Bandwidth and Gain improvement by using Suspended Fractal MSA at 2.4GHZ

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ABSTRACT
In this paper the design of compact broadband Koch island fractal patch antenna for bandwidth improvement and antenna size reduction in a single design at 2.4GHz is proposed. The suspended technique is used to improve bandwidth whereas for size reduction the electrical length of the conducting patch has been increased. By space-filling property of fractal geometry, this antenna reveals lower resonant frequency. Based on experimental result, it is found that as iteration and iteration factor increases, the resonant frequency of this patch antenna decreases. A comparison of fractal antenna with conventional microstrip patch antenna is made regarding the bandwidth, return loss, VSWR, and gain. The antenna is simulated by the HFSS software.(High frequency structure simulator)

Keywords
Microstrip patch antenna, Fractal koch antenna,bandwidth enhacement, broadand wireless application.

1. INTRODUCTION
The explosive growth in wireless telecommunication services and increase in their application small size and wideband antenna are in great demand. Operators are looking for systems that can perform over several frequency bands or are reconfigurable as the demands on the system changes. Antenna is a transducer designed to transmit or receive electromagnetic waves. Microstrip antennas have several advantages over conventional microwave antenna and therefore are widely used in many practical applications[1].Microstrip antennas have low profile, low cost, light weight and conveniently to be integrated with RF devices. Reduction of antenna size becomes extremely important in wireless communications and hence it is desired to bring down the size of antenna while achieving the same performance of the large size antenna. Fractal geometry plays a prominent role for these requirements. Fractals have non-integral dimensions and their space filling capability could be used for miniaturizing antenna size. To overcome microstrip antenna's limitation of narrow bandwidth by generating more than one resonant frequencies many techniques have been used in the past e.g. different shaped slots [2], multilayer[3],two folded parts to the main radiating patch and use of air gap have been proposed and investigated. In the design presented in this paper Koch island fractal patch antenna with air gap is used.

2. MICROSTRIP PATCH ANTENNA
A microstrip patch antenna (MPA) consists of a conducting patch of any planar or non planar geometry on one side of a dielectric substrate with a ground plane on other side.[1]. The advantages of microstrip antenna have made them a perfect candidate for use in the wireless local area network (WLAN) applications. The size of the microstrip antennas becomes too large to be manageable. Koch island fractal patch antenna is a very good solution to reduce the size of antenna. Fractal shaped antennas show some interesting features which results from their geometrical properties. The unique features of fractals such as self-similarity and space filling properties enable the realization of antennas with interesting characteristics such as multi-band operation and miniaturization.

3. FRACTAL GEOMETRY ANTENNA
Fractal was first defined by Benoit Mandelbrot in 1975 as a way of classifying structures whose dimensions were not whole numbers[4].Fractals are generally self-similar and independent of scale. There are many mathematical structures that are fractals; e.g. Sierpinski's gasket, Cantor's comb, von Koch's snowflake Fractals also describe many real-world objects, such as clouds, mountains, turbulence, and coastlines that do not correspond to simple geometric shapes. The Koch fractal microstrip patches are commonly used in virtue of their attractive properties: they have small size, a single feeding port is enough and their higher order modes result in directive radiation patterns.

4. ANTENNA DESIGN
In this paper to design the Suspended Koch antenna HFSS (high frequency structure simulator)software is used. Different iteration stages of triangular Koch curve is shown in figure 1.

The Koch snowflake can be constructed by starting with an equilateral triangle, then recursively altering each line segment as follows:

1. Divide the line segment into three segments of equal length.
2. Draw an equilateral triangle that has the middle segment from step 1 as its base and points outward.
3. Remove the line segment that is the base of the triangle from step 2.[5]

The Koch curves have neither a piecewise continuous everywhere, it is nowhere differentiable. Its shape is highly rough and uneven. Thus it shows good candidate for becoming an efficient radiator.

