# Designing of Fractal Antenna for Wideband Application

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***Abstract:*** **This paper presents a novel design of a fractal antenna based on the use of Sierpinski triangle shape, it's designed and simulated by using FR4 substrate in the operating frequency bands (GPS, WiMAX), the design is a fractal antenna with a modified ground structure. The proposed antenna is simulated and validated by using CST Microwave Studio Software, the simulated results presents good performances in term of radiation pattern and matching input impedance.**

***Keyword:*** **Sierpinski Gasket, CST MWS V14.0, Return Loss, Directivity, Fractal antenna and Multiband.**

## I. INTRODUCTION

The Nature of wireless communication and its applicability is very abstruse and complex during the past few decade even then the necessity for wireless communication is beyond technology requires antenna with wider bandwidth and smaller dimension an antenna that covers multiple applications using a single device and therefore efforts are being made to concentrate more on the fractal antenna structure [1].The word fractal comes from latinfractus which means broken lines. fractal geometry is using iterative process that leads to self-similarity and self-affinity structure[2].The sierpinski in 1915 and it is an important part of fractal set fractal antenna is used for multiband applications because it is small in size, low cost and easy to fabricate[3].

Fractal concept has been applied to many branches at science and engineering including fractal electrodynamics for radiation and propagation[4].There are various type of fractal antenna geometries discussed in literature available[5].

- The von koch curve
- The Sierpinski (Gasket and carpet)
- Minkowski fractal island

Most at the fractal geometry antennas have two common properties which are multi-banding and space filling(6).Proximity coupled feeding technique has been used in this paper because it provides maximum bandwidth and also reduces the spurious radiation and mutual coupling(7).Because of the remarkable properties that fractal possesses it is becoming an attractive way in designing antenna. The disadvantages at fractal are gain loss numerical limitation and computational structure is used to represent structure in nature such as cloud, mountain. In this paper design of sierpinski gasket fractal antenna starts with an equilateral triangular with operational frequency 1 GHz to 5GHz figure figure shows the zero/initial, first and second iteration at proposed sierpinski gasket antenna.

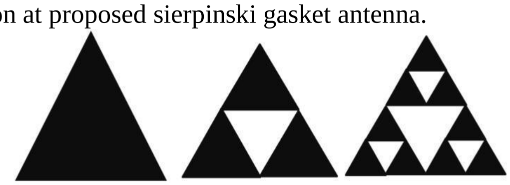


Figure1(a): Sierpinski Triangle for Zero, First and Second Iteration [6]

Table 1: Physical Dimension of Proposed Antenna

| Sr. No | Antenna Parameter | Design Value |
|---|---|---|
| 1 | Dielectric material | FR4_LOSSY |
| 2 | Substrate height | 1.5 mm |
| 3 | Flare angle | 60 |
| 4 | width | 40 |
| 5 | Dielectric constant | 43 |
| 6 | Side lenght | 50 |

The final designed sierpinski Gasket antenna shown in figure 1(b) is designed on FR-4 Lossy substrate with substrate thickness of 1.6 mm. There are three important parameters for the designing of designed antenna: height of substrate ,and resonant frequency. For first iteration, remove central inverted triangle from main triangle from main triangle and process is repeated for further iteration . This antenna is fed through proximity coupled feeding technique which provides maximum bandwidth with the benefit of minimizing spurious radiations.

## II. RESULT AND DISCUSSION

The dimensions of designed antenna are optimized by hit and trial method using parameter sweep option available in transient solver window of CST MICROWAVE STUDIO version 14.0 S11 parameter indicates return loss and it is defined as maximum reflection of power from the given antenna. The design antenna structure is simulated starting from the initial iteration/generator to second iteration. The corresponding return loss curves are also shown side by side for all the three iteration thus illustrating the value of frequency of resonance and return loss. As the number of iteration increases, number of resonating frequencies also increases.

The second iteration of the proposed antenna shows multiband behavior. Directivity is defined as maximum value of directive gain[1]. The simulated return loss curves of proposed antenna second iteration are shown in figure 1(c), 3D radiation patterns that represent directive gain are also analyzed for second iteration using the field monitors option in CST MWS V14.0 and are presented in figures 2(b)

