# Modified GiusepePeano fractal monopole planar antenna Design for Wireless Application

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***Abstract*** **- Fractal antenna can meet the requirements of designing a multiband, low profile and small antenna. With advancement in wireless technology over the past decade, there is an increasing demand for miniaturization, cost effective, multiband and wideband antennas. Fractal antenna designs can support in meeting these requirements. Fractal antenna design is a geometric pattern that is repeated at every scale and hence cannot be represented by classic geometry A modified compact fractal monopole planar antenna is designed by combination of fractal geometries on a substrate with permittivity $\epsilon_r$ = 4.4, height = 1.6mm. is designed, simulated and optimized using Ansys-High Frequency Structure Simulator (HFSS). The proposed antenna can be used for satellite communication, medical imaging and microwave imaging application, Vehicular radar applications and wireless industry application.**

***Keywords*** **- Fractal antenna, microstrip antenna**

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## I. INTRODUCTION

In today's era rapid increase in the need and demand for next generation wireless network applications motivated the antenna designers to design new antennas that simultaneously appear miniaturized and at the same time useful for many wireless standards [1]. The most important requirements for such kind of antenna are that the antenna should work for many applications simultaneously and must have small size [2]-[3]. For performing multi-application operations at a single time, multiband characteristic is required. These multiband characteristics can be achieved by using the concept of fractal antenna.

In 1970, Dr B. Mandelbrot coined the term Fractal. Fractal symbolises broken or irregular fragments. He investigated the relationship between fractals and nature using discoveries made by Gaston Julia, Pierre Fatou, and Felix Hausdorff [6]. He was able to show that many fractals exist in nature and can be used to accurately model certain phenomena. Fractals are a class of shapes which have no characteristic size.Each fractal is composed of multiple iterations of a single elementary shape. The iterations can continue infinitely, thus forming a shape within a finite boundary but of infinite length or area. Fractals describe a family of complex shapes that possess an inherent self-similarity in their geometrical structure. Fractal has various properties like recursive, infinite; space filling and self-symmetry [5]Because of these properties fractals antenna have more resonant frequency which contributes to lower return loss.Therefore less power is reflected back to the source and radiation emission is stronger. Fractal antennas are based on the concept of a fractal, which is a recursively generated geometry that has fractional dimensions..

The paper has been organized into following sections. Section 2 includes the design and simulation results of reference antenna [9]. Section 3 includes a modified compact fractal monopole planar antenna which is designed by combination of GiusepePeano and Sierpinski Carpet fractal geometries on a substrate with permittivity $\epsilon_r$ = 4.4, height = 1.6mm.

## II. Design & Simulation Results of Reference Antenna

Reference Antenna is a rectangular patch antenna designed on FR4 epoxy substrate having dielectric constant = 4.4, loss tangent δ=.0025 and thickness = 1.6 mm as shown in Figure 1. The feed circuit is microstrip line with a matching section over a semi-elliptical ground plane. The ground plane is selected as a combination of the rectangular and semi-elliptical plane.

**Dimension Calculation:**

Substrate height = 1.6 mm,
Substrate dielectric constant = 4.4,
Length of the rectangular patch = 30 mm and
Width W of the rectangular patch antenna comes out to be 25 mm by using design equations:

1. Calculate patch length:L = $\frac{c}{2f_0\sqrt{\epsilon_r}}$
2. Calculate patch Width: W = $\frac{c}{2f_0\sqrt{\frac{\epsilon_r+1}{2}}}$

