DESIGN OF FRACTAL ANTENNA USING CIRCULAR PATCH FOR MULTIBAND

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ABSTRACT

This paper presents a novel on design of fractal antenna for multiband using circular patch. In this design sierpinski gasket geometry is used. Sierpinski gasket geometry uses triangle. Fractal antenna allows smaller size, broadband and multiband performance. This antenna is designed using IE3D software on FR4 substrate having dielectric constant 4.4 and having fed 50 ohms micro-strip line and optimized to operate in multiple bands between 0 – 10GHz.

Keywords: Fractal Antenna, Sierpinski Gasket, Circular Patch, Microstrip Feed Line

I. INTRODUCTION

In modern wireless communication systems and increasing of other wireless applications, wider bandwidth, multiband and low profile antennas are in great demand for both commercial and military applications. Traditionally, each antenna operates at a single or dual frequency bands, where different antenna is needed for different applications. This will cause a limited space and place problem. In order to overcome this problem, multiband antenna can be used where a single antenna can operate at many frequency bands. The combination of infinite complexity and detail and self-similarity makes it possible to design antennas with very wideband performances. One technique to construct a multiband antenna is by applying fractal shape into antenna geometry. Fractal is a concept extension to the microstrip antenna. In many fractal antennas, the self-affinity and space-filling nature of fractal geometries are often quantitatively linked to its frequency characteristics. Fractals are geometrical structures, which are self-similar, repeating at regular intervals of time. The geometry of fractals is significant because the physical length of the fractal antennas can be enlarged while keeping the total area same.

II. FRACTAL ANTENNA

Fractal was first invented by Benoit Mandelbrot [1], and he is known as the predecessor of fractal geometry. He stated, “I devised fractal from the Latin adjective”.Fractal antenna theory is a relatively new area. The geometry of the fractal antenna provides an attractive multi-band solution. Mandelbrot offered the following definition “A fractal is by definition a set for which the hausdorff dimension strictly exceeds the topological dimension”, which the later retracted and replaced with: - “A fractal is a shape made of parts similar to the whole in some way”[2]. Fractals are geometrical shapes, which are self-similar, repeating themselves at different scales.

Fractal offers several advantages such as-

1. Multiband performance is at non-harmonic frequencies.

2. Compressed resonant behaviour.
3. In many cases, the use of fractal element antennas can simplify circuit design.
4. Reduced construction costs.
5. Improved reliability.

Features of fractal are as shown below.

1. Self-similarity feature is useful in designing multiband antenna
2. Small dimension is essentially useful in the design of electric small antennas
3. Increasing the number of iterations enhances the electrical length of an antenna
4. Space filling ability is necessary to miniaturize the antenna size

Disadvantages of fractal antenna

1. They have low gain
2. We have to take care of numerical limitation.
3. Geometry of the antenna is complex.
4. Practically few iterations are possible.

Fractals have no size characteristics and it has self- similarity property. There are some unique geometries which are useful in developing new and innovative design for antennas. These geometries are sierpinski gasket, sierpinskicarpet ,Koch curves. In this paper sierpinski gasket is designed using circular patch. The Sierpinski triangle, also called the Sierpinski gasket or the Sierpinski Sieve, is a fractal named after the Polish mathematician WaclawSierpinski who described it in year 1916 [3]. Sierpinski gasket geometry is the most widely studied fractal geometry for antenna applications. Sierpinski gaskets have been investigated extensively for monopole and dipole antenna configurations [4]. Several structures are derived from the original Sierpinski fractal structure and analyzed in order to get better multi-band behaviour. The generation of this geometry is explained in two ways:

- The multiple copy approach
- Decomposition approach

It starts with small equilateral triangle. Two more copies of this triangle (same size) are generated and attached to the original triangle. This process can be done n number of times, n being the order of the fractal iteration. In the decomposition approach, one starts with a large triangle encompassing the entire geometry. The midpoints of the sides are joined together, and a hollow space in the middle is created. This process divides the original triangle to three scaled down (half sized) versions of the larger triangle[5].

