A MINIATURIZED FRACTAL ANTENNA WITH ROTATED SQUARE SLOT

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ABSTRACT

Modern telecommunication system require antenna with wider bandwidth and smaller dimensions. Various antennas for wide bandwidth operation have been studied for communication and radar system. The fractal antenna is preferred due to small size, light weight and easy installation. A fractal micro strip antenna is used for wideband application in this project provides a simple and efficient method for obtaining the compactness. An inverted square Koch based fractal antenna is designed for these applications. Its compactness and lighter weight is the major point for designing an antenna. This antenna is providing better bandwidth, return loss and gain.

Index Terms: Fractal, Wideband Antenna

I INTRODUCTION

The term fractal was coined by the French mathematician B.B. Mandelbrot during 1970's after his pioneering research on several naturally occurring irregular of conventional geometrics not contained within the realms of conventional Euclidian geometry has significantly impacted many areas of science and engineering .one of which is antennas [6,7]. Antenna using some of these geometries for various telecommunication application are already available commercially .The use of fractal geometrics has been shown to improve several antenna features to varying extents. Microstrip patch antenna (MPA) has attracted wide interest due to its important features .Such as light weight, low cost, simple to manufacture and easy to integrate with RF devices. For reducing the size of antenna, fractal geometries have been introduced. The main objectives are to design a square shaped fractal antenna which will be small in size [1]. A fractal is a rough of fragmented geometric shape that can be split into parts, each of which is reduced size copy of the whole. Roots of the mathematical interest in fractals can be traced back to the late 19th century. However mathematical fractal is based on an equation that undergoes iteration, a form of feed based on recursion. Fractals are a class of shapes which have not Characteristics size. Each fractal is composed of multiple iterations of single elementary shapes. The iterations can boundary but of infinite length or area [7].

A fractal is a rough of fragmented geometric shape that is generated by starting with a very simple pattern that grows through the application of rules. In many cases the rules to make the figure grow from one stage to next involve taking the original figure and modifying it or adding to it. The process can be repeated recursively an infinite number of times. Fractal geometries have two common properties: self-similar property, space filling property. The self-similarity property of certain fractals results in multiband behavior. Using the self-similarity properties a fractal antenna can be designed to receive and transmit over a wide range of frequencies. While using space filling properties, fractal makes reduce antenna size. Fractal antenna engineering is the field, which utilize fractal geometries for antenna design [5]. It has become one of the growing fields of antenna engineering due to its advantage over conventional antenna design.

II ANTENNA DESIGN

2.1 Equation

The transmission line model represents the Microstrip Antenna by two slots each of width W' and height h' separated by two impedance ZC transmission line of length L. the essential parameters for the design an antenna according the transmission line method are dielectric constant of the substrate (ε), resonant frequency (fr) and the height of substrate h. The conventional Microstrip rectangular antenna is designed by following the standard procedures [3]:

1. Calculation of the width W of antenna, which is given by:

$$W = \frac{C}{2\,fo\sqrt{\frac{(\mathcal{E}r+1)}{2}}}$$

2. Calculation of effective dielectric constant, εreff, which is given by:

$$\varepsilon reff = \frac{\mathcal{E}r+1}{2} + \frac{\mathcal{E}r-1}{2}[\left[1/\sqrt{(1+12(h/W))}\right]$$

3. Calculation of the effective length, Leff which is given by:

$$\mathrm{Leff} = \frac{\lambda 0}{2\mathrm{fr}\sqrt{\varepsilon \mathrm{eff.}}}$$

4. Calculation of the length extension, ΔL, which is given by:

$$\Delta \mathrm{L} = 0.412\mathrm{h}\frac{(\mathcal{E}r + 0.3)(\frac{\mathrm{W}}{\mathrm{h}} + 0.264)}{(\varepsilon \mathrm{eff} + 0.258)(\frac{\mathrm{W}}{\mathrm{h}} + 8)}$$

5. Calculation of the effective length extension of patch L which is given by:

$$L = L_{eff} - 2\,L$$

6. Ground plane dimension L_S and W_S which are given by:

$$Ls = 6h + L$$
$$Ws = 6h + L$$

2.2 Design

The parameter taken into account for the design are the resonant frequency (f_r =2.45GHz), dielectric constant (ε_r =4.4) and thickness of the substrate (h=1.5mm) [2]. The conventional patch antenna is shown in figure-1 with dimensions. The rectangular Microstrip patch antenna is based on square Koch fractal with iteration level two. For designing this fractal antenna IE3D software is used and the dimensions are taken as shown in Table 1. Resonant frequency is found at 2nd iteration.fig.1 shows the rectangular patch antenna with 2nd iteration.

Here a finite ground plane of the size 42 mm × 47 mm with a slot at the centre is used in the proposed geometry. The size of the rectangular patch antenna is 29.09 mm × 37.23 mm (without iteration) as shown in Table 1. Thereafter on the edges of this patch a inverted square Koch curve is applied with scale factors of iteration equals to 1/3 in L and 1/4 in W at the non-radiating and radiating edges of the patch antenna, keeping the opposite contour to the radiating edge for impedance matching. A 50 Ω SMA connector is used for feeding the antenna through the microstrip line section.

