Analysis of Koch Snowflake Fractal Antenna for Multiband Application

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***Abstract*— This paper discusses the Koch snowflake behavior of the fractal antenna. The antenna has been designed for increasing outer perimeter of triangular shape patch by using self-similarity property and analyzed performance on multiband .There are number of example of self-similarity and space filling property of fractal antenna. We are examining number of iteration by the designing Koch snowflake for different resonant frequency.**

***Keywords*— fractal antenn; iterative method; multi band;**

I. INTRODUCTION

The Koch snowflake it became an important sample of fractal set. The objective of this paper is to be design and, simulate Koch snowflake fractal antenna. The behavior and properties of an antenna are investigated. Multiband operation is becoming increasingly popular in several practical applications including next-generation wireless terminals. Fractals antennas that are small in size and simple in structure are typically demanded for such applications [1]. Fractals antennas are widely preferred for wireless communication systems as they are of small size, light weight, low profile, low cost, and are easy to fabricate and assemble [2]. The Koch snowflake geometry drew the attention of researchers as it is smaller than other patch geometries [3].

II. GEOMETRY OF KOCH SNOWFLAKE

A. Koch Snowflake

Fractal investigated in this study is based on a Koch snowflake. Comparisons can be drawn here between the Periodic Patterned designs highlighted in fig. (1), it was known as a Koch snowflake fractal. It originates from a plain square patch and subsequent iterations produce a cross-like fractal patch with ever more fine details at its edges such a design has several parameters which can be varied such as the depth and size of the removed segments [3].

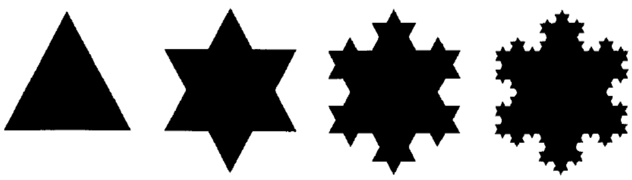

Fig. 1. Basic Steps construction of a Koch snowflake fractal

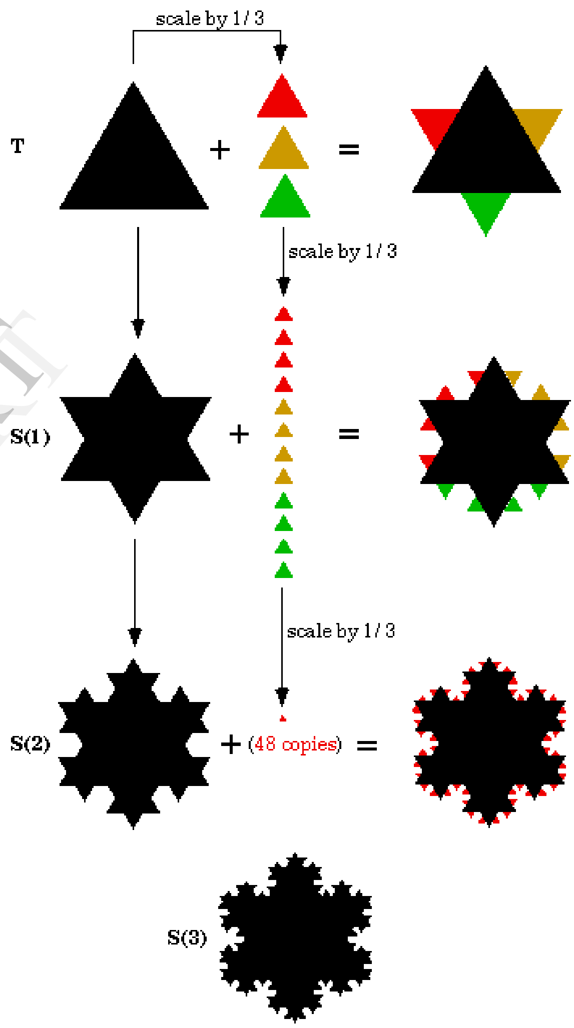

Fig. 2. Design Steps construction of a Koch snowflake fractal

B. Self-Similarity Design

As shown in Fig. (2) Increasing outer perimeter of triangular patch according to the fractal formula of regular self-similarity pattern.

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III. ANTENNA DESIGN

Many variation are possible with square size of patch antenna dimension A's value changes as well as fractal steps iteration factor [3]. Here we take 1/3 iteration factor with dimension A= 9cm. Here we describe up to 4 iteration step are Koch fractal geometry [4].