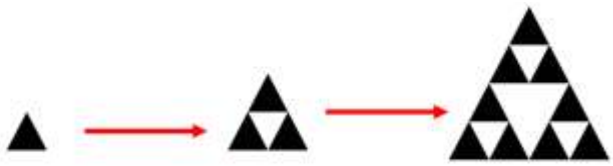

Fig No.1 Multiple Copy Approach

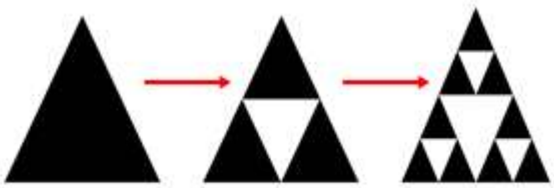

Fig No. 2 Decomposition Approach

III. ANTENNA DESIGN

In this paper sierpinski gasket geometry is used with circular monopole antenna . In this paper decomposition approach is used. But two circles are used with radius R_1= 26mm, R_2= 25mm, h= 1.6mm, $€_r$= 4.4 and loss tangent= 0.019 with ground plane L_g x W_g = 54mm x 16 mm. The width of the micro strip feed line is calculated and optimized to achieve 50 Ω impedance match. In this paper one large triangle is constructed inside the circle. After that midpoints of the sides of the triangle are joined together and hollow space in the middle is created. This process divides the large triangle into three scaled down version and then three circles are constructed inside that large triangle.

Table No.1 Antenna Configuration

Size of first triangle	50x48 mm
Size of second triangle	25x24mm
Diameter of the circle	8mm

The proposed antenna structure is as shown in the figure below.

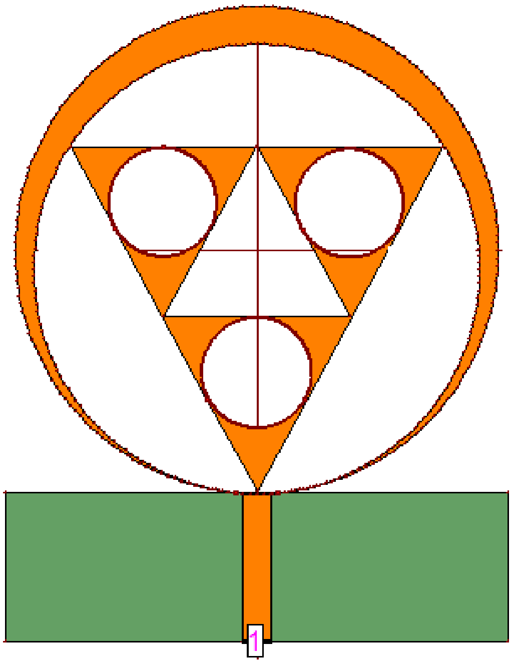

Fig No.3 Schematic of Proposed Sierpinski Gasket Antenna

IV. SIMULATION RESULTS

S11 gives reflection coefficient. The return loss is defined as loss of power in the signal reflected by discontinuity in the transmission line. This transfers happens only when characteristic impedance is matched with input impedance of antenna otherwise reflected waves are generated which results in the degraded performance of an antenna. Ideally reflected waves must be zero.Figure 3 shows the S11 parameter of proposed antenna design. Table no.2 of frequency band is as shown below.

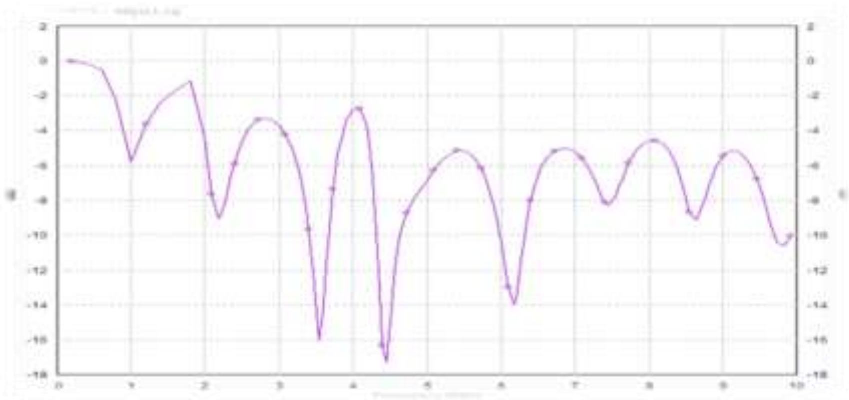

Fig.No. 3 S11 Parameter of Sierpinski Gasket Antenna

Table No. 2 Frequency Band of Proposed Antenna

First band	2.1-2.4 GHZ
Second band	3.3-3.6 GHZ
Third band	4.3-4.6 GHZ
Fourth band	6- 6.3 GHZ
Fifth band	7.3 GHZ
Sixth band	8.4 GHZ

V. CONCLUSION

Fractal antenna with a circular patch using micro strip line for multiband is designed in IE3D and fabricated on FR4. From the simulation results proposed antenna resonates at frequency band 2.1-2.4 GHZ, 3.3-3.6 GHZ and 4.3-4.6 GHZ, 6-6.3 GHZ, 7.3 GHZ, 8.4 GHZ. Sierpinski Gasket geometrical structures have been investigated for multiband applications. By increasing the radius of the patch , ground plane length and width the frequency shifts to the lower side.

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