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Fractal Antenna as a Multiband Antenna for WiMAX Applications

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***Abstract*— With the advancement in antenna technology, there is a great need of a low profile, multi and wide band antennas for wireless communication. Fractal antennas are different from others because of their self-similarity and space filling properties. Fractal micro strip patch antennas have small size, light weight and support multiple frequencies. In this paper, a multiband square fractal antenna is designed and analyzed. This antenna is a direct fed and has truncated ground plane. Antenna properties such as return loss, gain, VSWR, and Bandwidth are analyzed and discussed in this present work. Design and Analysis of fractal antenna is done by using software named HFSS (High Frequency Structural Simulator). This antenna can be used for Wi-Fi and WiMAX applications.**

***Index Terms*- Fractal Antenna, Gain, Multiband Antenna, Wireless Communication**

I. INTRODUCTION

Fractal is derived from a Latin word "fractus" which means broken or irregular fragments. Mandelbrot coined the word fractal and described it as a family of shapes which possess self-similarity and space filling properties in their geometry. A self-similar structure is structure that is made up of scaled down copies of the original structure, i.e., a contraction of the original structure which reduces by same factors horizontally and vertically.

In modern wireless communication systems and of other wireless applications, wider bandwidth, multiband and low profile antennas are in great demand for both commercial and military applications. It has initiated antenna research in fractal shaped antenna elements. Traditionally, each antenna operates in a single or dual frequency bands, where different antenna is required for various applications. It will cause a limited space and place problem. In order to overcome this problem, multiband antenna can be used in which a single antenna can operate at many frequency bands. One technique to construct a multiband antenna is by applying fractal shape into antenna geometry. Fractal technology has great potential in antenna miniaturization; multi-frequency, ultra-wideband application, and this paper are about fractal technology in the application of multi-frequency micro strip antenna.

Benefits of Fractal Antenna: There are many benefits when we applied these fractals to develop various antenna elements. By applying fractals to antenna elements:

1. We can create smaller antenna size.
2. Achieve resonance frequencies that are multiband.
3. May be optimized for gain.
4. Achieve wideband frequency band.

II. FRACTAL GEOMETRIES

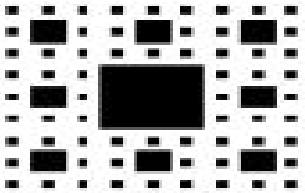
Fractal designs offer better parameters and controlled designs. Fractal antennas not only provide multiband characteristics but also have self-similarity of the geometry. A Fractal antenna provides excellent performance at many different frequencies simultaneously. There are four commonly used geometries.

a) Sierpinski Gasket

Sierpinski gasket is named after the mathematician Sierpinski. In this the central triangle is subtracted from the main triangle shape. After subtraction three equal triangles appear on the structure, each being half the size of original triangle. Iterations can occur infinite number of times and hence Sierpinski gasket is obtained.

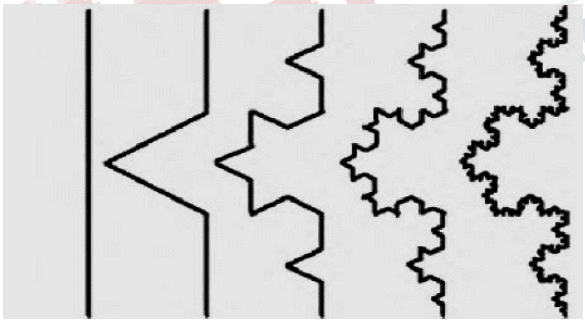
b) *Sierpinski Carpet*

This geometry is similar to Sierpinski gasket, but it uses squares in place of triangles. It starts with a square at first, and divides itself in nine smaller squares while dropping the central square. The same process is again repeated with smaller squares. The Sierpinski Gasket shape is widely used because by using this shape a single antenna can be operated on multiple frequencies.