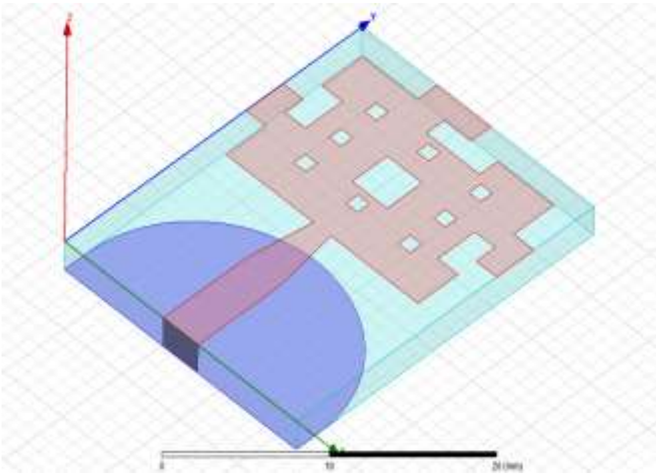

**Fig.1 Reference Antenna Design**

Designed antenna has efficiency = 88.25%, peak directivity = 1.1829 dB and radiated power = 0.87322. The simulated return loss of the propose antenna plotted against frequency is shown in Fig.2. By varying the length of the patch edges we can easily change the frequency. The proposed antenna achieves bandwidth from 3.1 GHz to 10.6 GHz, which covers the complete ultra wideband frequency range

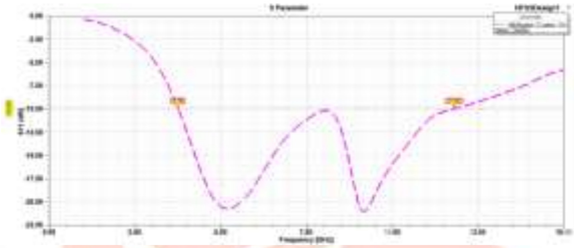

**Fig.1 S-parameter of Reference Antenna Design**

## III. Design of Proposed Reconfigurable Fractal Antenna

A modified fractal monopole planar antenna which is designed by combination of GiusepePeano and Sierpinski Carpet fractal geometrieson a substrate with permittivity $\epsilon_r$ = 4.4, height = 1.6mm, shown in fig.3.Length of the rectangular patch = 30 mm and the width W of the rectangular patch antenna comes out to be 25 mm by using design equations :

1. Calculate patch length:L = $\frac{c}{2f_0\sqrt{\epsilon_r}}$
2. Calculate patch Width: W = $\frac{c}{2f_0\sqrt{\frac{\epsilon_r+1}{2}}}$

**Feed Point Calculation:**

The feed circuit is micro strip line with a matching section over a semi-elliptical ground plane. The ground plane is selected as a combination of the rectangular and semi-elliptical plane. To improve the return losses and overall efficiency of antenna, base of patch and transmission line is modified.

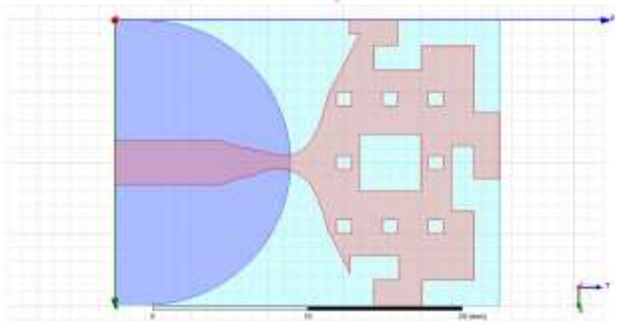

**Fig.3ProposedAntenna Design**

**1. S11 Parameter**

The simulated S11 parameter of the propose antenna plotted against frequency is shown in Fig.4. By varying the length of the patch edges we can easily change the frequency. The proposed antenna achieves bandwidth from 3.1 GHz to 10.6 GHz, which covers the complete ultrawideband frequency range.

