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Comparison Of E-Shape Microstrip Antenna And E-Shape Fractal Antenna

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Abstract

In this paper, simple E-shape microstrip antenna is presented. Further by introducing fractal concept to the E-shaped microstrip antenna, bandwidth enhancement, multiband operation, self similarity, space filling properties are obtained. A comparison of fractal antenna with conventional microstrip patch antenna is made regarding the bandwidth, radiation pattern, return loss, VSWR, and gain. Ansoft HFSS 11 is used to simulate the fractal antenna and microstrip patch antenna.

Keywords

E-*shaped Fractal, patch antenna, wideband antenna, multiband operation, self-similar structures.*

1. Introduction

The increasing range of wireless telecommunication services and related applications is driving the attention to the design of multifrequency (multiservice) and small antennas. The telecom operators and equipment manufacturers can produce variety of communications systems, like cellular communications, global positioning, satellite communications, and others, each one of this systems operates at several frequency bands. To give service to the users, each system needs to have an antenna that has to work in the frequency band employed for the specific system. The tendency during last year's had been to use one antenna for each system, but this solution is inefficient in terms of space usage, and it is very expensive. The variety of communication systems suggests that there is a need for multiband antennas. The use of fractal geometry is a new solution to the design of multiband antennas and arrays. Fractal geometries have found an intricate place in science as a representation of some of the unique geometrical features occurring in nature.

Fractal was first defined by Benoit Mandelbrot [5] in 1975 as a way of classifying structures whose dimensions were not whole numbers. These geometries have been used previously to characterized unique occurrences in nature that were difficult to define with Euclidean geometries, including the length of coastlines, the density of clouds, and branching of trees [5]. Fractals can be divided into many types; various types of fractal geometries are shown in Figure 1. The purpose of this article is to introduce the concept of the fractal, review the progress in fractal antenna study and implementation of fractal antenna and compare with microstrip patch antenna.

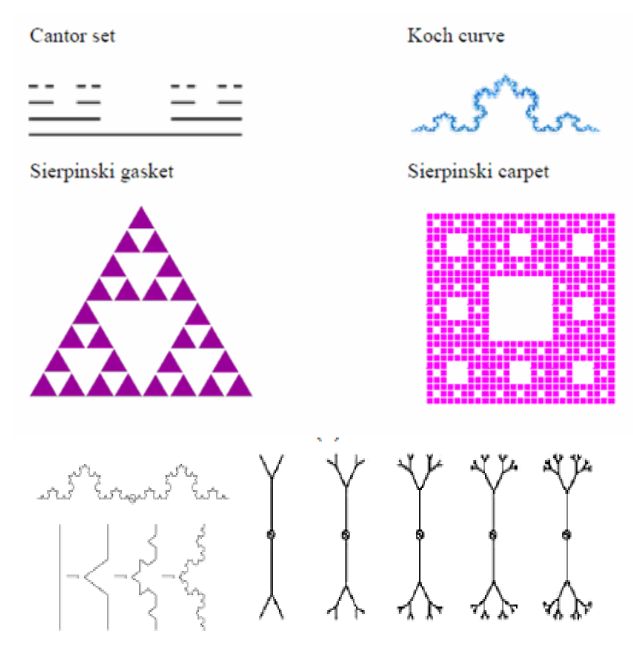
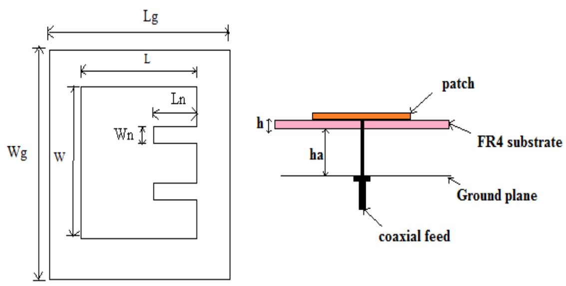


Figure 1. Various types of fractal geometry

2. Antenna design specifications



(a) (b)

Figure 2. (a) E-shape microstrip patch antenna top view, (b) side view

The E-shape microstrip patch antenna is constructed on grounded two layers of dielectric sheets (air and FR4), and a vertical probe connected from ground to the upper patch. The FR4 substrate with relative dielectric constant of 4.2, thickness of h=1.59 mm, and loss tangent=0.02. An air-filled layer with dielectric permittivity of 1 and thickness of 5mm is sandwiched between the substrate and the ground plane. The slots having dimensions of length Ln and width Wn, where n is number of iteration are cut from the rectangle. At first iteration two parallel slots having length L_1=50mm and width W_1=15mm are cut from main rectangle. The dimensions for E shape microstrip patch are listed in Table 1.