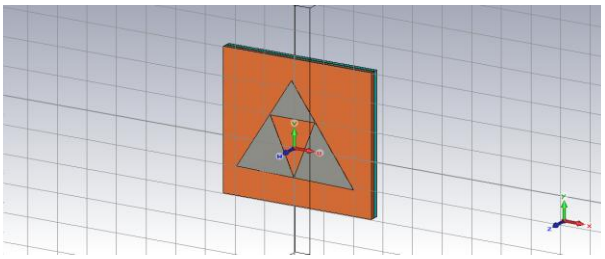

Figure1 (b): First iteration

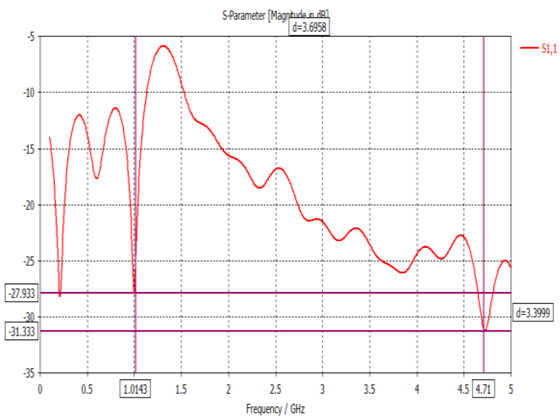


Figure1(c): Return loss of first iteration

Figure shows the simulated and measured return loss variation with frequency for the 1st level iterated fractal antenna. It can be seen that the −20 dB bandwidth for the measured return loss is-31.33 at resonance frequency 1.00 GHz and -27.933 at 4.71GHz respectively.

- VSWR of First iteration: At resonance frequency 1.01GHz VSWR is 1.1 and at frequency 4.7 VSWR is 1.03

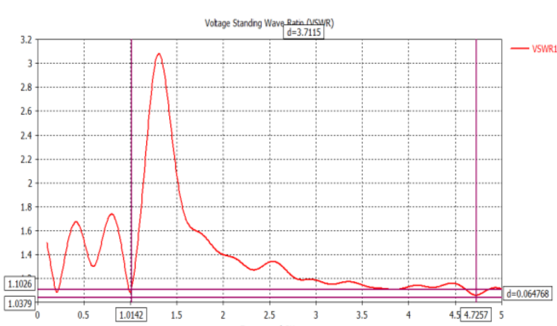


Figure 1(d): VSWR of first iteration

- Directivity of designed antenna is 15.8 dB at resonance frequency 5GHz.

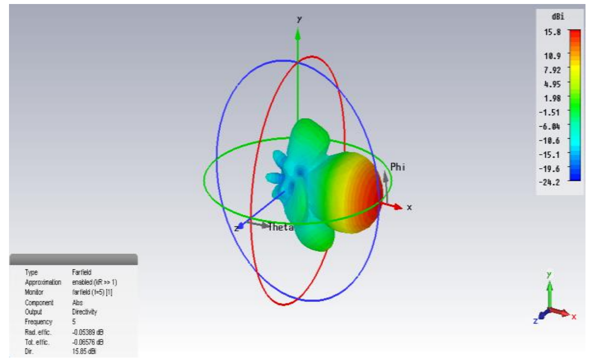


Figure 1(e): Directivity of first iteration

- *Gain*

In this iteration gain of designed antenna is 15.8dB at resonance frequency 5 GHz.

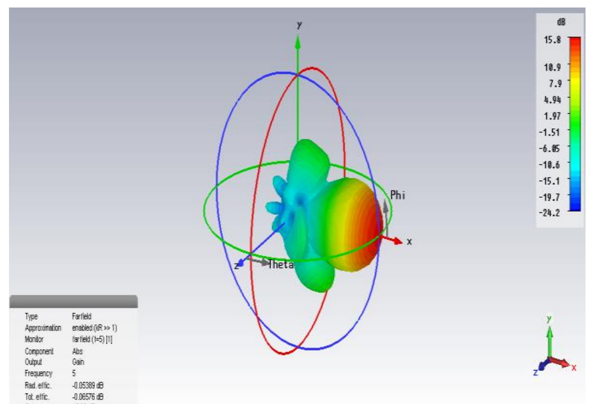


Figure1 (f):Gain of first iteration

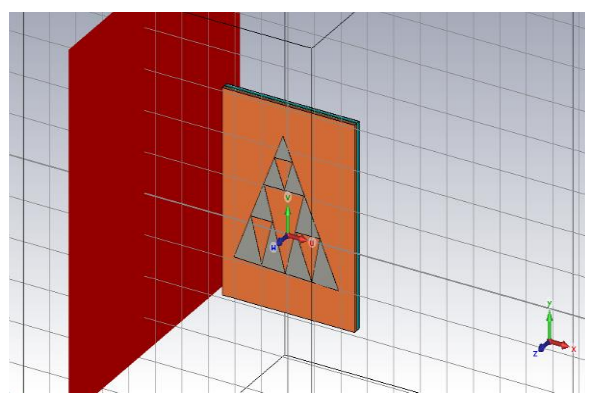

Figure2 (a): Second iteration

- *S-Parameter:* Figure shows the simulated and measured return loss variation with frequency for the 1st level iterated fractal antenna. It can be seen that the −20 dB bandwidth for the measured return loss is-31.33 at resonance frequency 1.00 and -27.933 at 4.71GHz respectively.

