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A Review Paper on Specially Designed Sierpinski Gasket Fractal Microstrip Patch Antenna

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***Abstract* – Microstrip Antenna can be designed to obtain higher bandwidth operations, maintaining its various parameters simultaneously. Fractal geometry for this antenna improve its results in desired direction. Since fractal shape have their own unique characteristics that improve antenna achievement without degrading antenna properties. Fractal can be designed in Sierpinski,Koch and crown shape. Further iterations are applied on antenna that can be three in maximum number. The whole designing depends upon microstrip patch antenna and further iteration for fractal.This paper present fractal geometry for which bandwidth of 20% is obtained. Related results regarding radiation pattern, input impedance and operating frequency are further evaluated.**

***Keywords*--- Antenna,Fractal,Return loss,Impedance,Iteration**

I. Introduction

In recent time microstrip antenna have attracted the attention of scientist for their possible application in satellite, mobile and wireless communication system due to their compact size, light weight and easy production characteristics.These antenna in general ,resonant efficiently at a single resonance frequency corresponding to their dominant mode and have typically narrow bandwidth (1-2%)and lower gain.

Therefore in their conventional form,microstrip antenna fail to find much application in modern communication system. Rapid changes are taking place in mobile and wireless communication devices.[4]

These communication devices are becoming an imperative need of our daily life.

With time and requirement, these devices are becoming smaller in size and hence antenna required for transmit and receive signals is becoming smaller and lightweight while maintaining high gain characteristics. Several efforts are reported in recent times to achieve compact antennas with improved performance [1].Parasitic elements may be applied to miniaturize geometrical structure[2] but proximity of a grounding surface increase the quality factor of antenna and the presence of antenna which in turn increase the impedance of antenna which in turn increase losses and decreases the gain of antenna[3].Further radiation efficiency of antenna also decreases.

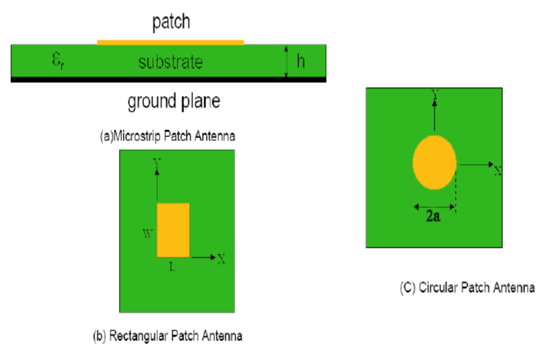

Fig 1:Microstrip patch antenna

In this paper, the radiation performance of a compact rectangular microstrip antenna combining design of fractal shapes on a glass epoxy FR-4 substrate of thickness 1.524 mm is analyzed through IE3D simulation software by considering free space condition and compared its performance with that of a conventional microstrip antenna under identical condition. Different radiation parameters are analyzed and results are presented.[5]

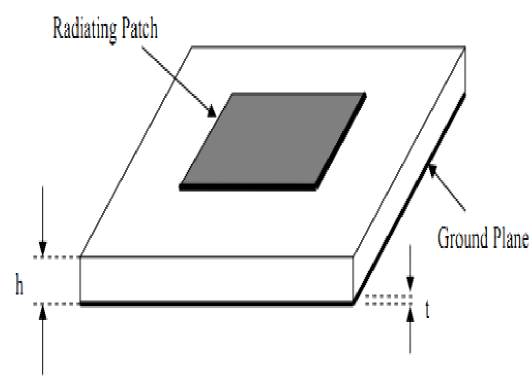

Fig 2:Ractangular Patch

Fractals are formed using iteration system, this procedure is normally called iterated function system(IFS).Fractals are made up from the sum of copies from itself, each copy smaller than the previous iteration.IFS works by applying a series of affine transformations w to an element shape A through many iterations[4]. The affine w, compromising rotation, scaling and translation, is given by

$$W(x) = Ax + t = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} e \\ f \end{bmatrix}$$