The length of the boundary of S (n) at the nth iteration of the construction is 3*(4/3) ^n*s, where s denotes the length of each side of the original equilateral triangle [5]. Therefore the Koch snowflake has a perimeter of infinite length

The area of S (n) is

$$\frac{\sqrt{3}s^2}{4}\left(1+\sum_{k=1}^{n}\frac{3\cdot 4^{k-1}}{9^k}\right)$$

Letting **n** go to infinity shows that the area of the Koch snowflake is $\frac{2\sqrt{3}s^2}{5}$.

Substrates Material R. T. duroid epoxy having permittivity (ε_r) of 4 Dimension: 110*100*1.5 mm Patch Design shapes changes according to fractal variation A=9 cm Feeding: Commercial coaxial dimension used and feeding position center of the patch.

IV. EXPERIMENTAL RESULT AND SIMULATION

A. *Simulation Result For Iteration 1*

Simulation result of individual iteration step by step with S_{11} (Return loss in dB), VSWR radiation pattern and reading tables

The structure of Koch snowflake fractal antenna with first iteration is as follows and on simulating the above structure with the help of Ansoft HFSS, the following results were obtained.

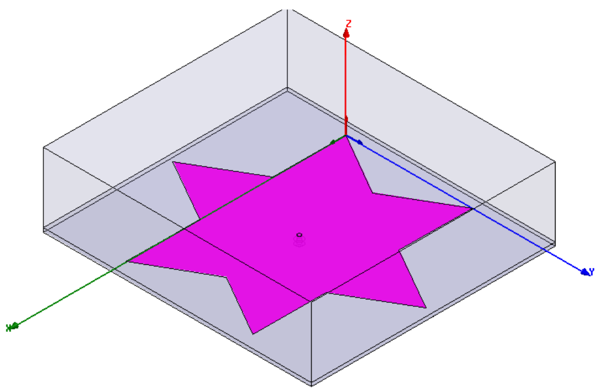

Fig. 3. Iteration -1 of Koch snowflake Fractal Antenna

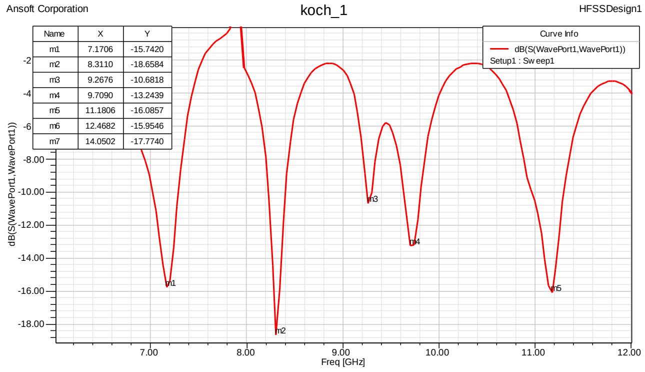

Fig. 4. Iteration -1 of Koch snowflake Fractal Antenna's Return Loss

B. *Simulation Result For Iteration 2*

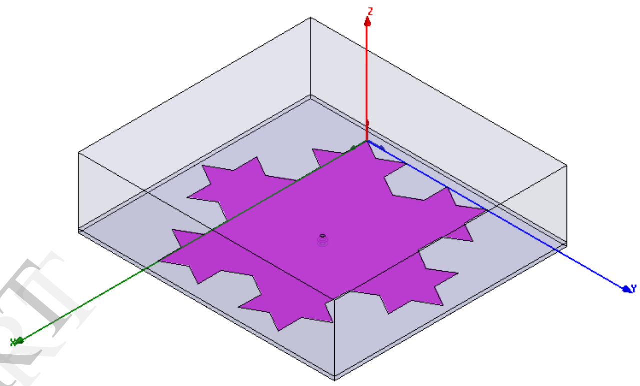

Fig. 5. Iteration -2 of Koch snowflake Fractal Antenna

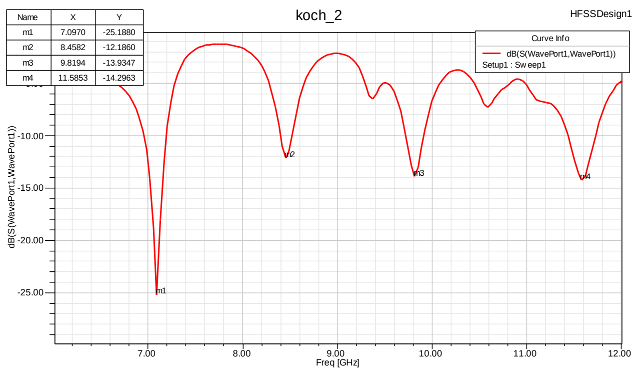

Fig. 6. Iteration -2 of Koch snowflake Fractal Antenna's Return Loss

C. Simulation Result For Iteration 3

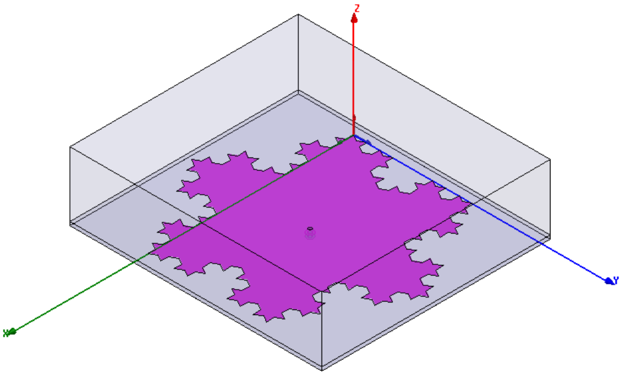

Fig. 7. Iteration -3 of Koch snowflake Fractal Antenna

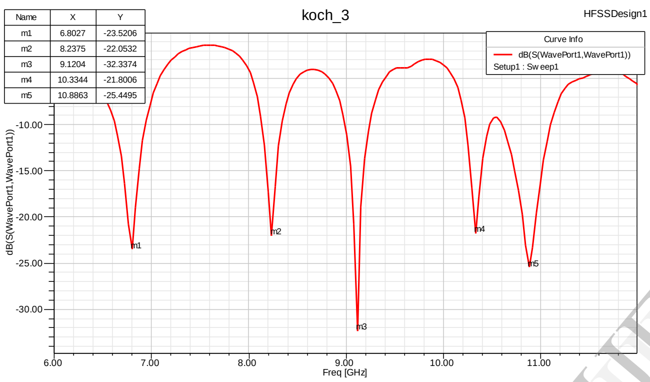

Fig. 8. Iteration -3 of Koch snowflake Fractal Antenna's Return Loss

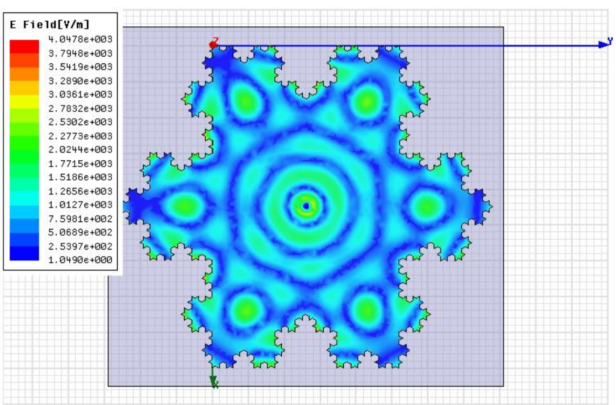

Fig. 9. E-Field Distribution of Koch snowflake Fractal Antenna