Table 1. Dimensions of E shape microstrip patch antenna

Sr.No.	Layer	Width (mm)	Length (mm)	Height (mm)
1	Ground	180	160	-
2	FR4 substrate	180	160	1.59
3	Patch	150	130	-

4. Results and discussion

4.1. E-shape microstrip patch antenna

The figure 3. shows the HFSS generated design of E shape microstrip patch antenna. The return loss and VSWR are computed using Ansoft HFSS11. As per the theory voltage wave standing ratio should be ≤ 2. Ideally it should be 1.VSWR bandwidth is taken at 2 i.e. the 11% reflected power or -10dB return loss. The simulated return loss and VSWR is shown in Figure 4. and Figure 5.The gain of antenna at 900MHz is 1.9dB and 3-4dB over 1.8GHz. The radiation efficiency is about 95% for both bands.

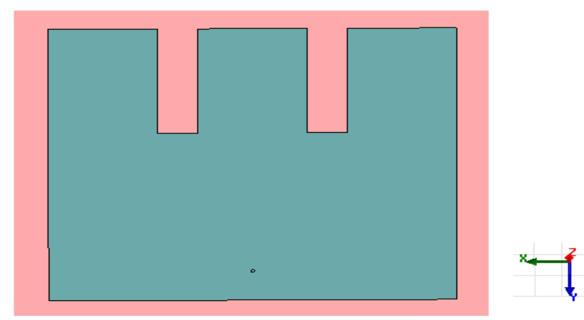


Figure 3. Ansoft HFSS11 generated E-shape microstrip patch antenna

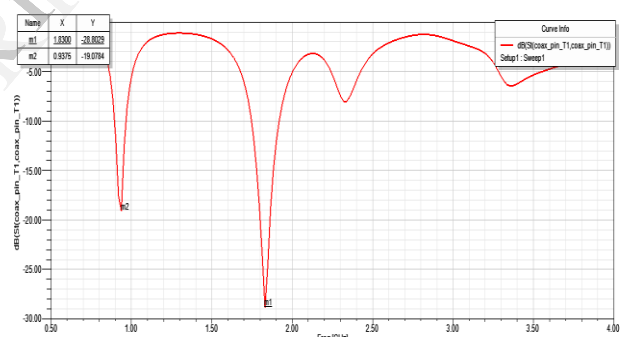


Figure 4. Simulated return loss for E-shape microstrip patch antenna.

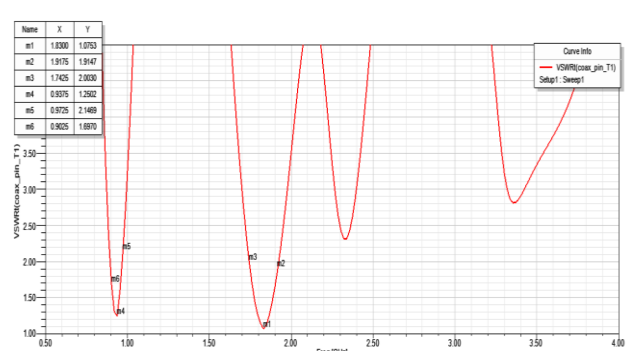


Figure 5. Simulated VSWR for E-shape microstrip patch antenna

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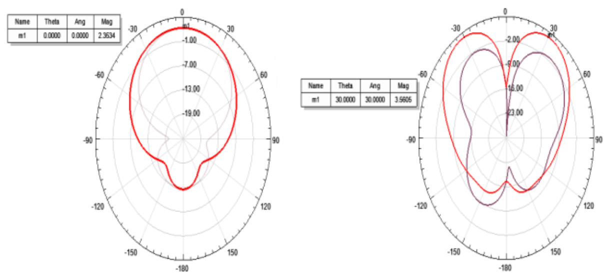

(a) (b)

Figure 6. Simulated radiation pattern for E-shape microstrip patch antenna (a) at 900 MHz, (b) at 1.8 GHz

4.2. E-shape microstrip patch antenna with fractal geometry

This proposed fractal E-shape antenna is obtained by subtracting pair of smaller rectangles from E-shape microstrip patch antenna, then the procedure iterates. This iterative procedure itself proceeds, forming the novel fractal E-shape geometry as shown in Figure 7.

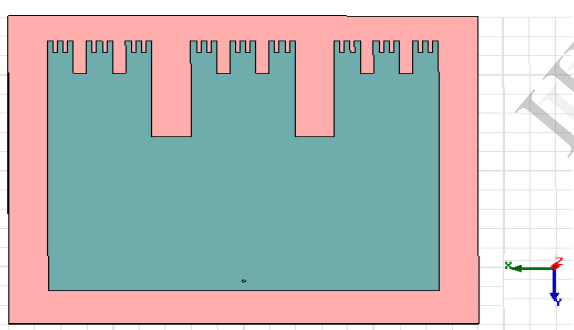

Figure 7. Ansoft HFSS11 generated E-shape fractal antenna

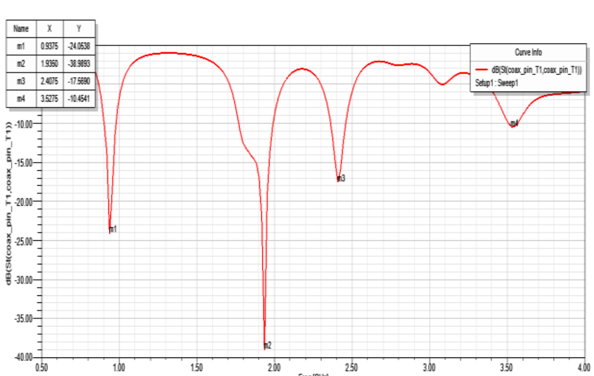

Figure 8. Simulated return loss for E-shape fractal antenna.