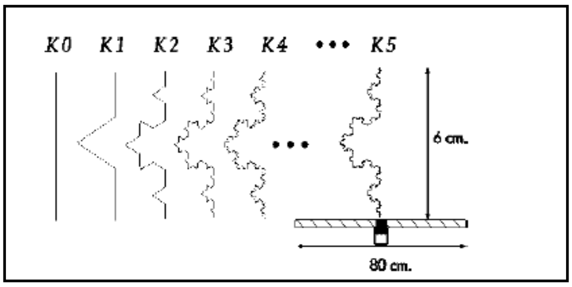


Figure1: Different iteration stages of triangular Koch curve

There are three essential parameters for design of patch antenna i.e. resonant frequency (fr), dielectric material of the substrate (Er), and the thickness of substrate (D). Here 2.45 GHz has been chosen as the resonant frequency. The dielectric material of the substrate selected for this design is FR-4 which has a dielectric constant (Er) of 4.4 First three iteration of Koch curve is shown in figure 2.

The fundamental mode resonant frequency of such antenna is given by

$$\mathbf{Fr} = \frac{2C}{3W\sqrt{Er}}$$

Where,

C = speed of light

Er = relative permittivity of substrate

Then patch side length W is given by

$$\mathbf{W} = \frac{2C}{3fr\sqrt{Er}}$$

$$\mathbf{Lambda} = \frac{c}{f}$$

F=2.4Ghz

Er=4.4

Ground Length =**lambda/2**

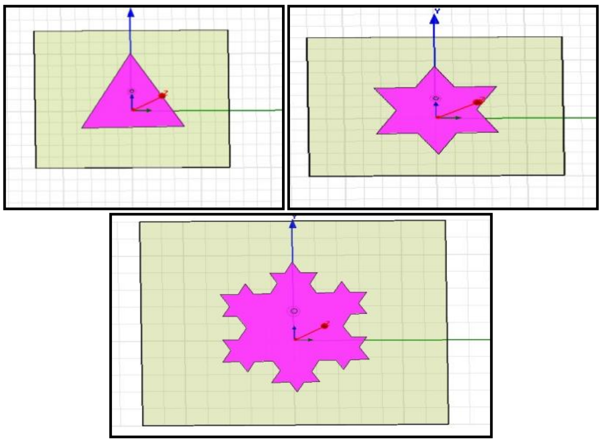


Figure2: First three iteration of Koch curve

In order to improve bandwidth a suspended technique means use of air gap between ground and patch is used. The configuration yielded improved measured bandwidth with dual f**r**equency band. Suspended configuration is shown in figure.

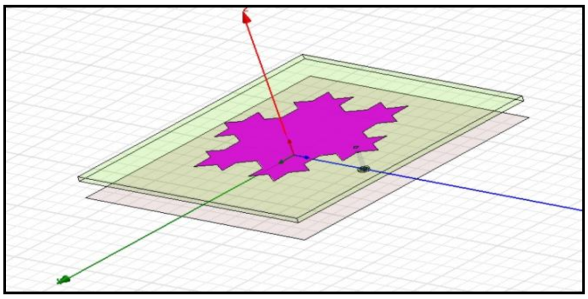
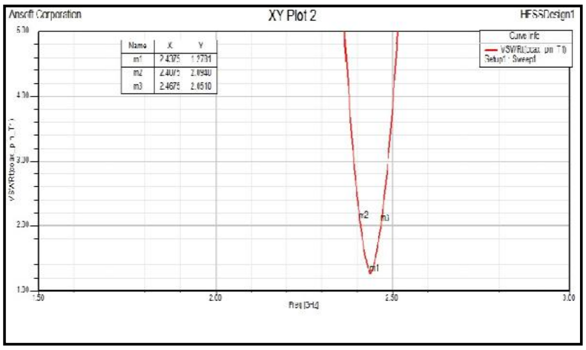


