, two squares of length 1.4 mm have been cut out from the left side to the E-Shape patch as shown in figure 4.

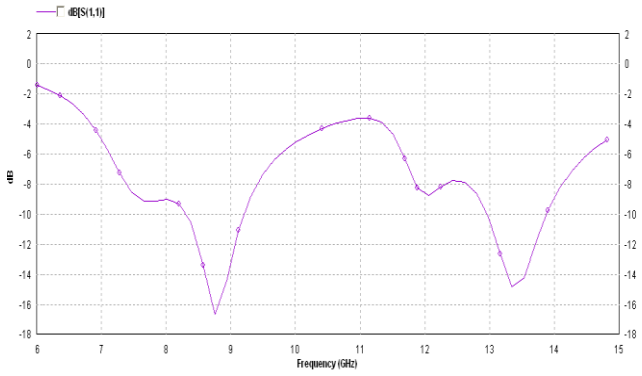

Fig 5. Base iteration

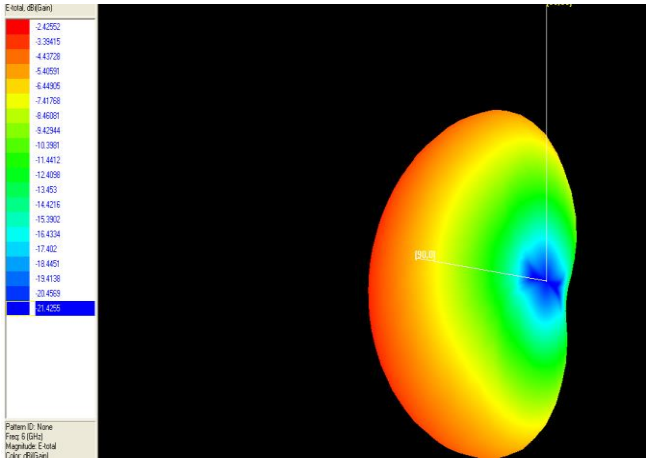

Fig 6. Radiation pattern of base iteration

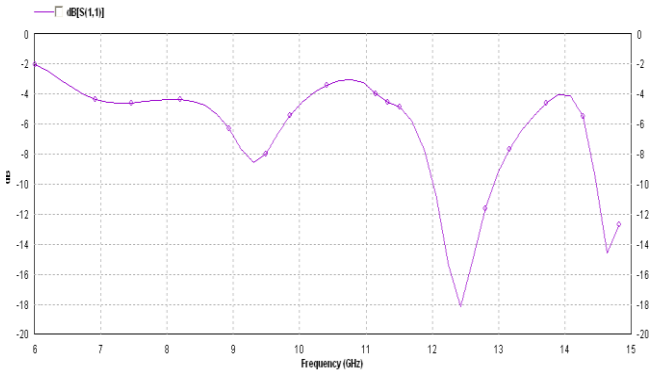

Fig 7. First iteration

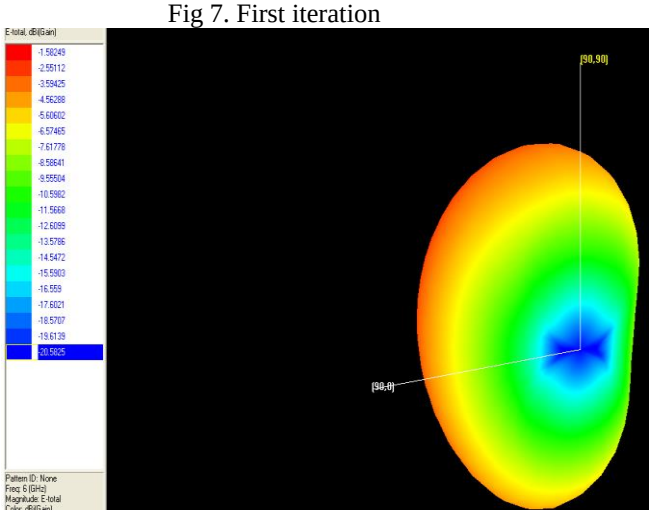

Fig 8. Radiation pattern of First Iteration

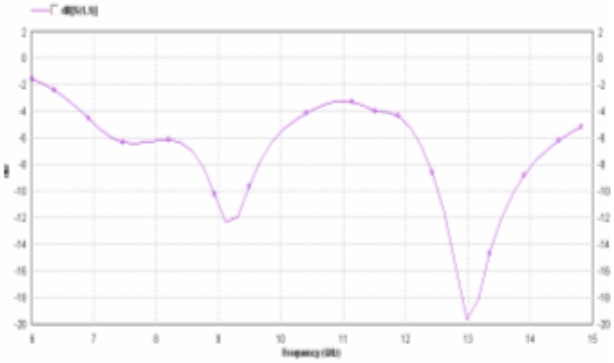

Fig 9. Second iteration

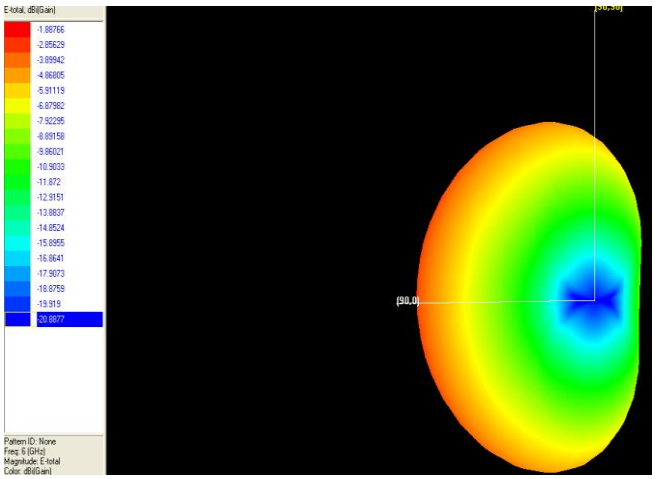

Fig 10. Radiation pattern of Second Iteration

IV. Conclusion

Microcontroller shaped fractal antenna can be used for X and Ku frequency band, in satellite communication, mobile communication, TV, police radar and broadcasting satellite service. This work can be extended if we apply more iterations on microcontroller fractal antenna so that the size of antenna can be reduced.

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