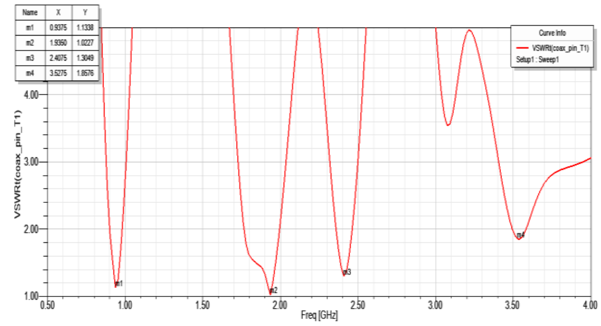

Figure 9. Simulated VSWR for E-shape fractal antenna

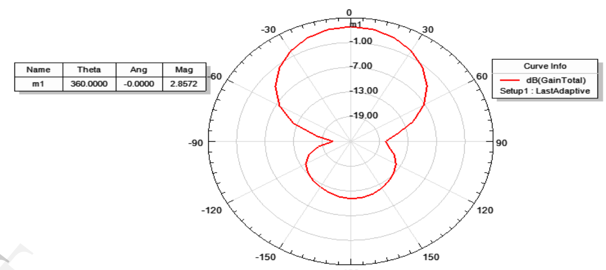

Figure 10. Simulated radiation pattern for E-shape fractal antenna at 937 MHz

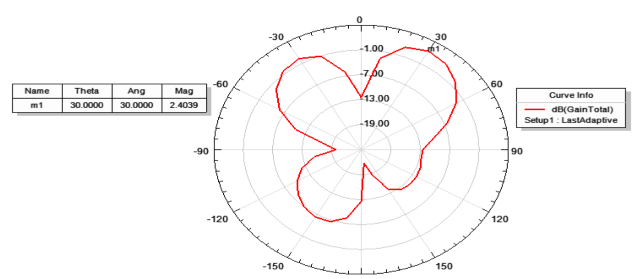

Figure 11. Simulated radiation pattern for E-shape fractal antenna at 1.93 GHz

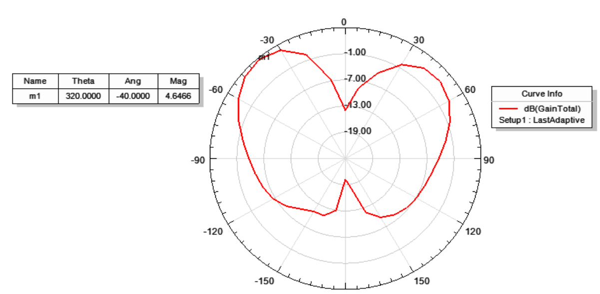

Figure 12. Simulated radiation pattern for E-shape fractal antenna at 2.4 GHz

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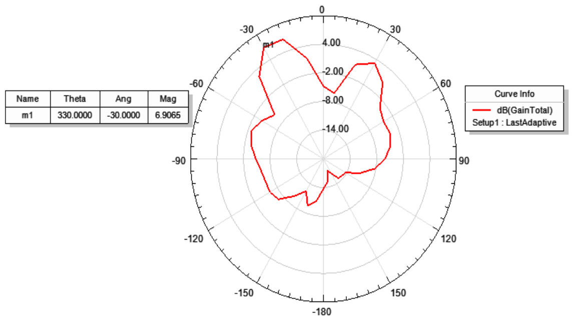

Figure 13. Simulated radiation pattern for E-shape fractal antenna at 3.52 GHz

Table 2. Comparative results of E-shape microstrip patch antenna and E-shape fractal antenna

Parameters	E-shape microstrip antenna		E-shape fractal antenna			
Resonating frequency (GHz)	0.9	1.8	0.937	1.93	2.4	3.52
Return loss(dB)	-19	-28	-24.7	-28	-17	-10.6
VSWR	1.2	1.07	1.12	1.07	1.3	1.79
Bandwidth(MHz)	70	175	80	228	100	75
Gain(dB)	2.5	3.75	2.85	2.40	4.6	6.90

5. Conclusion

Thus from this study it is analysed that Fractal antennas are multi-resonant and smaller in size. Qualitatively, multi-band characteristics have been associated with the self-similarity of the geometry and Hausdorff dimensions are associated with size. The proposed E-shape fractal antenna resonates at 937MHz, 1.93GHz,2.4GHz,and 3.52GHz, to cover GSM850/900, GSM1800/1900/UMTS,Bluetooth,WiMax applications respectively. Because of fractal geometry bandwidth will get enhanced. The multiband and wideband operation further can be achieved by increasing number of fractal iterations.

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