Antenna Parameter	Reference (mm)	Proposed (mm)
Length of 50Ω Inset feed line (L_0)	8.38	7.8
Width of 50Ω Inset feed line (w_0)	2.87	2.84
Patch length (L)	29.09	29.09
Patch width (W)	37.23	37.23
Length of inset – fed (y_0)	7.84	14.175

Table 1

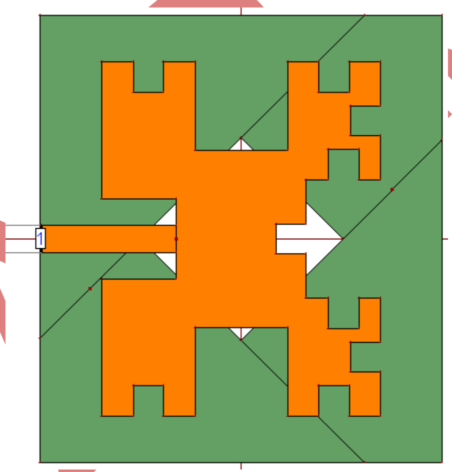


Figure 1.Design of proposed antenna with 2nd iteration

III RESULT AND DISCUSSION

3.1 Simulation Setup.

The software used to model and simulate the Microstrip patch antenna is Zeland Inc‘s IE3D. IE3D is a full-wave electromagnetic simulator based on the method of moments. It analyzes 3D and multilayer structures of general shapes. It has been widely used in the design of MICs, RFICs, patch antennas, wire antennas, and other RF/wireless antennas. It can be used to calculate and Return loss plot, VSWR, current distributions, radiation patterns etc.

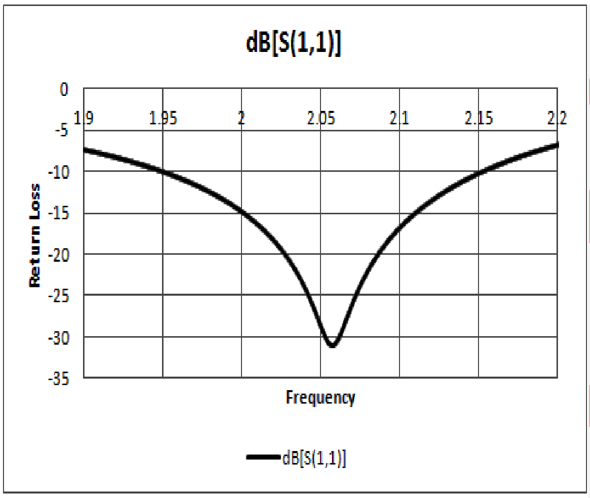
3.2 Return Loss Characteristics

The Inset feed used to design the rectangular patch antenna. The center frequency is selected as the one at which the return loss is minimum [8].

The bandwidth can be calculated from the return loss (RL) plot. The bandwidth of the antenna is said to be those range of frequencies over which the return loss is greater than 10 dB. Return loss graph is shown in figure 2. In this figure it can be seen that the return loss is -30.946 at the resonance frequency of the value 2.057. So the bandwidth of the proposed antenna is 200 MHz

3.3 Gain vs. Frequency

As observed in Fig. 3, gain vs. frequency plot, it is found that the gain is around 3.42 dB at resonant frequency 2.057 GHz.



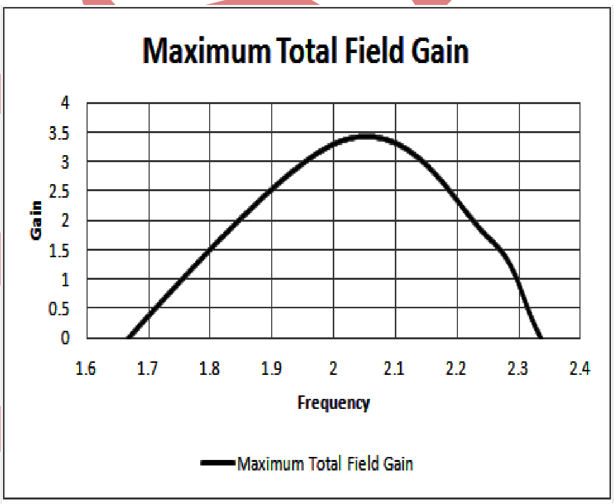
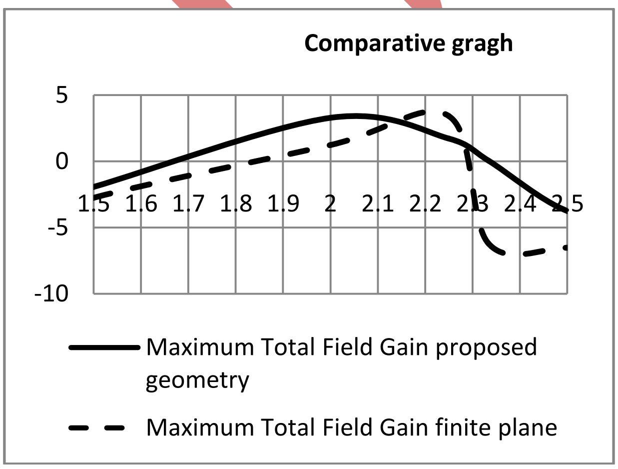