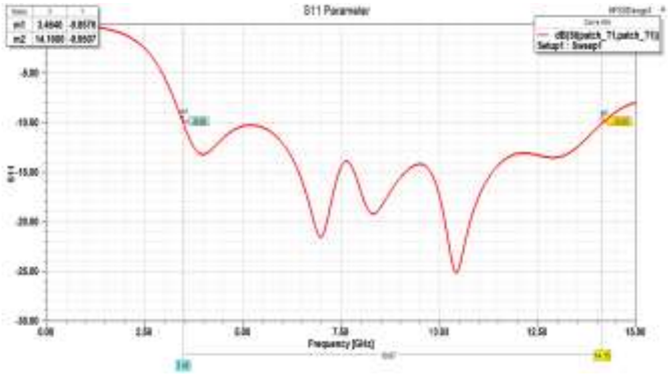


**Fig.4 S-parameter of proposed antenna**

### 2. VSWR

When a transmitter is connected to an antenna by a feed line, the impedance of the antenna and feed line must match exactly for maximum energy transfer from the feed line to the antenna to be possible. When an antenna and feed line do not have matching impedances, some of the electrical energy cannot be transferred from the feed line to the antenna. Energy not transferred to the antenna is reflected back towards the transmitter. It is the interaction of these reflected waves with forward waves which causes standing wave patterns.

Matching the impedance of the antenna to the impedance of the feed line is typically done using an antenna tuner. The tuner can be installed between the transmitter and the feed line, or between the feed line and the antenna. Both installation methods will allow the transmitter to operate at a low VSWR. Ideally, VSWR must lie in the range of 1-2. Below fig.5shows the VSWR plot.

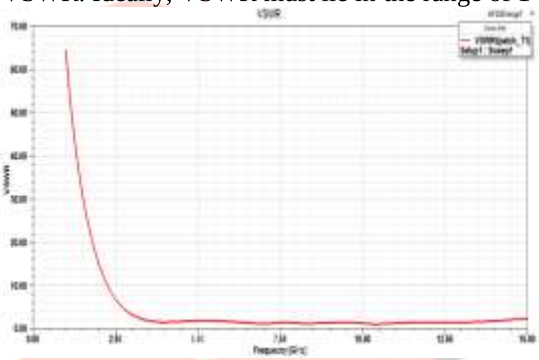


**Fig 5. VSWR of Proposed antenna**

### 3. Smith Chart

The Smith Chart is shown in fig.6 and plotted on the complex reflection coefficient plane in two dimensions and is scaled in normalized impedance (the most common), normalized admittance or both, using different colors to distinguish between them. These are often known as the Z, Y and YZ Smith Charts respectively. Normalized scaling allows the Smith Chart to be used for problems involving any characteristic impedance or system impedance, although by far the most commonly used is 50 ohms. Smith Charts can be used to increase understanding of transmission lines and how they behave from an impedance viewpoint. Smith Charts are also extremely helpful for impedance matching.

