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A Design of Crown-Shape Fractal Patch Antenna

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Abstract*-In this paper, a novel design of crown Fractal Patch Antenna is presented. It is a compact design of 20×20 mm^2 area on FR_4 substrate with dielectric constant of 4.4, thickness of 1.6 mm and fed by a coaxial feed technique. Micros trip patch antenna consists of a fractal patch with crown- shaped meandered lines to provide multi band operations. The proposed antenna resonates at four different frequencies 10.6GHz,8.4GHz,10.1GHz and 11.3GHz with high return loss of -46dB,-17 dB ,-17dB and -29dB respectively with satisfactory radiation properties. The antenna operated in X- band, viz. 9.95-10.99 GHz with percentage band width of 9.9% at8.26-8.68 GHz with percentage bandwidth of 5%, at 9.44-10.35 GHz with percentage bandwidth of 9%, and 11.02-11.55 GHz with percentage bandwidth of 5% .The parameters that affect the performance of the antenna in terms of its frequency domain characteristics are investigated. The antenna design has been simulated on HFSS; an electromagnetic (EM) simulation software tool.This antenna is good for satellite, radar and wireless applications.

Keywords—**Fractal antenna, X- band, HFSS, Return loss.**

I. INTRODUCTION

Fractal crown-shaped antennas exhibit some interesting features that stem from their inherent geometrical properties. The self-similarity of certain fractal structures results in a multiband behaviour of self-similar fractal antennas and frequency-selective surfaces (FSS) [1-3].The interaction of electromagnetic waves with fractal bodies has been the study of many researchers in the recent years [4]. The word "Fractal" is outcome of Latin word "fractus"which means linguistically "broken" or "fractured". Benoit Mandelbrot, a French mathematician, introduced the term about 20 years ago in his book "The fractal geometry of Nature" [5].The term fractal was coined by Mandelbrot in 1975, but many types of fractal shapes have been proposed long before. Fractals are generally self-similar and independent of scale [6].Micro strip patch Antennas are very popular in many fields as they are low-profile, low weight, robust and cheap. In last year's new techniques employing fractal geometries are studied and developed [7].One of them is the fractalizing of antennas boundary where new qualitative effect as the higher mode localization appears that result in directive radiation patterns [7]. In this paper, we propose a novel space filling q fractal crown- shaped meandered patch antenna to reduce the size of micro strip patch antenna. The original meander is constructed by removing a strip of constant width and length from central main rectangle. The proposed antenna is designed and simulated using HFSS Software. The fractal Antenna is advantageous in generating multiple resonances.

II.PROPOSED ANTENNA DESIGN

In this paper, the performance of space-filling crown–shaped meandered fractal lines on coaxial fed patch antennas has been investigated till third order. It maybe contended that the bends and corners of these geometries would add to the radiation efficiency of the antenna, thereby improving its gain.[7] Advantage of these configurations is that they lead to multiband conformal antennas[6].The proposed antenna is designed on Fr_4 epoxy substrate having the dielectric constant of 4.4 and 0.02 loss tangent. In the design of this type of antennas, the width 'W' and length 'L' of base shape (zero order) patch play a crucial role in determining the resonant frequency. Here for the zero order or base shape the length of rectangular patch is taken as l=20mm and width as w=20mm. The designed value of the antenna is optimized with HFSS tool. The first order design is created from first iteration by removal of two "L" shaped slots placed as shown in the figure 2. In next second iteration to create order shape we will repeat this process and increase one "L" shaped strip inside first and in second order increase one more than first order. A ground plane of copper is printed on the back of the substrate as a ground plane for the probe feed line technique .Figure 1 shows the base shape of proposed antenna of dimension 20*20$mm^2$and figure2 shows the first order shape after cutting the crown-shaped meanders of dimension 14.14*14.14mm^2 and 10.25*10.25mm^2.