Figure 2 Return loss vs. frequency **Figure 3 Gain vs. Frequency of proposed geometry**



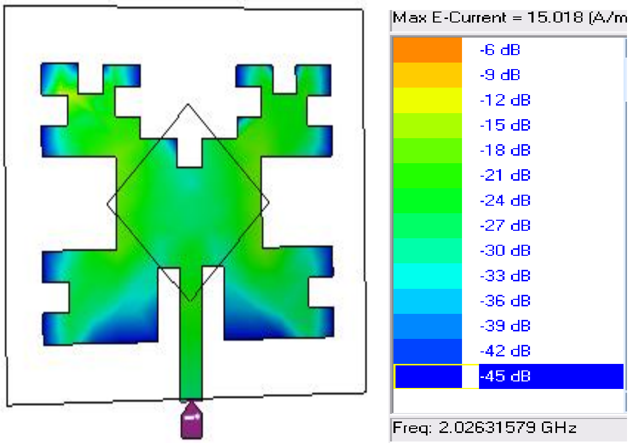


Figure 4: Comparative graph of gain Vs frequency **Fig 5: 3 D Current Distribution view**

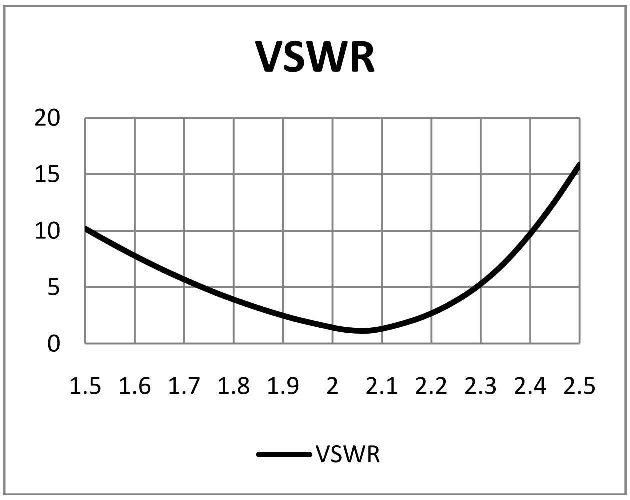


Fig 6 : VSWR Vs Frequency graph of proposed geometry

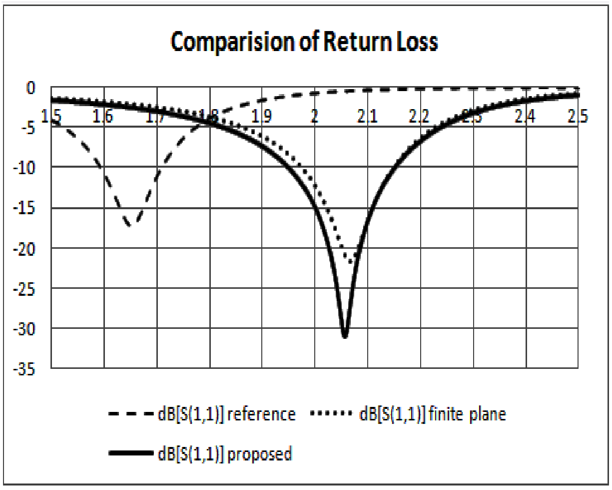


Fig 8: Comparison of return loss of proposed and reference geometry

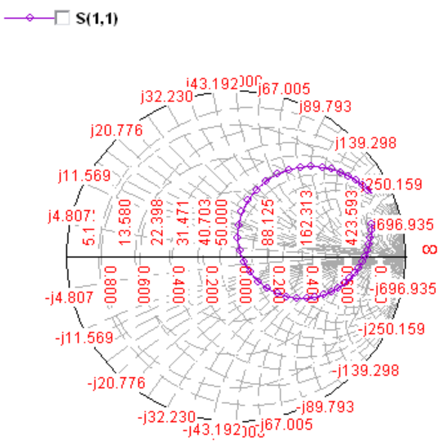


Fig 7: Smith Chart of proposed geometry

Geometry	f_r (GHz)	RL (dB)	Gain	BW(MHz)
Reference	1.64	-17.24	2.24	53
Proposed	2.05	-30.94	3.28	200

Table 2

IV. CONCLUSION

The aspect is the design of inverted square Koch fractal antenna with iteration level two. The Microstrip fractal antenna is proposed for the various wireless applications. The antenna is designed for resonance frequency 2.05 GHz and the simulation result are obtained up to second iteration. The proposed antenna show a significant size reduction compared to the conventional fractal antenna. The designed antenna is compact enough to be placed in typical wireless devices and having bandwidth 200 MHz while the reference geometry has bandwidth only 53 MHz [2]. This proposed antenna is providing better bandwidth, return loss and gain as shown in Table 2.

V. REFERENCES

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