Compact Fractal Boundary Microstrip Antenna for RF Applications

P.Nageswara Rao and N V S N Sarma
National Institute of Technology, Warangal, India
nrraop@yahoo.com and sarma@nitw.ac.in

Abstract : *A compact linearly polarized fractal boundary microstrip antenna is presented. There is a reduction of resonance frequency from 2525 MHz to 1896 MHz i.e around 25 % with the proposed antenna compared to the square patch of the same size. The antenna provides gain of about 4.9dBi over the entire band of frequencies. By changing the indentation depth factor of the boundary of the fractal curve, it is also possible to control the resonance frequency effectively.*

I. Introduction

Compact and multiband antennas are required in satellite and mobile communications. Fractals are used in the design of microstrip antennas for multiband operation and miniaturization [1]. The behavior of Koch island fractal boundary antennas with different iterations is presented [2] and the concept of Koch curve is used in the design of dipoles with different indentation angles is described in [3]. The effect of indentation angle on the performance of microstrip antenna is presented in [5] and the behavior of square patch with Koch curve as boundary is presented in [4]. In the present paper the concept of increasing electrical length using Minkowski fractal curve with thickness of 1mm as boundary for the square patch is considered mainly aiming for compact size.

II. Antenna Geometry

The proposed fractal antenna can be obtained by replacing the boundary of square patch with the minkowski fractal strip of width 1mm. The generation of the fractal curve is shown in fig. 1

When all the Euclidean boundaries of the square patch are replaced by Minkowski fractal curve as shown in the fig 1 with different indentation depths, the proposed antennas can be obtained. The geometries of the antennas are shown in fig 2. All the antennas shown in the fig are of size 36.4 mm from end to end.

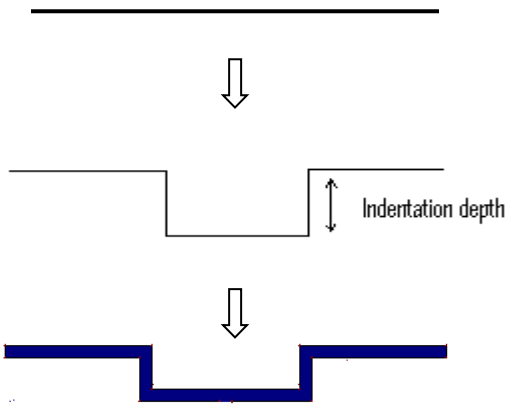

Fig 1: The generation of fractal curve

III. Results and discussion

The antennas shown are simulated using Zeland IE3D electromagnetic simulator with RT Duroid as substrate of thickness 3.2 mm and relative permittivity of 2.33. As can be seen from the fig 3 as the indentation depth factor of the given Minkowski curve which is used as boundary is changed, the resonance frequency is shifted left towards the origin. It is because of increase of electrical length. The electrical length can be systematically controlled by changing the indentation depth factor of the curve as shown in fig 1. This control of resonance frequency is very useful in obtaining circular polarization. By using this fractal curve as boundary for the square patches it is not only possible to design compact antenna but also operate at multiple bands. Table-I gives the resonance frequency of the proposed antenna for different cases. If a simple square patch of size 36.4mm X 36.4 mm is used, then the antenna operates at 2525 MHz where as the proposed antenna with indentation depth factor of 0.5 operates at 1896 MHz i.e. a reduction in size to an extent of about 50 % is possible.

978-1-4244-2315-6/08/$25.00 ©2008 IEEE.

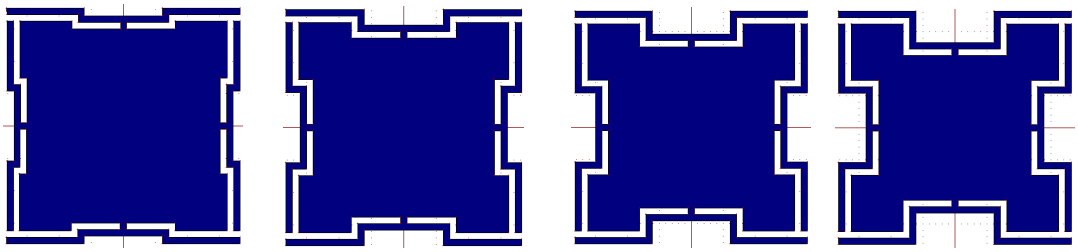

Fig 2: Geometry of the proposed fractal boundary microstrip antenna with indentation depth factors (a) 0.1 (b) 0.2 (c) 0.3 (d) 0.4