Where A is

$$A = \begin{bmatrix} (^1/_s)\, cos(\theta) & -(^1/_s)\, sin(\theta) \\ (^1/_s)\, sin(\theta) & (^1/_s)\, cos(\theta) \end{bmatrix}$$

R is scale factor

Θ is rotation angle

t is translation factor

S is scaling factor

Initially a rectangular patch geometry is simulated considering glass epoxy FR-4 substrate (ε_r =4.4,tan δ=0.001) with copper as its ground plane. Patch dimensions are considered to be 2cmx2cm as shown in figure 2. The theoretical analysis of this antenna reveals that the resonant frequency of this antenna is 3.408GHz while simulation results indicates that the resonant frequency is in its dominant mode is 3.45 GHz.The impedance bandwith,gain and efficiency of antenna are very low therefore the conventional rectangular patch geometry in its present form is not much easier or suitable for modern communication[1].

A. *Fractal Antenna*

In modern wireless communication systems and in other wireless applications, wider bandwidth, multiband and low profile antennas are in general of great demand for both commercial and military applications. Fractal shape antenna have already been proved to have some unique characteristics that are linked to the geometry properties of fractal[3]. A fractal is a set in which dimensions strictly exceeds its topological dimensions. Every set having non-integer dimensions is a fractal but it can have integer dimensions. Fractal is defined by a set of F such that:-

1) F has a fine structure with details on small scale.

2) F having some sort of similarity.

3) Dimensions of F is greater than its topological dimensions.

For example if there is n copies of original geometry scaled down by a factor f,the similarity dimension D is defined as:

$$D = \frac{\log N}{\log r}$$

B. *Fractal Designs*

Fractal can be designed in following ways:-

a)Sierpinski Gasket

b)Sierpinski Carpet

c)Koch

d)Hilbert Curves

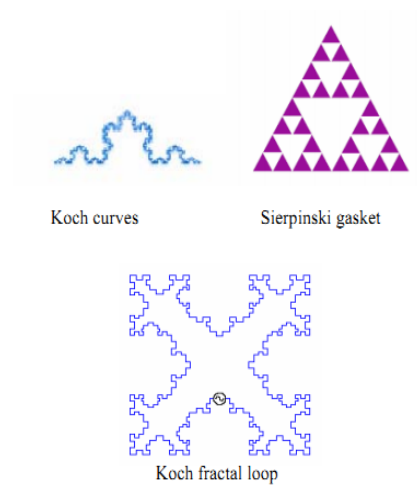

Fig 4:Designes of Fractals

C. *Multi Copy Approach*

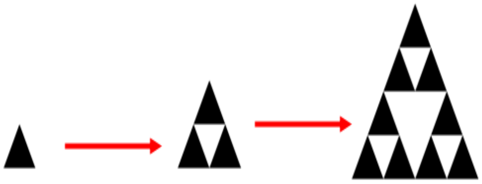

Fig 3:Iteration Process

D. *Design Procedure*

The substrate FR-4 is used here, since it is cheapest among several dilectrics.Also it can operate until 10GHz frequency. The thickness of the dielectric available is 1.6mm and loss tangent is .001[4].

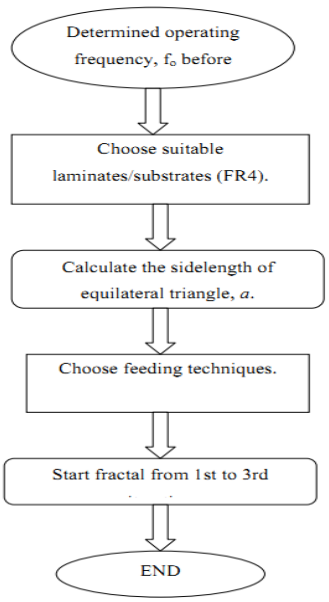

Fig 5:Steps for Fractal

II. Antenna Design

A different and also useful attribute of some fractal element is their self scaling aspect. Self similarity is the ability of antenna that make it invariant at number of frequencies. For super wideband antenna two aspects are followed 1)make an antenna for a given frequency band as small as possible 2)Make an antenna to cover several bands. With number of iteration, fractal antenna can cover frequency bands[1] .