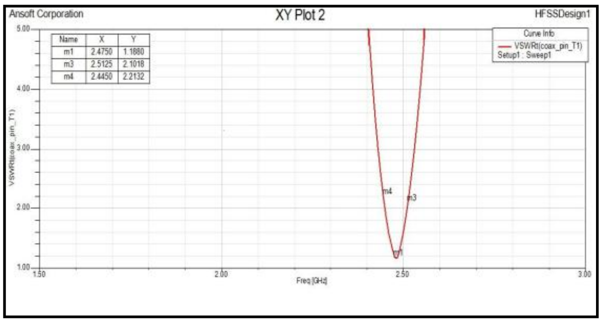
Figure3: Suspended Koch Fractal antenna

5. SIMULATED RESULTS

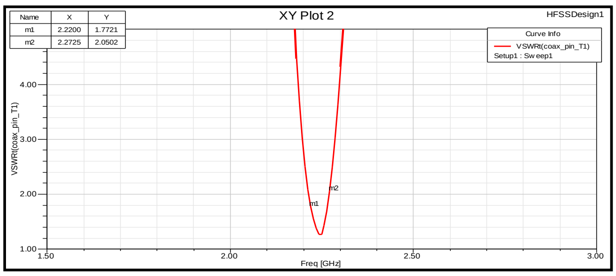
The figure.3 shows the HFSS generated design of Suspended Koch curve antenna. The VSWR, return loss, directivity are computed using HFSS.As per the theory voltage standing wave ratio should be ≤ 2.Idealy it should be1.The simulated result for VSWR is as shown in fig.4. The VSWR, which can be derived from the level of reflected and forward waves. The simulated VSWR for simple MSA, VSWR for Koch curve Iteration-1and Iteration 2 and VSWR for Suspended Fractal antenna is as shown in fig.4.(a),(b),(c) and (d) respectively. The VSWR, which can be derived from the level of reflected and forward waves.



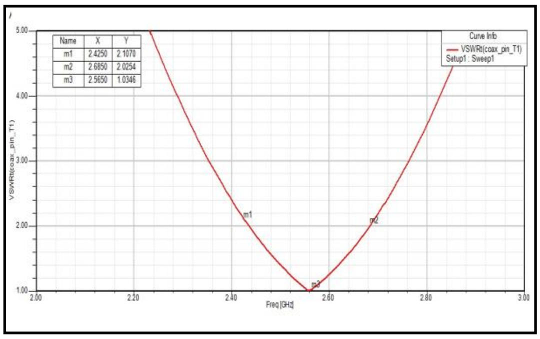
(a)



(b)



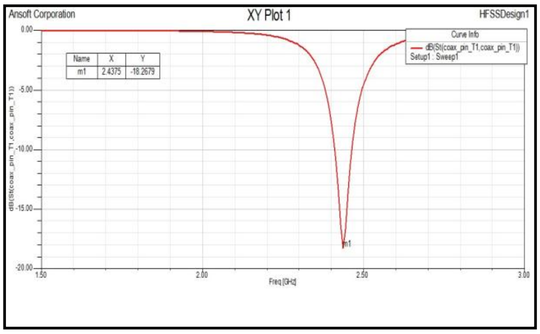
(c)



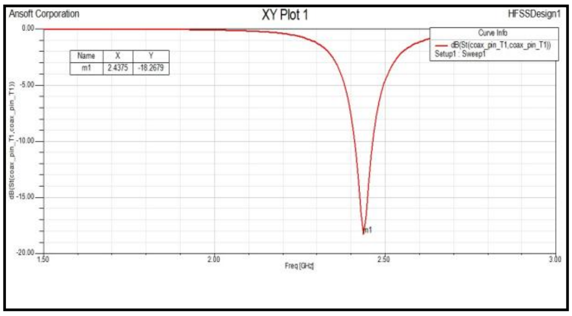
(d)

Figure.4(a)VSWR for simple MSA, (b)VSWR for Koch curve Iteration-1, (c) VSWR for Koch curve Iteration2 (d) VSWR for Suspended Fractal antenna

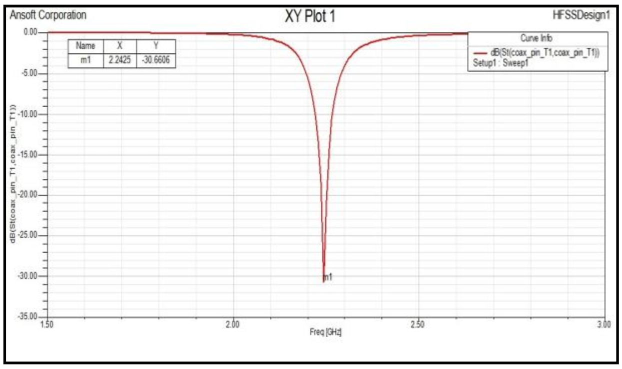
Return loss indicates the amount of power that is lost to load and does not return as reflection. The simulated return loss for simple MSA, Koch curve Iteration-1and Iteration 2 and Suspended Fractal antenna shown in fig.5 (a), (b), (c) and (d) respectively.



