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Using Koch Geometry Multiband Antenna Design

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Abstract- Multiband Koch curve antenna is proposed in this paper with fractal concept. Such kind of antenna consists of two-stage Koch curve as the radiating element with compact dimension of 88×88×1.6 mm^3. With the help of this antenna, multiband characteristic for a return loss less than 10dB is achieved. For mobile communication systems such design is best suitable with lowest losses. It has a Self -similarity and Space filling properties. Fractal antennas are utilized in the design of antennas with notable characteristics like multiband behavior and miniaturization. In this paper, a Koch curve antenna embedded with a Minikowski fractal geometry, which exhibits a large size reduction is proposed.

Index Terms- Koch curve antenna, CST, IFB.

1. INTRODUCTION

The proposed multiband antenna is modified from the fractal ground slot antenna [1]. The height of initial generator model shown in Figure 1.1 varies with Wp. Generally, Wp is smaller than Ws/3 and the iteration factor is

$$\eta = \frac{Wp}{(WS/3)}$$

In this design, we use the iteration factor η = 0.66. Koch curve is printed on a 1.6 mm thick substrate having relative dielectric constant value of 4.4 [2].

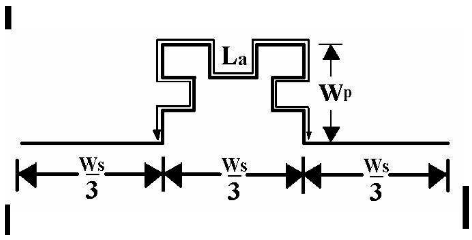

Figure 1. 1 Initial generator model for large slot antenna

Usually, the length La is varied to get the good impedance match to transmission line [3]. The recursive procedure to get the final geometry is shown in figure 1.2.

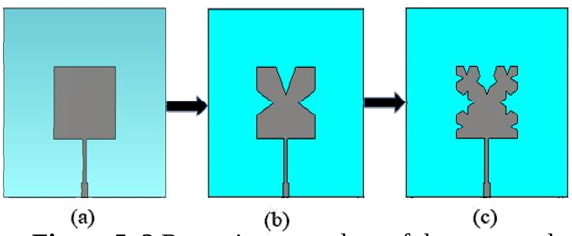

Figure 5. 2 Recursive procedure of the proposed antenna (a) motif (b) first iteration (c) second iteration

2. SYSTEM REQUIREMENT

Final fractal geometry is obtained by the application of series of affine transformations to the initiator. The fractal antenna is simulated using CST microwave studio. Affine transformation is used to describe about IFS[4]. Iterated function Systems is the general method to illustrate the fractal structure. The expression for affine transformation is given by

$$\begin{pmatrix} x_{n+1} \\ y_{n+1} \end{pmatrix} = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \begin{pmatrix} x_n \\ y_n \end{pmatrix} + \begin{pmatrix} e \\ f \end{pmatrix}$$

Scaling parameters a, b, c and d are always real integers [5]-[7]. Parameters a, b, c and d are governs scaling and shearing. Whereas e and f are responsible for linear translation. Therefore, the linear affine transformation, W is defined by this constraints as given below.

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix} \begin{pmatrix} e \\ f \end{pmatrix}$$

Koch curve has an endless electrical length and it was invented by Triadic von Koch. Each segment of length L is divided into three equal parts of length L/3, the middle portion of the segment is replaced by a generator[8].

The fractal dimension of classical Koch curve is given by

$$D= \frac{\log 4}{\;} = 1.261$$

The parameter return loss is a figure of merit that mathematically describes the impedance

matching between transmission line and antenna. This transfers happens only when characteristic impedance is matched with input impedance of antenna otherwise reflected waves are generated which results in the degraded performance of an antenna. Ideally reflected waves must be zero.
The proposed Koch curve patch dimensions are listed in table 2.1.

Parameter	Dimensions in mm
W_p	18.08
W_a	33.49
W_b	26.56
W	88
W_s	81.40
W_t	1.93
W_f	3.46
L_t	20.75
L_f	6.49

Table 2. 1 Dimensions of the Koch curve antenna

3. SET UP AND RESULTS

Reflected waves are responsible for VSWR. The proposed antenna gives good impedance matching at 0.9 GHz for GSM, 1.98 GHz for Digital Communication Systems, and 2.4 GHz for Bluetooth.

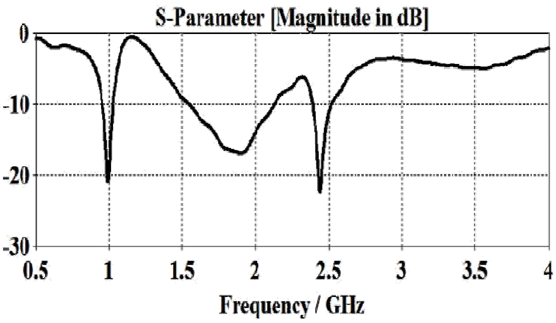

Figure 3.1 Simulated return loss curve of the final Koch curve geometry

Table 1. Measured results from the return loss curve

Bands	Fr in GHz	Fractional BW(%)	S11 in dB	Gain in dB
1st band	0.9	6.96	-20.34	1.6
2nd band	1.99	30	-16.908	5.78
3rd band	2.4	5.83	-22.166	4.74

Radiation pattern defines the deviation of maximum power radiated by an antenna in the fraunhofer realm. Multiband antennas usually requires omnidirectional radiation pattern. That means radiation is isotropic in a single plain. It is easier to analyse the radiation pattern in Cartesian coordinate system compared to spherical coordinate system. In order to represent radiation pattern in a Cartesian coordinate system usually we require two principle planes.

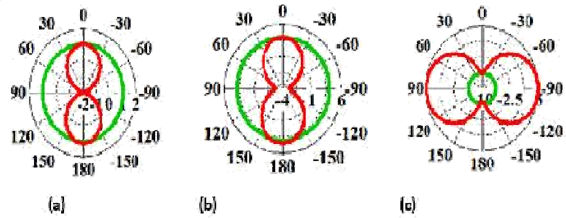

Figure 3.2 Simulated radiation patterns at (a) 0.9 GHz, (b) 1.99 GHz, (c) 2.4 GHz

One is E-plane (x-y plane) and the other is H plane (Y-z plane). As the frequency increases the number of lobes associated with them are keep on increasing, this type behaviour generally observed in multiband antennas.

The figure 3.3 shows the simulated gain vs frequency characteristics of the compact fractal antenna using Sierpinski Gasket Carpet geometry. It is observed that the proposed antenna gain lies between 1 to 5dB

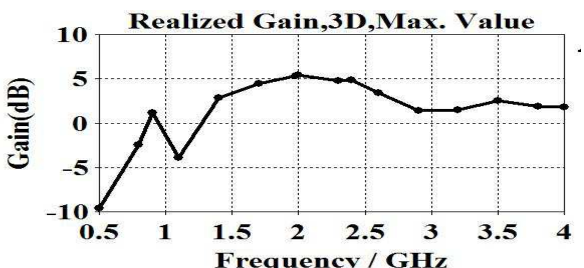

Figure 3.3 Simulated gain vs. Frequency curve of the proposed multiband antenna

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4. CONCLUSION

The multiband Koch curve antenna has been investigated it has fractal geometry. The results obtained from the antenna are measured and found applicable for some wireless/mobile communication systems, such as 0.9 GHz for GSM(Globel System Mobile), 1.99 GHz for Digital Communication Systems, and 2.5 GHz for Bluetooth. The antenna have approximates omni directional radiation pattern.

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