Simulation results of various iteration steps shown on above figures. Incremental properies of koch snowflake gives increasing in resonanant frequency observed result shown in table 1.

TABLE I.

Iteration	Antenna Parameters				
	Resonant freq. (GHz)	***VSWR***	***Return Loss (dB)***	***Peak gain***	***Peak Directivity***
1st	7.17	1.4	-15	5.17	4.29
	8.31	1.26	-18	5.97	5.54
	11.18	1.3	-16	1.05	4.69
2nd	7.09	1.11	-25	17.65	6.85
	8.45	1.65	-12	0.80	4.79
	9.8	1.5	-13	1.59	8.05
	11.58	1.47	-14	4.39	14.86
3rd	6.80	1.14	-23	12.63	6.38
	8.23	1.17	-22	2.96	6.94
	9.12	1.04	-32	6.91	16.8
	10.33	1.17	-21	2	8.73
	10.88	1.11	-25	1.60	5.95

V. CONCLUSION

The resonant frequency increases with increase in the number of iterations. The multiband behavior is obtained as the numbers of iterations are increased .The return losses improve as the number of iterations increase. The bandwidth of the antenna gets increased too with increase in the number of iterations. Improvement in VSWR is also observed with increase in iterations. The fractal geometry effect on patch antenna has been analyzed. This Koch snowflake antenna is a good example of the properties of fractal incremental boundary patch antennas. As the fractal iteration increases, perimeter of patch increases and effective area of antenna increases with improve multiband application. . The radiator is now resonant at more frequencies. It gives multiband properties to fractal geometry antenna with directive patterns. This behavior is obtained with a coaxial feeding scheme. So, fractal boundary patch antennas are an interesting replacement in the multiband antenna with broadside radiation patterns and with efficient directivity. This geometry offers numerous variations in dimension and design, hence gives wide scope for commercial applications.

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