Design of Hybrid Fractal Antenna for UWB Application

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***Abstract*— A compact fractal monopole planar antenna with size of 30× 25 mm^2 is proposed for ultra wide band (UWB) application. The proposed antenna is designed by combination of Giusepe Peano and Sierpinski Carpet fractal geometries. The feed circuit is a microstrip line with a matching section over a semi-elliptical ground plane. The proposed antenna has an omnidirectional radiation pattern and good gain. The simulated results of return loss, gain and radiation patterns are presented and discussed.**

Keywords- **Fractal antenna, micorstrip line feed, ultrawideband.**

I. Introduction

The dramatic development of a variety of wireless aplications have remarkably increase the demand of wideband antennas with smaller dimensions than conventional possible. This has initiated antenna research in various directions, one of which is fractal shaped antenna element[1,2]. First Mandelbort proposed fractal geometries in 1951[3], which were extensively used in various engineering fields. Fractals are class of shapes which has no characteristic shapes. Fractal is a fragmented geometric shape that can be sub-divided into parts each of which is a reduced copy of the whole. By using fractal, we can describe any real world objects such as clouds, mountains, turbulences and coastlines that do not correspond to simple geometric shape. Each fractal is composed of multiple iterations of single elementary shape. The iteration can continue infinitely, thus forming a shape within a finite boundary but of infinite length or area. This shows that fractal shapes are compact, meaning that they can occupy a portion space more efficiently than other antennas. Since the fractal structures are generated by a recursive process, they can produce a very long length or a wide surface area in a limited space. Consequently, fractal structures can give rise to miniaturized wideband antennas having radiation pattern similar to larger antennas. Multiplication of an antenna size by a factor generally decreases the operating frequency of the antenna by same factor, so antenna geometries and its dimensions are the main factors determining their operating frequencies[4].

In this paper we proposed a simple and compact fractal monopole antenna which is realised by combination of Giusepe peano and Sierpinski Carpet fractal geometries [5,6]. The Giusepe peano fractal is applied to the edges of a rectangular patch and sierpinski carpet fractal implemented by making circles by cutting slots on the patch area. The antenna feed is through a microstrip line with a matching section[**7**, 8]. The presented antenna has an omnidirectional radiation pattern and good gain.

II. Antenna Design

The Giusepe Peano fractal which is applied on the edges of the rectangular patch is shown in fig.1. Sierpinski carpet fractal implemented by making circles by cutting slots on the patch area is shown in fig.2. The proposed antenna applies the above two fractals to the rectangular patch is shown in fig.3. The structure of the proposed fractal antenna and its dimensions are shown in fig.4. The antenna feed is through a microstrip line with a matching section over a semi eliptical ground plane. The ground plane is selected as a combinatuion of the rectangular and semi eliptical palne. As the iteration of fractal geometry increases, its resonance frequency decreases, this may lead to effective antenna miniaturization.

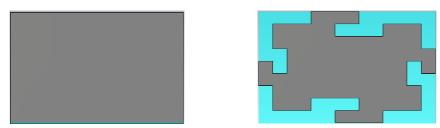


Fig. 1. Giusepe peano fractal

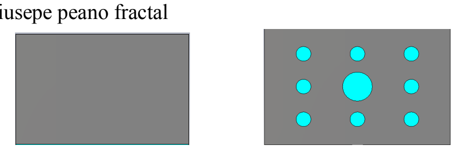


Fig.2. Sierpinski Carpet Fractal

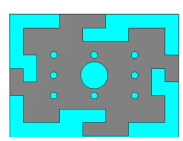


Fig.3. Structure of the proposed geometry

The selected substrate has dielectric constant ε_r=4.4(FR4 substrate), thickness of substrate is h=1.6 mm, and rectaqngular patch (L × W) has dimensions 30×25 mm^2, the radius of the larger cricle is 2 mm and radius of the small cricle is 1 mm, the dimensions of the radiating patch is L_3×W. The feed line of width w_1 is designed for a 50 Ω characteristics and trapered with g_2 for impedance matching. The length of the rectangular section of the ground plane is L_2 and gap between the ground plane and radiating patch is g_1. All dimensions of the proposed antenna is shown in Table.1. By changing the length of the edges of the patch we can shift the frequence i.e if we increase the length of the patch frequency is decreases, if we decrease

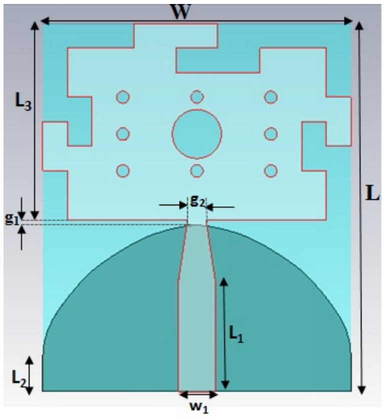


Fig.4. Structure of the proposed fractal antenna

Table 1:Proposed antenna dimensions(in mm)

L	L_1	L_2	L_3	W	w_1	g_1	g_2
30	9	3	16	25	3	0.5	1.5

then frequency increases. The ground plane is combination of rectangular and elliptical sheets.

III. Results and Discussion

The proposed antenna is analyzed using CST Microwave studio suite 2011. The simulated return loss of the propose antenna plotted against frequency is shown in Fig.5. 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.