The geometry of Sierpinski Gasket Antenna is as following:

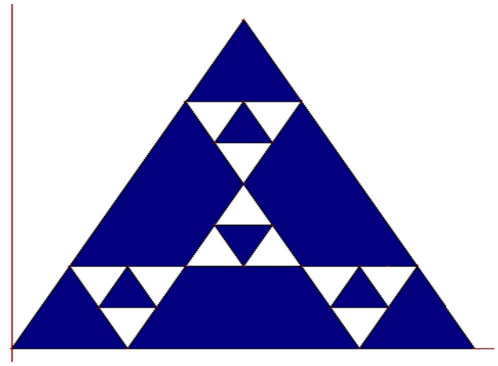

Fig 6 :Fractal Design of Sierpinski Gasket

This antenna is fabricated on a FR-4 substrate of thickness 1.524 mm and relative permittivity of 4.4.It is mounted above ground plane at height of 6mm.Coaxial feeding is provided to match the input impedance[1].

III. Results and Discussions

This antenna has been simulated using IE3D software. The physical parameters of antenna are same but the resonant frequency decreases as the iteration order increases, thus the electrical length of the ground plane also decreases in their resonant frequency for the proposed fractal patch antenna. Plot result shows that resonant frequency is 1.45GHz.And the available impedance bandwidth is 950MHz that is 65.51% from the proposed antenna. Input impedance curve passing through the 1 unit impedance circle that shows the perfect matching of input[1].

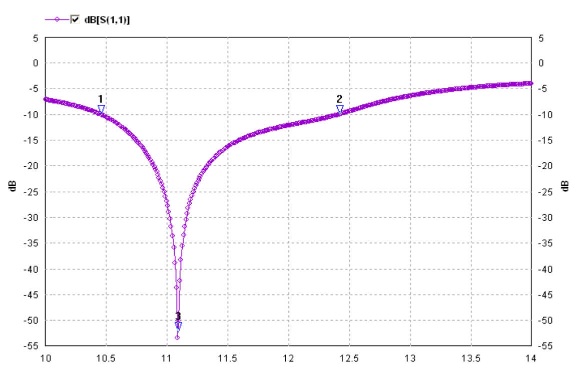

Fig 7:Plot for Resonant Frequency

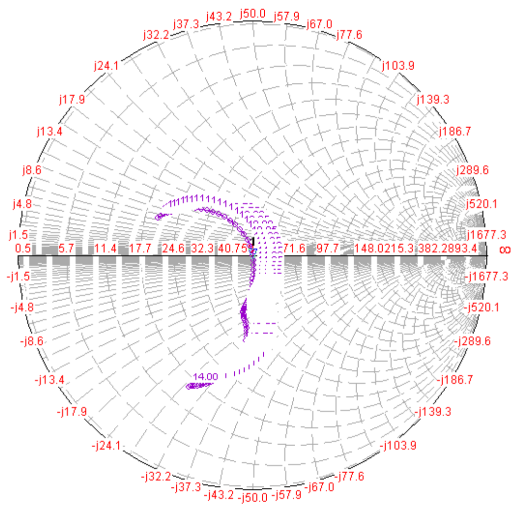

Fig 8:Input Impedance Plot

IV. CONCLUSIONS

Wideband antennas and arrays can be formed and can be analyzed with fractal geometry. The proposed technique can achieve a maximum size reduction. The main advantage of this design is that radiation pattern remain maintained and wider operating frequency bandwidth is achieved. Further by using different feeding process the results for bandwidth can be improved.

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