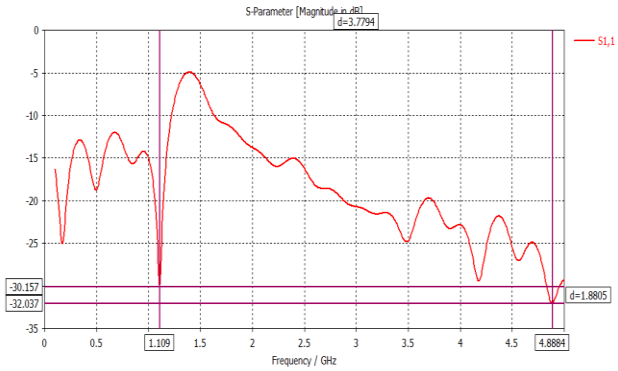


Figure 2(b): Return loss of second iteration of designed antenna

VSWR of second iteration: At resonance frequency 1.1GHz VSWR is 1.05 and at frequency 4.8 VSWR is 1.05

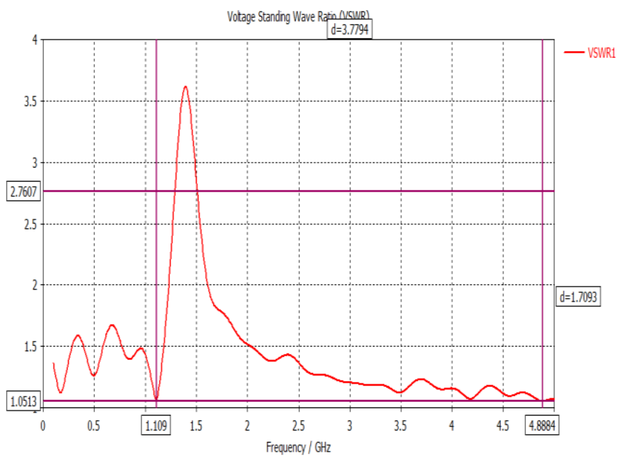


Figure2(c): VSWR of second iteration of designed antenna

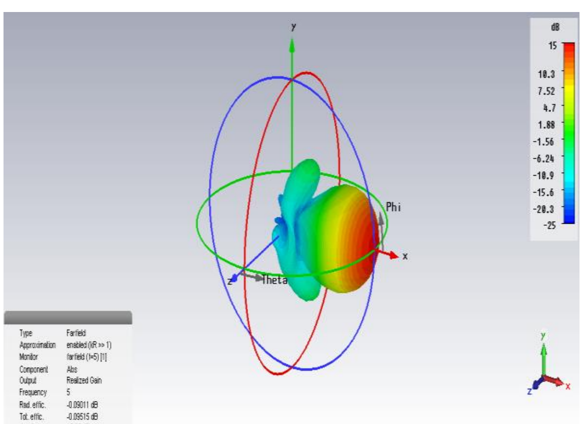


Figure2 (d): Directivity of second iteration of designed antenna at 5GHz.

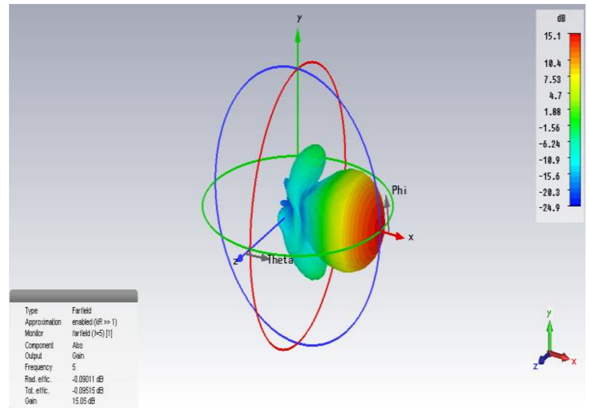


Figure2 (e): Gain of second iteration of designed antenna at 5GHz.

## III. CONCLUSION

Sierpinski Gasket fractal antenna with proximity feeding technique has been presented in this paper. This fractal antenna has been analyzed using CST microwave studio V14.0. It is observed that from second iteration onwards, it starts exhibiting multiband behavior with an acceptable frequency response at multiple frequencies response at multiple frequencies simultaneously.The result shows that antenna gives appreciable return loss and directivity with miniaturization and is best suited for wireless applications.

## REFERENCES

[1]. C.balanis, 'Antenna theory: Analysis and design' 2nd edition, New York, wiley,1997.
[2]. Mandelbort, B.B.Petigen, 'The fractal geometry of nature' W.H.Freeman and company,1982.
[3]. R. Garg, P bharti and A.ittipiboon, 'Microstrip antenna design handbook' Artech House, Norwood MA,2001.
[4]. W.L.Chen and G.M.Wang, 'Small size edge-fed sierepinski carpet microstrip patch antenna' PIERS C, vol.3, pp. 195-202,2008.
[5]. Philip Felber, 'Fractal Antennas' ,III inois institute of technology, 2nd edition,2001.