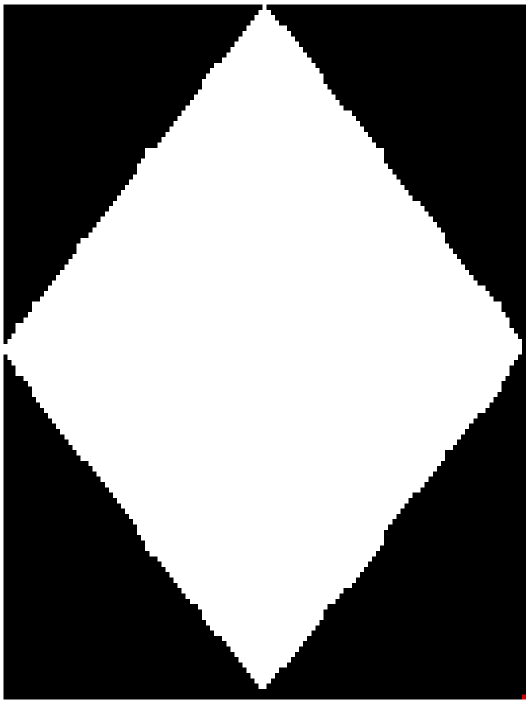

Fig. 1:-Base Shape of Crown-Shaped Meandered Fractal Antenna (L=20mm, W=20mm)

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The main advantages of the proposed antenna are: (1) compact size, (2) multibandcharacteristics (3) size reduction.

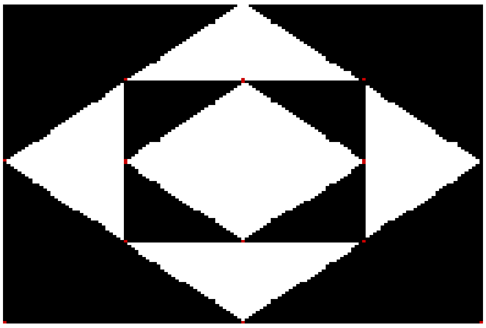

Fig. 2:- First Order Shape of Crown-Shaped Fractal Antenna

Here the size of the antenna will be depending on the resonant frequency which will be reducing as we keep on iterating the first order design. The correct resonant frequencies and impedance matching of the proposed antenna can be established by adjusting the location of feed point and the distance between the crown- shaped meandered portions.

III RESULTS AND DISCUSSION

The results for the two iterations performed on the rectangular patch to get the desired crown- shaped meandered quasifractal antenna are as follows:

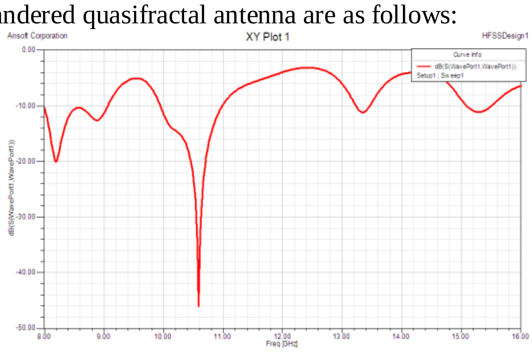

Fig. 3:- Return Loss for Base Shape

Fig.5 shows that the antenna resonates at 5.4 GHz with return loss of -14.38 dB. This design can be used in IEEE 802.11a Wireless LAN application and in C band applications.