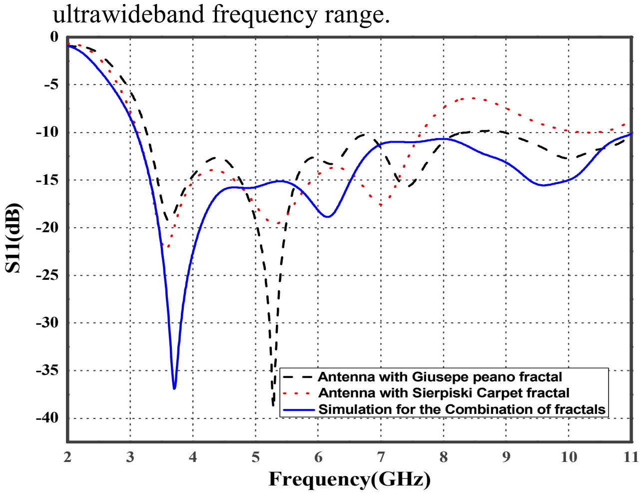


Fig. 5. Simulated Return Loss

B. Gain and VSWR

From fig.6 we can observe that the Peak Gain of antenna in ultrawideband frequency range is 4.713dBi at 8.5 GHz and lowest gain is 1.5dBi at 4.2GHz. The graph of VSWR versus frequency of the proposed antenna is shown in fig.7.

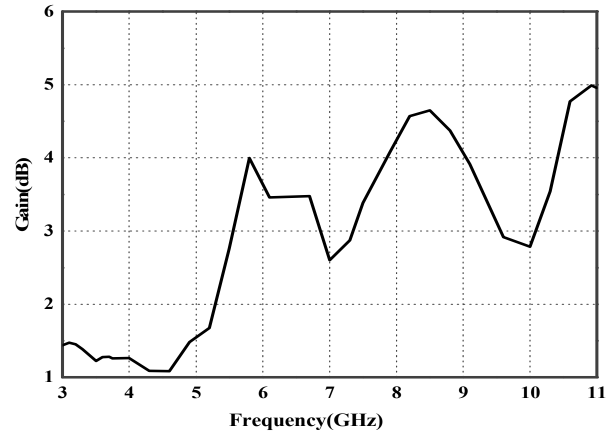


Fig. 6. Gain versus Frequency of the proposed antenna

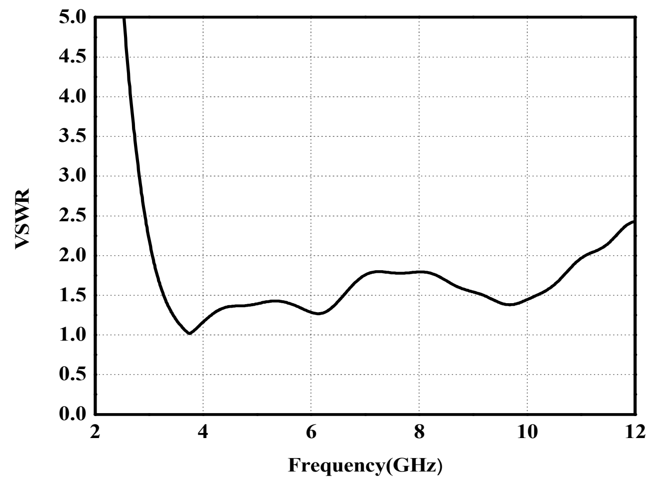
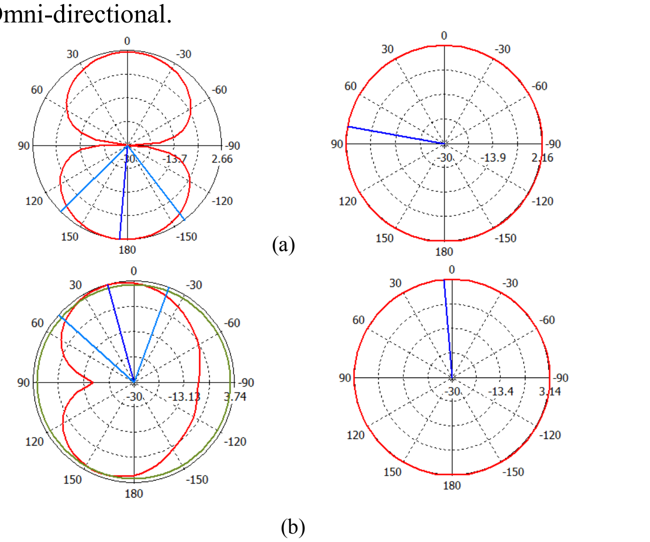
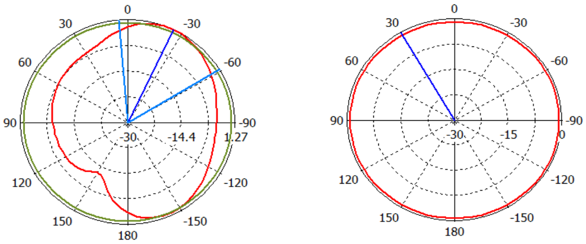


Fig. 7. VSWR versus Frequency of the proposed antenna

C. Radiation Pattern Characteristics

The simulated far field radiation patterns of E-Plane and H-Plane of the proposed antenna are shown in Fig.8 at different frequencies. The simulated radiation patterns show that the E-Plane radiation pattern is in broadside direction and H-Plane in Omni-directional.





(c)

Fig.8. Simulated radiation patterns in E & H Plane of the proposed antenna at **(**a) 3.7 GHz (b) 6.12 GHz (c) 9.7 GHz

IV. CONCLUSION

A simple and compact fractal monopole antenna is designed for covering the complete ultrawideband frequency range by combination of Giusepe Peano and Sierpinski Carpet fractal geometries is discussed.Its feeding system is microstrip line,which is placed over a semi-elliptical ground plane.The proposed antenna has omnidirectional pattern and good gain in ultrawideband frequency range.

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