Wideband Microstrip Koch Fractal Antenna by Star Geometry with Half Ground DGS

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Abstract- *This paper presents a novelKoch fractal antenna suitable for wide band frequency spectrum application.The Proposed antenna is designed and implemented to support personal communication system (PCS 1.85–1.99GHz), universal mobile tele-communication system (UMTS 1.92–2.17 GHz), Bluetooth /wireless local area network (WLAN), which operate in the 2.4 GHz (2.4–2.484 GHz) bands, mobile worldwide inter-operability for microwave access (Mobile WiMAX), and WiMAX, which operate in the 2.3/2.5 GHz (2.305– 2.360 GHz/2.5–2.69 GHz). This antenna has800 MHz (1.82 GHz to 2.62 GHz) -10dB bandwidth.The properties of the antenna such as return losses, radiation patterns and gain are determined via numerical simulation and measurement.Due to fractal property this antenna achieves a very small size as compare to normal microstrip patch antenna at the same resonant frequency.*

Keywords *— Kochfractal, Wideband, Microstrip Feed, DGS.*

I. INTRODUCTION

The dramatic development of a variety of wireless applications have remarkably increases the demand of wideband antennas with smaller dimensions than conventionally possible. This has initiated antenna research in various directions, one of which is by using fractal shaped antenna element [1-2].Fractal antennas have stimulated significant research interest lately due to their advantages of multiband operation. The multiband behavior of fractal antennas is due to their self-similarity structure, which means that some of their parts have the same shape as the whole object but at a different scale [3].There are an important relation between antenna dimensions and wavelength. This relation states if antenna size less than λ/2 then antenna is not efficient radiator because radiation resistance, gain and bandwidth is reduced. This is because as size of antenna reduces mismatch between antenna and source increases. Fractal geometry is a very good solution for this problem[4-6]. To design a koch fractal antenna take an arbitrary unit of length x, and see how many times you are using this unit to cover the entire length of the fractured line. Let us say you used it N times, so the total length of your fractal is N*x. In this case the fractal dimension according to Mandelbrot is:

$$D = \lim_{X \to 0} \frac{\log(N)}{\log(x)}$$

The fractal dimension D is called also the “the crippling factor” of a Fractal and can be written in a more simple form like

$$D = \frac{\ln(N)}{-\ln(\gamma)}$$

Where N is the number of the non-overlapping copies of the whole and γ is the scaling factor of these copies [7].

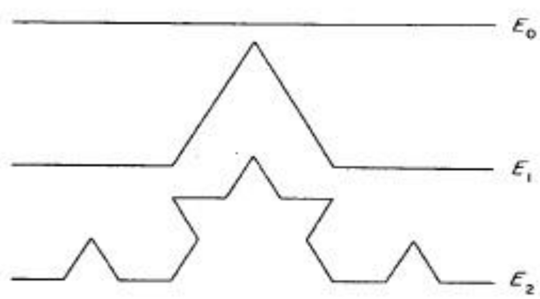

Figure 1 Generation of Koch fractal structure

Design of this fractal Koch antenna was performed and optimized using CST Microwave studio 2010 and return loss measured by Network analyzer Model No. E507IC. The proposed antenna has an omnidirectional radiation pattern and good gain.

II. DESCRIPTION OF THE PROPOSEDSMALL SIZE FRACTAL MICROSTRIP PATCH ANTENNA

“Fractals” were first defined by Benoit Mandelbrot in 1975 as a way of classifying structures whose dimensions were not whole numbers. Fractal antenna has been designed on FR4 substrate of height h = 1.6 mm and εr=4.3 shown in figure 1.

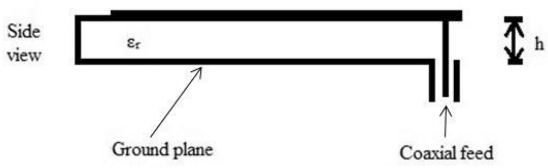

Figure 2 Side view of proposed antenna

The overall dimension of antenna is 30mm×60mm×1.676mm.The50Ω microstrip line is use to the antenna and it is calculated using (1) and (2).