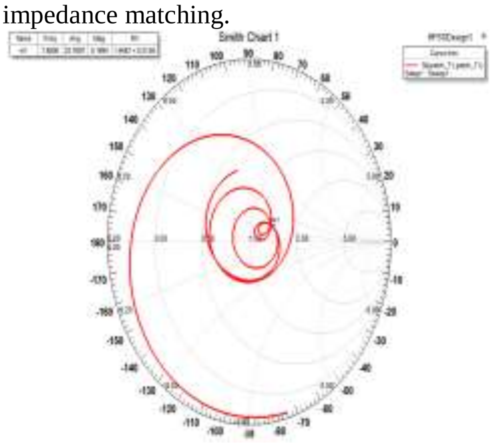


**Fig 6.Smith Chart**

**4. Current Distribution**

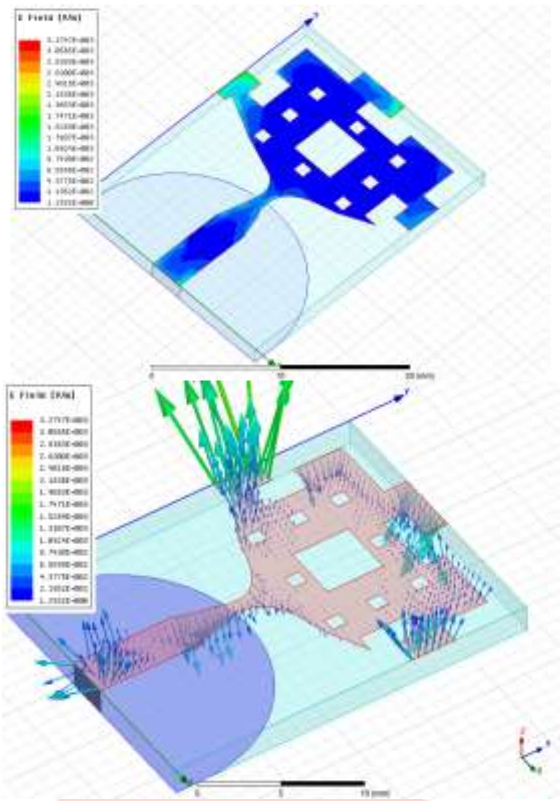

**Fig7. Current Distribution (Magnitude & Vectors)**

**5. Gain**

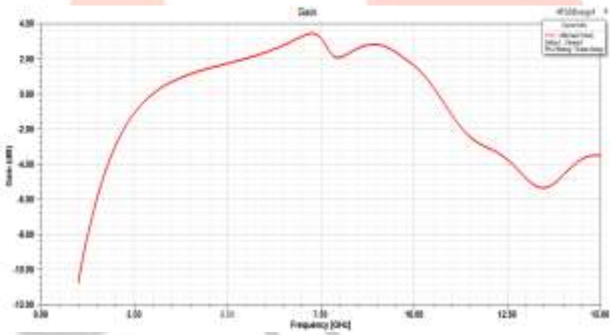


**Fig8. Gain**

**6. Radiation Pattern**

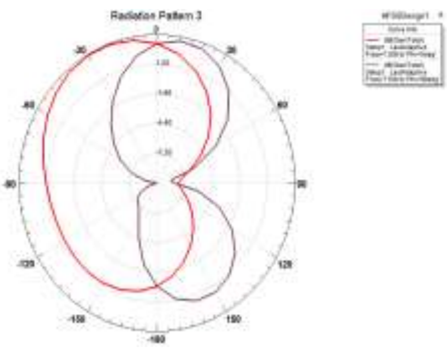


**Fig9.-3D radiation Pattern**

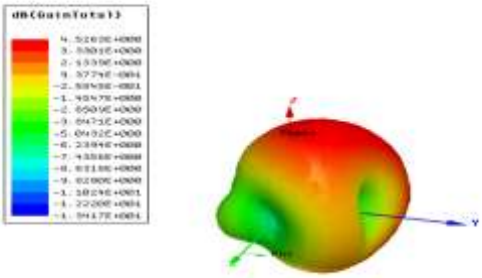

**Fig10 3-D radiation Pattern**

**7. Comparison between GiusepePeano fractal antenna and modified fractal antenna**

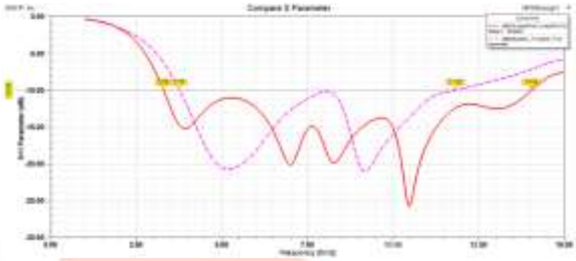

**Fig11.Comparison between return losses of anteena fig1 and antenna fig3**

## IV. CONCLUSION

In this paper fractal antenna supported multiband operation has been presented. The designing of microstrip antenna has also been done and simulated. A modified compact fractal monopole planar antenna is designed by combination of giusepepeano fractal geometries on a substrate with permittivity $\epsilon_r$ = 4.4, height = 1.6mm. is designed, simulated and optimized using Ansoft-High Frequency Structure Simulator (HFSS). Modified antenna is designed with the help of reference antenna, in which the return losses and efficiency of antenna is improved.The performance characteristics like bandwidth, gain, impedance, VSWR (standing wave ratio) are also improved. These results show a good agreement with next generation mobile terminal applications. The resulted frequency bands can be used for next generation applications like Wi-Fi, WLAN, Bluetooth, PCS, CDMA, Satellite and radar applications.

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