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Design ,Simulation ,Fabrication and Measurement of 900MHZ Newhybrid Fractal Dipole Antenna

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Abstract: **In this paper has been provided simulation design and Fabrication of hybrid fractal dipole antenna. This structure is composed of two famous fractal of Koch and Minkowski and it is provided based on design of dipole antenna and is simulated by Ansoft HFSS13 software. Result indicated that there is a 30 percent reduction in size of new structure. Also return loss curve is lesser than -10dB in GSM900 band.**

Keywords: **Fractal Antenna, New Koch Fractal, 900MHz, Dipole Antenna**

I. INTRODUCTION

With the expanding use of wireless networks, need to use of antennas with small size can be felt more than before. Nowadays, the small antennas are used extensively in mobile communication networks and military. In design of antenna, if the antenna is usually less than one-quarter wavelength, antenna has not needed efficiency based on band width and other parameters. Nowadays, fractals are used as a solution for needs and downsizing of antenna.

Shapes of fractal are created based on repetition and self – similarity properties [1, 4]. Another feature of this problem is lack of proper dimensions. The use of various repetitions in production of fractal shape cause to increase electrical length in fixed area. So this leads to downsize structure of produced antenna to grounded model. With fractal structure, we can define the shapes which actually are not to model mathematically with Euclidean geometry. Forms such as trees, clouds and mountains are but a fractal structure. In recent years, many studies have been conducted on different kinds of fractal structures in design of antenna. Fractals of Koch, Minkowski and Sirpeneski are in this category in form of dipole, monopole, page are studied.

In this article, new structure is introduced based on Koch's fractal. This structure leaded to reduce size of antenna. Ansoft HFSS software was used for simulating antenna. Simulation results indicate that size reduction of 30% is achievable in 900 GSM.Koch's structure is from self – repetition fractals. IFS(Iterated Function System).IFS work by applying a series of affine transformations w to an elementary shape A over much iteration.General equation in self – repetition fractals is following[1,5]:

$$\omega\begin{pmatrix}x_1\\x_2\end{pmatrix}=\begin{pmatrix}a & b\\c & d\end{pmatrix}\begin{pmatrix}x_1\\x_2\end{pmatrix}+\begin{pmatrix}e\\f\end{pmatrix}=Ax+t \quad (1)$$

Here, matrix A is

$$A=\begin{pmatrix}\frac{1}{S}cos\theta & \frac{-1}{S}sin\theta\\ \frac{1}{S}sin\theta & \frac{1}{S}cos\theta\end{pmatrix} \quad (2)$$

Short from of affine transformation

$$\omega=[a,b,c,d,e,f] \quad (3)$$

Which $\frac{1}{S}$ is factor of measure of self - function.

$$\frac{1}{S}=\frac{1}{2(1+cos\theta)} \quad (4)$$

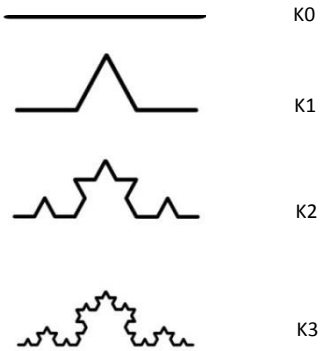

Fig. 1 iteration of the standard koch curve [1, 4]

II. FRACTAL GEOMETRY

The new structure is formed from a combination of two famous fractal called Koch and Minkowski. In this algorithm, to any Koch's fractal is applied Minkowski's generator a square pulse in any level. When the generator is applied to each line, it is divided three identical parts called width of dip. It varies between zero and one. If width of dip is 0.5, it means that width of dip is half of size of direct parts.

Fig. 2: Minkowski's generator

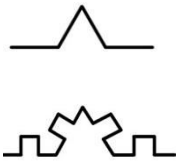

Fig. 3: generation of new fractal from Koch's fractal with usage of square pulse with $\omega=1$

The resulting structure has five sections for any repetition. Here, width of dip is one and with respect to primary shape of Koch's fractal, any section of shape in Koch's fractal is divided five same sections. Length of Koch's fractal and new fractal is calculated from following formula in first stage:

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Figure: generation of new fractal from Koch's fractal with usage of square pulse with $\omega = 1$

Relation between new fractal and Koch's fractal

Let l is the effective length

h is the antenna height

n is the number of iteration

θ is the indentation angle

$$l_{koch} = h\left(\frac{4}{3}\right)^n \quad (5)$$

$$l_{NewKoch} = l_{koch}\left(\frac{5}{3}\right)^n \quad (6)$$

$$l_{NewKoch} = h\left(\frac{4}{3}\right)^n\left(\frac{5}{3}\right)^n = \left(\frac{20}{9}\right)^n * h \quad (7)$$

For the systems which need to isotropic pattern, especially wireless network, planner dipole antennas use extensively. Because of properties of these antennas in vast range, Micro strip antennas are used as radiation element. Advantages of Micro strip antennas are low price and ease of construction that it is attainable with usage of PCB technology.