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r+1}{2}\left[\frac{1}{\sqrt{1+12\frac{h}{w}}}\right] \quad (1)$$

$$z_0 = \frac{120\pi}{\sqrt{\varepsilon_{eff}}\left[\frac{w}{h}+1.393+0.667\,ln\left(\frac{w}{h}+1.444\right)\right]} \quad (2)$$

The dimension of patch is shown in figure (3)

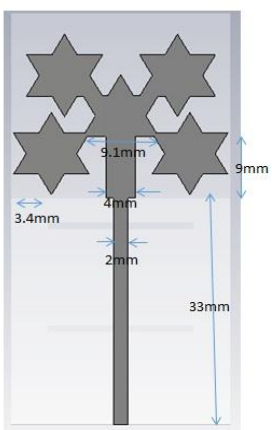

Figure 3 Structure of proposed fractal Koch antenna

This Koch antenna having defected ground plane the dimensions of ground plane is shown in figure (4).

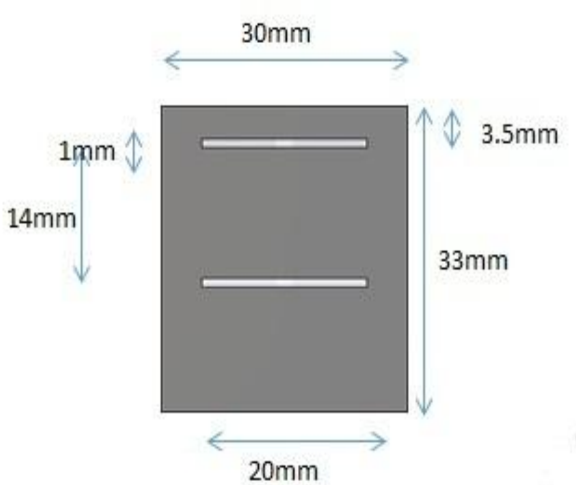

Figure 4 Ground plane of proposed antenna

III. SIMULATION AND MEASUREMENT RESULTS

Fabricated proposed Koch fractal antenna is shown in figure (e). The simulated return loss coefficient plot using CST simulation software is shown in figure (f). It is observed that the return loss of second iteration is reduced as compare to first iteration. It is also observed that bandwidth of second iteration is 85% more than the first iteration bandwidth. Figure (f) has shown the simulated result for the return loss. It is observed that the -10 dB bandwidth of Koch fractal antenna is from 1.82GHz to 2.62GHz. This frequency band is useful for many wireless applications such as GSM, Wi-Fi, and Bluetooth.