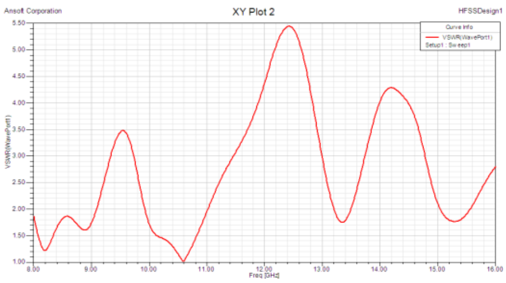

Fig. 4:- VSWR of Base Shape

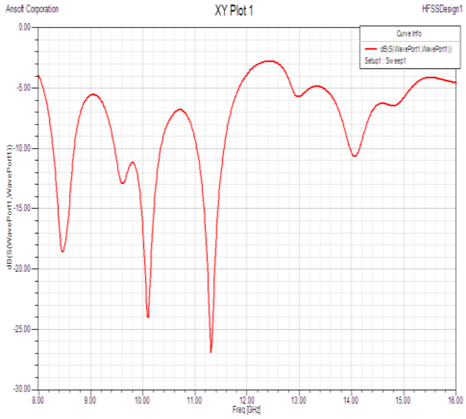

Fig. 5:- Return Loss of First Order

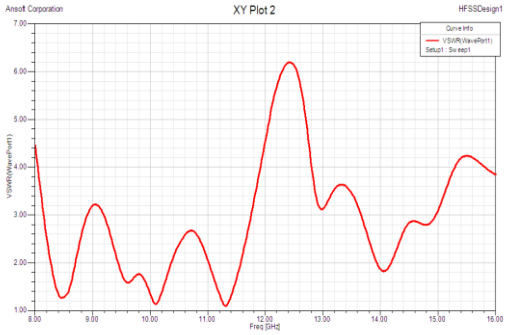

Fig. 6:- VSWR of First Order

For base order there are one bands occurring with resonance frequency at 10.6 GHz. For first iteration three bands are occurs at resonance frequency of 8.4 GHz, 10.1 GHz and 11.3 GHz. The proposed antenna resonates at four different frequencies 10.6GHz, 8.4GHz, 10.1GHz and 11.3GHz with high return loss of -46dB, -17 dB,-17dB and -29dB respectively with satisfactory radiation properties The antenna operated in X- band, viz. 9.95-10.99 GHz with percentage bandwidth of 9.9% at 8.26-8.68 GHz with percentage bandwidth of 5%, at 9.44-10.35 GHz with percentage bandwidth of 9%, and 11.02-11.55 GHz with percentage bandwidth of 5%. Frequency detail table we see that the antenna gives the gain of 3.23dBi with directivity of 7.202dBi. A Comparative table for all the iterations is given in appendix-I for detailed performance evaluation of the proposed design.

IV. CONCLUSION

In this paper, the crown-shaped meandered fractal antenna up to third order has been designed & simulated using the HFSS. It has been observed that with the increase in number of orders the band-width of the antenna, VSWR and return loss also increased. In first order, antenna is showing multiband results at higher bandwidth and maximum return loss.The self-similarity properties of the fractal shape are translated into its multiband behaviour. The simulation shows a size reduction is achieved by the proposed fractal antenna,

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without degrading the antenna performance, such as return loss and radiation pattern due to the crown shaped which have increased the length of the current path.

REFEREENCES

[1] C. Puente, J. Romeu, R. Pous, and A. Cardama, "On the behaviour of the Sierpinski multiband antenna," IEEE Truns. Antennas Propagation. Vol. 46, pp. 5 17-524, Apr. 1998.

[2] J. Solcrand J. Romeu, "Generalized Sierpinskifractal antenna," IEEE Truw. AntennusPrapugution., Vol. 49, pp. 1237-1234, Aug. 2001.

[3] J. Romeu and Y. Rahmat-Samii, "Fractal FSS: A novel multiband frequency selective surface,"lEEETrans.Antennas Propagation., Vol. 48, pp. 7 13-7 19, July 2000.

[4] Carles Puente-Baliarda et al, "On the behaviour of the Sierpinski Multiband Fractal Antenna", IEEE Transactions on Antennas and Propagation, 1998, Vol.46, No.4, pp.517-523.

[5] Mandelbrot, B.B. (1983): The Fractal Geometry of Nature. W.H. Freeman and Company, New York.

[6] M. R Haji-Hashed , H. AbiriA ,"Comparative Study of some Space-Filling Micro strip Patch antennas" IEEE International Workshop on Antenna Technology 2005,pp.274-277.

[7] M. R. Haji-Hashemi, H. Mir-Mohammad Sadeghi, and V. M. Moghtadai"Space-filling Patch Antennas with CPW Feed" Progress In Electromagnetic Research Symposium 2006, Cambridge, USA, March 26-29, pp. 69-70.

[8] P. Dehkhoda*, A. TavakoliA Crown Square Micro strip Fractal Antenna 0-7803-8302- 8/04/$20.00 2004 IEEE 2396.

APPENDIX

Comparative Table of Crown- Shaped Fractal Patch Antenna

S. No.	Shape	Resonant Freq. (GHz)	Return Loss	Bandwidth	VSWR
1.	Base Shape	F_{r1} =10.6 GHz	-46db	9.9%	1
2. 1st Iteration		Fr_1 =8.4 GHz	-17db	5%	1.2
		F_{r2} = 10.1GHz	-24db	9%	1.1
		F_{r3} = 11.3GHz	-29db	4.6%	1.1