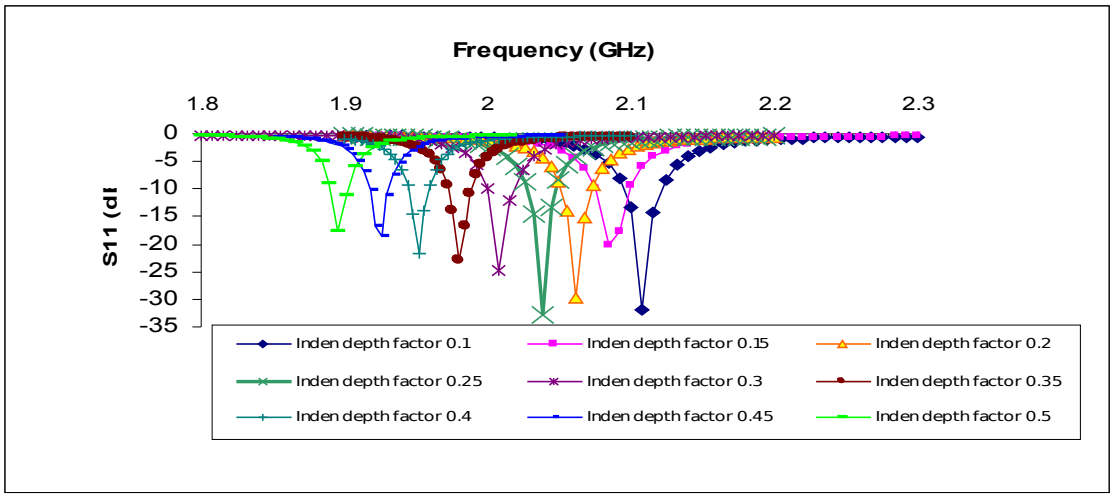

Fig 3 : S11 characteristics of the proposed fractal boundary antenna for different indentation Depth factors

Table I : Resonance frequencies of the proposed antenna for different Indentation depth factors

Antenna	Indentation depth factor	fo(MHz)
Antenna1	0.10	2108
Antenna 2	0.15	2084
Antenna 3	0.20	2062
Antenna 4	0.25	2038
Antenna 5	0.30	2008
Antenna 6	0.35	1980
Antenna 7	0.40	1952
Antenna 8	0.45	1926
Antenna 9	0.5	1896

Conclusion: A Minkowski fractal strip boundary linearly polarized microstrip antenna with different indentation depth factors is presented. It is demonstrated that the resonance frequency can be systematically controlled by changing the boundary indentation depth factor. The resonance frequency is varied by more than 25 % when the boundary is replaced by the fractal curve. The reduction in frequency of 25 % is equivalent to about 50% size reduction of the patch compared to the corresponding square patch. This antenna can be used for RFID, GPS applications and mobile satellite communications.

References:

[1] Douglas H Werner and Suman Ganguly, "An overview of Fractal Antenna Engineering Research ", IEEE Antenna and Propagation Magazine , Vol. 45, No.1 Feb 2003.

[2] Carmen Borja and Jordi Romeu, " On the Behavior of Koch Island Fractal Boundary Microstrip Patch antenna", IEEE Transactions on Antennas and Propagation, vol. 51,No.6, pp-1281-1291, June 2003.

[3] K J Vinoy, K Abraham and Vijay K Vardhan, "On the relationship between fractal dimension and the performance of multi-resonant dipole antennas using Koch curves", IEEE Transactions on Antennas and Propagation Vol.51 No.9, pp- 2289-2302, September 2003.

[4] P Nageswara Rao and N V S N Sarma , "On the Behavior of Square Patch Antenna with Koch Fractal Boundary with Different Indentation Angles", International Journal of Microwave and optical technology, Vol.3,No.1, January 2008.

[5] P. Nageswara Rao and N V S N Sarma , "The effect of Indentation angle of fractal boundary on the performance of microstrip antenna", International Journal of Antenna and propagation , Vol-2008.