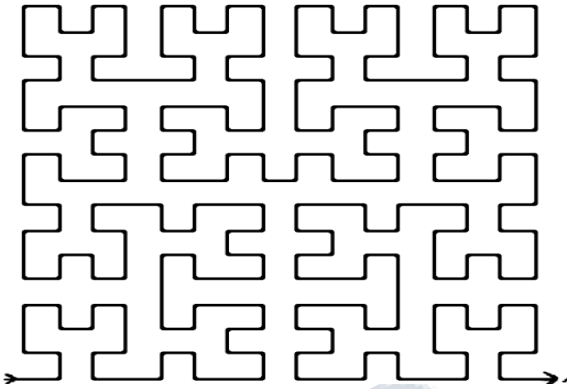
c) *Koch Curve*

This geometry starts with a straight line. This line is then again divided into three equal parts. The middle segment is substituted with two other segments of approximately same length. This is known as first iteration.



d) *Hilbert Curve*

This geometry is simplest from all since it covers the area it occupies. In this the line segments do not intersect with each other and hence reduces complexity.



III. FEEDING TECHNIQUES:

Feeding techniques are important in designing the antenna to make antenna structure so that it can operate at full power of transmission. Designing the feeding techniques for high frequency, need more difficult process. This is because the input loss of feeding increases depending on frequency and finally give huge effect on overall design. There are a few techniques that can be used.

1. Micro strip Line feeding
2. Coaxial Probe feeding
3. Aperture Coupled feeding
4. Proximate Coupled feeding
5. CPW feeding

Here in our project we use Micro strip Line feeding i.e., direct feed (Edge feed).

IV. METHODOLOGY

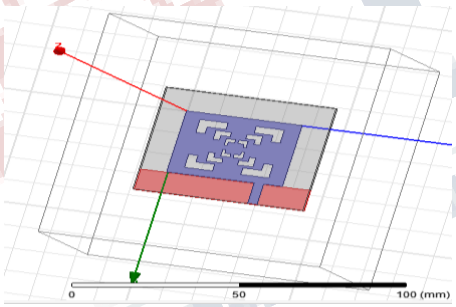
The HFSS (High Frequency Structure Stimulator). software has great flexibility in tackling a wide application range.Multi-frequency antenna has a low frequency operation also has a high frequency bandwidth and operating bandwidth. A fixed space often has many different communication systems, these wireless systems need to work on different operating frequency and pattern. If we can use one or very few antenna wireless systems that can meet these requirements, then no matter the cost size and weight of the system that are very meaningful. There are many methods of designing multi-frequency antenna. Resonant frequency of the antenna with the main unit placed near the resonant frequency of a parasitic element to another, you can get a dual-band antenna, which is to obtain dual-band antenna, the easiest method. The two works in different frequency antenna elements fed by a serial port work is also a way to achieve dual-band. We need to design the proposed antenna in HFSS software,

analyze it and observe the return loss, VSWR, Gain and Radiation pattern.

V. ANTENNA DESIGN

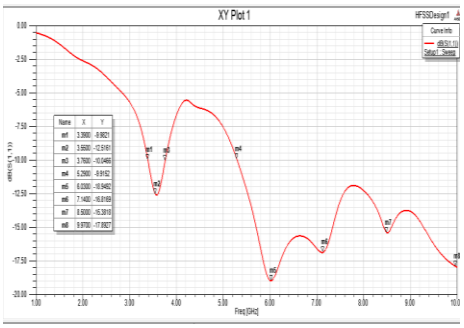
Micro strip antenna is a simple antenna that consists of radiated patch component, dielectric substrate, and ground plane. The radiated patch and ground plane is a thin layer of copper or gold which is a good conductor. Each dielectric substrate has their own dielectric permittivity values. This permittivity will influence the size of the Antenna. Micro strip antenna is a low profile antenna.

The presented antenna is a squarer patch antenna that is iterated up to 3rd level. The antenna is designed for multiband applications. The antenna resonates at four frequencies i.e., 1.86, 2.29, 3.02 and 4.05 GHz. The material of the substrate is FR4 with permittivity 4.4 and thickness h = 1.52mm. The length of the substrate is 54.36mm and width is 46.72mm and the ground plane is truncated. The length and width of the patch is 37mm and 28mm respectively. The final results of the antenna can be obtained from third iteration of micro strip patch antenna. The antenna is designed using High Frequency Structure Simulator (HFSS) software. The wideband characteristics increase as the number of iterations increases. The design of the antenna is shown in figure below.