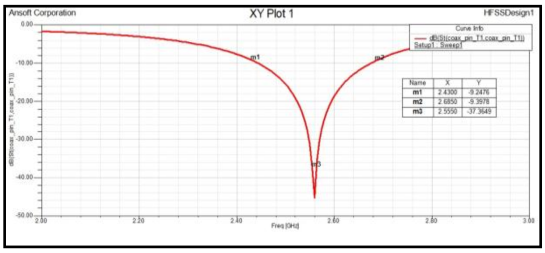
(a)



(b)



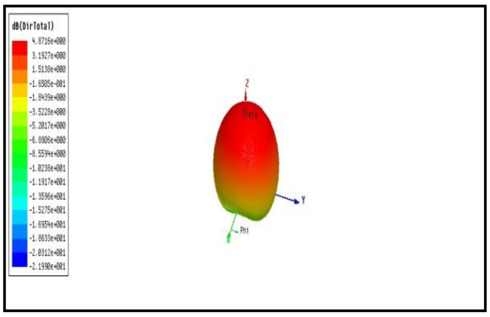
(c)



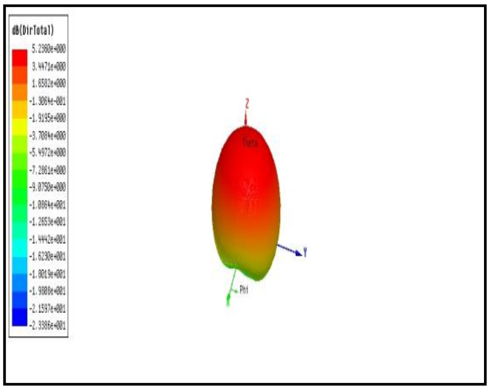
(d)

Fig. 5(a) Return loss for simple MSA, (b) Return loss for Koch curve Iteration-1, (c) Return loss for Koch curve Iteration2 (d) Return loss for Suspended Fractal antenna

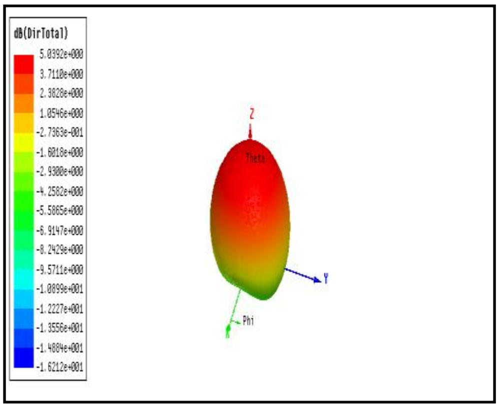
The gain of an antenna is essentially a measure of the antenna's overall efficiency. The simulated gain for simple MSA, Koch curve Iteration-1and Iteration 2 and Suspended Fractal antenna shown in fig.6 (a),(b),(c)and(d) respectively.



(a)



(b)



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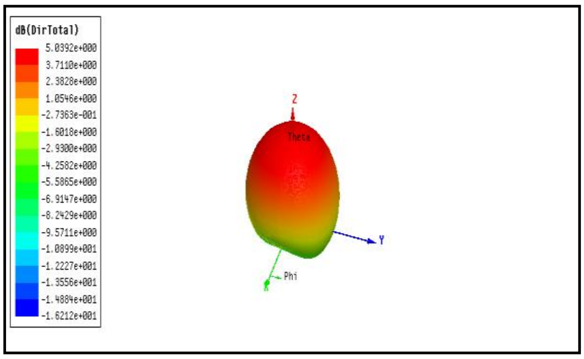

(d)

Figure.6(a) gain for simple MSA, (b) gain for Koch curve Iteration-1, (c) gain for Koch curve Iteration2 (d) gain for Suspended Fractal antenna

Table.1Comparative result for Triangular microstrip antenna, Star microstrip antenna, Koch curve antenna, Suspended fractal antenna

S. No.	Types of Microstrip antenna	Frequency (GHz)	Return loss (dB)	VSWR	B.W (MHz)	Gain (dB)
1)	Triangular Microstrip antenna	2.43	-18.26	1.27	52	4.87
2)	Star Microstrip antenna1st iteration	2.48	-22.21	1.18	52	5.23
3)	Koch 2nd iteration	2.24	-18.57	1.77	42	5.0392
4)	final suspended fractal antenna	1)2.55	-37.36	2.1	260	5.92
		2)4.14	-16.17	1.37	290	7.31

The above table shows comparative results for Triangular microstrip antenna, Star microstrip antenna, Koch curve antenna and Suspended fractal antenna. From above table it is clear that when iteration increases, the resonant frequency of this patch antenna shifted to lower side i.e. decreased. After each iteration gain is increased. For final suspended fractal antenna we get dual frequency band with large bandwidth and gain.