Figure (5) Fabricated antenna

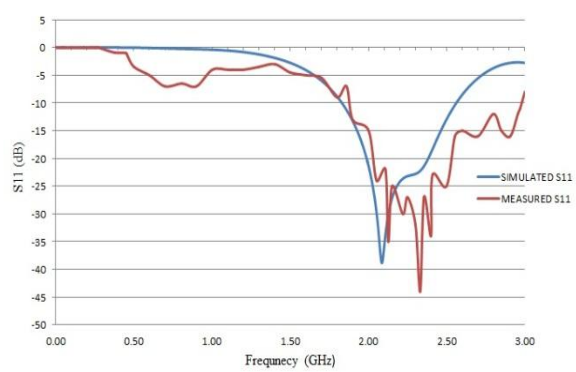

Figure 6 Simulated return loss coefficient

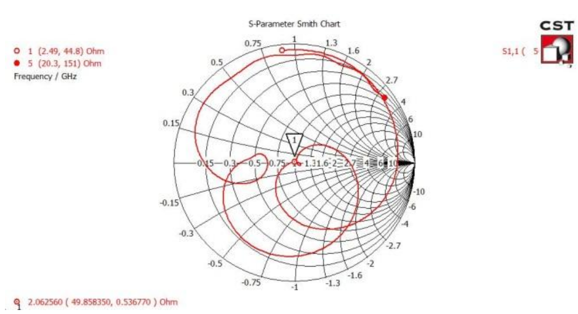

Figure 7 Smith chart of proposed antenna at 2GHz

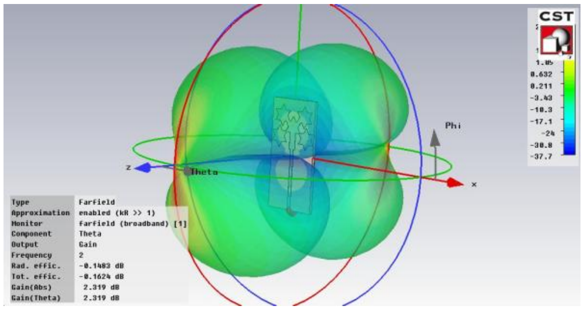

Figure 8 Angular radiation pattern

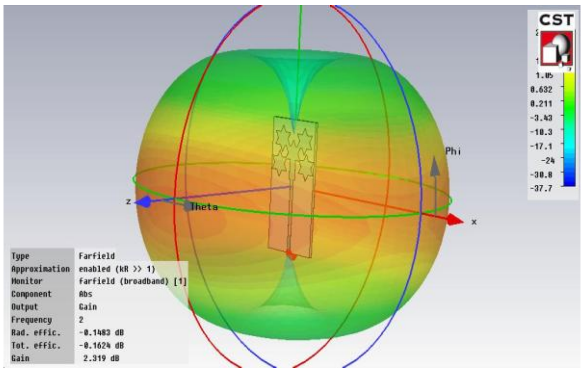

Figure 9 Absolute radiation pattern

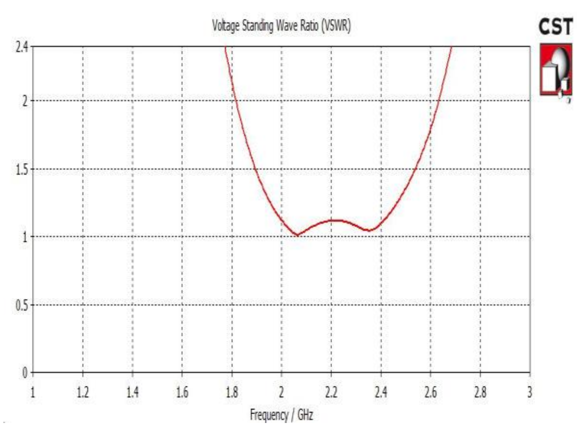

Figure 10 VSWR plot of antenna

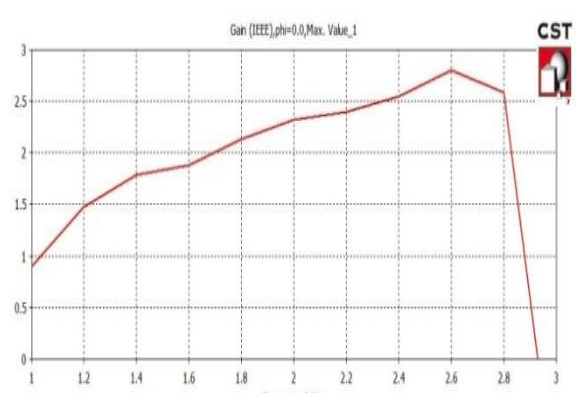

Figure 11 Gain of antenna

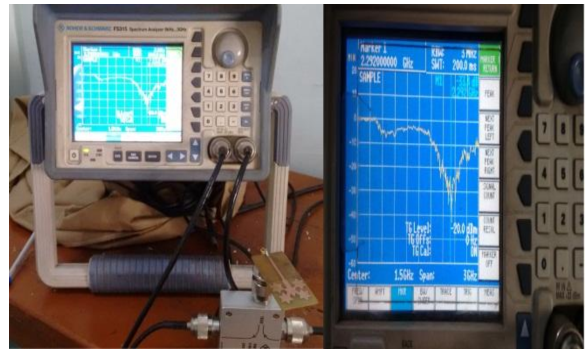

Figure 12 Measured S_{11} on spectrum analyzer.

IV. CONCLUSION

A novel Koch fractal antenna is proposed with wide bandwidth and low return loss and high directivity. Proposed fractal Koch microstrip antenna is perfectly matched with feed line (50Ω). It's VSWR $\leq$ 2 under antenna bandwidth (1.82GHz to 2.62GHz).

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