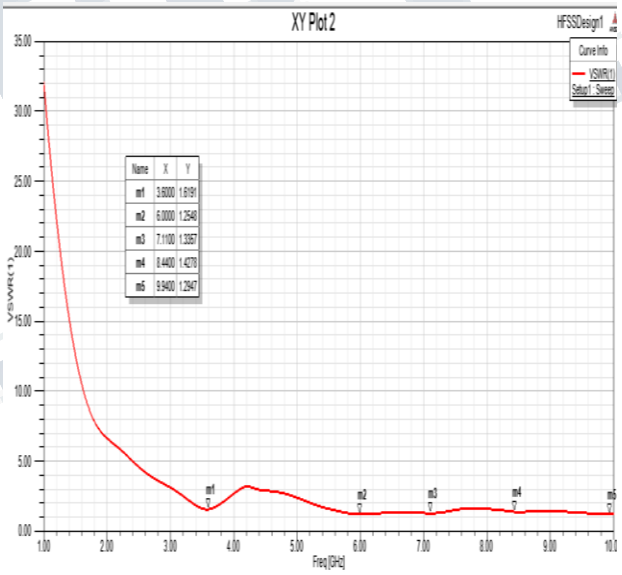
VI. SIMULATION RESULTS

RETURN LOSS:



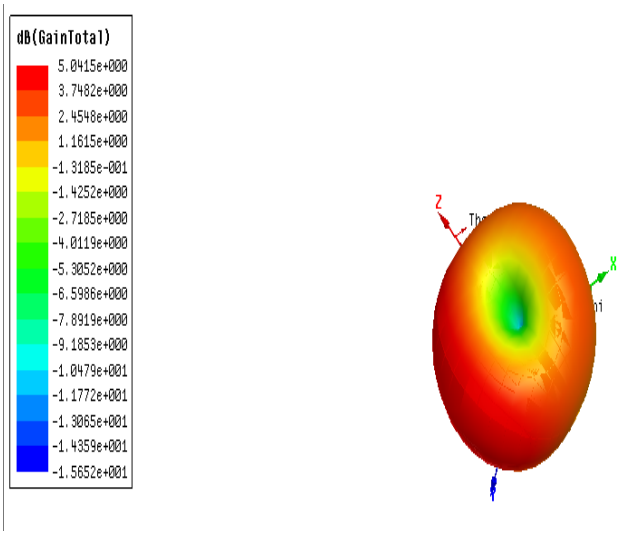
From the figure we observed better return loss at 5 frequencies which are 3.55 GHz (-12.52dB), 6.03GHz (-18.94dB), 7.14GHz (-16.81dB), 8.50GHZ (-15.38dB) and 9.97 GHz (-17.89dB) which are used for multi band applications.

VSWR:



VSWR reading should be in between 1 and 2 for an efficient antenna. And in our proposed antenna we got VSWR reading between 1 and 2 for multiple frequencies such as 1.61, 1.25, 1.3, 1.4 and 1.29.

GAIN:



Gain (in dB) should be more than 3dB for an efficient patch antenna. And in our proposed antenna we got 5.0415dB as gain. And we have also observed that by truncating the ground plane, the gain of the antenna got increased efficiently resulting in wide band characteristics.

VII. CONCLUSION

Multiband Square Fractal antenna is suitable for Wi- Fi and WiMAX Network applications. This geometry is covered the frequency range from 2.0 to 11.0 GHz. Return loss is in between -10 to -25 dB and VSWR is in between 1 and 2 and gain is 4.883dB.Microstrip line feeding is provided to proposed antenna which is simple and suitable for this. And we also observed that by truncating the ground plane gain of the antenna is increased and wide bands are also obtained.

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