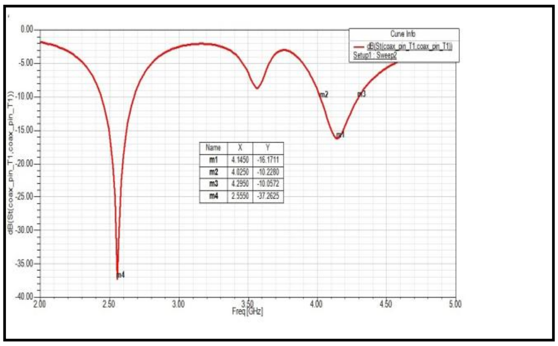

Figure.7 Dual frequency bands for Suspended Koch antenna

6. CONCLUSION

In this paper Koch fractal antenna with air gap is proposed Antenna is simulated by using HFSS software. The resonance behavior and space filling capabilities of the Koch curve fractal antenna have been investigated. It is found that as the resonant frequencies decreased and after each iteration gain is increased. As the generating iteration is increased by introducing number of triangle and length of one antenna was reduced by bending the 2/3 pattern of the Koch fractal antenna counter clockwise. Then, again rotating whole antenna 90° counter clockwise with specific dimension improves the antenna gain as well as its bandwidth. The proposed antenna have some favorable characteristics such as; compact size, almost symmetrical radiation pattern , higher gain, satisfactory return loss less than 10 db and acceptable bandwidth in desired frequency (2.4-2.483GHz)ISM(Industrial scientific medical)band. Due to suspended configuration we get dual frequency band with large bandwidth. This antenna is useful for broadband application.

7. REFRENCES

[1] Indrasen Singh, Dr. V.S. Tripathi Micro strip Patch Antenna and its Applications: a Survey.

[2] C.L.Mac,R.Chair,K.F.Lee,K.M.LukandA.A.Kishk"half U-slot patch antenna with shorting wall", electronic letters vol 39,pp 1779-1780,2009.

[3] B.Sanzizquierdo,J.C.Bachlor,R.J.Langley,M. I. Sobhy " single and double layer planer .

[4] Shubhangi S. Ghorpade Vidya B. Babare V. U. Deshmukh. Comparison Of E-Shape Microstrip Antenna And E-Shape Fractal Antenna.

[5] Dr. K.J.Vinoy, Size reduction of low frequency micro strip patch antennas with koch fractal slots.

[6] M. Ramkumar Prabhu, V. Reji and 3A. SivabalanResearch Journal of Applied Sciences, Engineering and Technology 4(12): 1740-1748, 2012 Improved Radiation and Bandwidth of Triangular and Star Patch Antenna

[7] Ms.priyanka, Mr. Navin Srivastava, International Journal of Advancements in Research & Technology,Volume2, Issue5, May-2013''Bandwidth enhancement for microstrip patch antenna using suspended techniques for wireless applications'' .

[8] Divya Dixit Saxena and Ankur Kumar Tripathi Fractal based microstrip patch antenna in wireless communication.

[9] PIERS Proceedings, Suzhou, China, September 2011 Combined Fractal Geometries for the Design of Wide Band Microstrip Antennas with Circular Polarization byHomayoon Oraizi and Shahram Hedayati.

[10] Baliarda, C. P., J. Romeu, and A. Cardama, *The Koch Monopole:* A Small Fractal Antenna& Propagation, Vol. 48, No. 11, November 2000.

[11] Balanis, C. A., Antenna Theory, John Wiley & Sons, Inc., New York, 2004.

[12] Shubhangi S. Ghorpade Vidya B. Babare V. U. Deshmukh Comparison Of E-Shape Microstrip Antenna And E-Shape Fractal Antenna

[13] [Raj Kumar and P. Malathi International Journal of Recent Trends in Engineering, Vol 2, No. 6, November 2009 On the Design of Wheel Shape Fractal Antenna.