Resonant frequency of antenna is calculated following:

l is the effective length

L is the resonate length

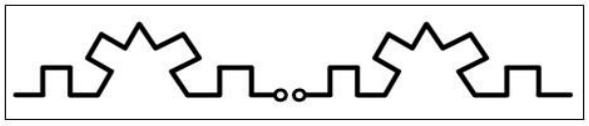
c is the speed of light

e_{re} effective dielectric constant of the microstrip line for the microstrip

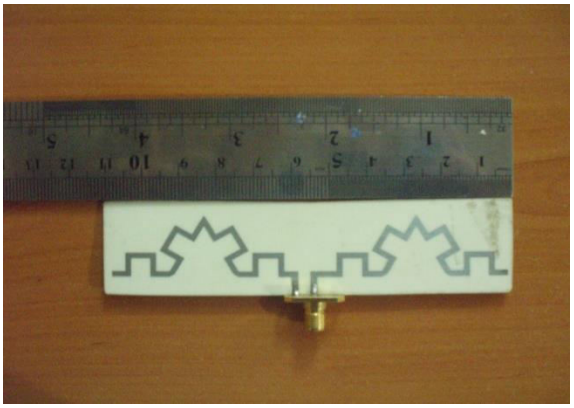
f_r resonate frequency of the antenna

$$L = \frac{c}{2f_r\sqrt{e_{re}}} \quad (8)$$

In this structure, first stage of Koch's fractal with applying fractal with angle of 60 degree is divided to 4 sections which it is equal to one – third its original shape. It is showed that new shape in generated with square pulse($\omega = 1$)[2,3]. Resonance frequency of antenna is simulated for 900GS band with HFSS software. In simulation and construction stage, used dielectric has Roggers 400s thickness and dielectric constant is 3.38.



(a)



(b)

Figure 4: dipole antenna from combination of Minkowski and Koch fractal.

III. Measurement Result

In following figure, return loss curve is shown. Return loss value is -23.45 dB in frequency 900 MHz. Earned results from usage of generator in first repetition in Koch's fractal indicate that resonance frequency in new antenna is 0.2 GHz lesser than dipole antenna and 17 MHz lesser than second repetition of Koch's antenna in second repetition. Reduction of resonance frequency may to decrease 30 percent antenna size.

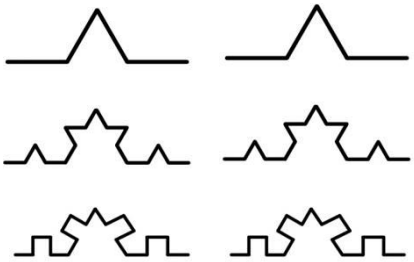


Figure 5: Koch fractal dipole antenna iterate 1, 2 and new fractal antenna

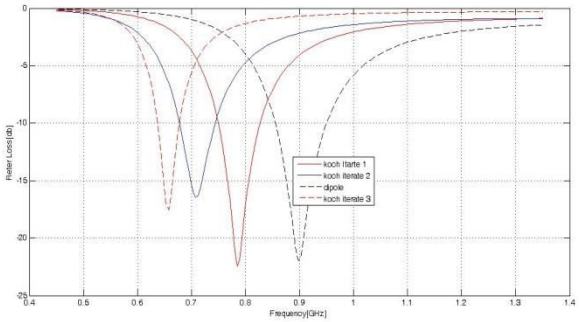


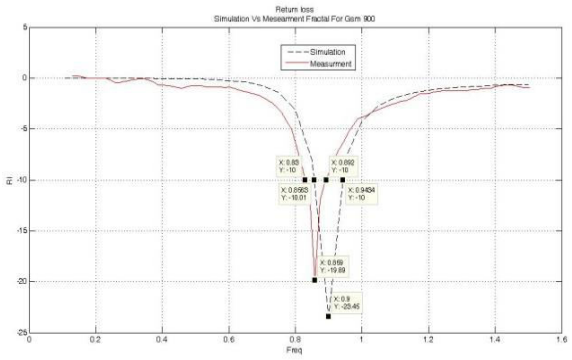
Fig. 4 : comparison return loss between koch fractal and new fractal

Table 1: Comparison table of size of new fractal antenna with dipole and Koch fractal in second repetition in frequency 900 GHz

Antenna Type	Substrate:Roggers 4003,H=0.8mm,		
	Length(cm)	Return Loss	B.W
Planer Dipole	14	-21.9	854-945 (10.1%)
Dipole Koch 2st Iter.	11	-15.5	857-929 (8%)
New Fractal	10	-23.45	856-943 (9.7%)

Table 2:Comparison table of measured and simulated results of new antenna Diagram of pattern of planes H and E in new fractal antenna in band 900, when $\theta = 0.90$

	Simulation& Measurement		
	Resonate Freq(MHz)	Return Loss	B.W
Simulation	900	-23.45	856-943 (9.7%)
Measurement	859	-19.89	892-929 (7.2%)



IV. CONCLUSION

In this article, structure of Koch and dipole Micro strip antennas for band 900 GHz GSM is provided with purpose of showing new fractal structure and reduction of its size. New fractal structure is composed from two famous fractal structures called Minkowski and Koch. Addition to having sufficient width band, this structure has proper value of return loss in comparison with base dipole antenna and Koch antenna. Size reduction of 40 % in comparison with dipole antenna and size reduction of 30% in comparison with microstrip antenna is attainable.

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