Design of Sierpinski Gasket using Circular Patch for Multiband

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Abstract—**A compact circular patch Sierpinski gasket antenna with micro strip feed line for multiband. The proposed multiband antenna design is based on the triangular geometry. This geometry is called sierpinski gasket. The dual band and triple- structures have been realized on FR4 substrate with circular patch. Multiband sierpinski gasket with circular micro-strip antennas offers increase in bandwidth and the size of antenna gets reduced. For operational frequency band are 2.1-2.4 GHZ, 3.1-3.5GHZ and 5.1-5.4 GHZ.**

Keywords— **Fractal antenna, Sierpinski gasket, monopole antenna, microstrip feed line.**

I. INTRODUCTION

Wireless communications is a rapidly growing segment of the communications industry, with the potential to provide high-speed high-quality information exchange between portable devices located anywhere in the world. Antenna is very important element in wireless technology.The field of antenna design has become one of the most attractive fields in the communication studies and research. The micro strip patch antenna plays important role in antenna design. These antennas offers low profile, small size, light weight. But the major disadvantage of this antenna is narrow bandwidth. To overcome this, by changing parameters, structures of antennas are designed which provides dual band, multi band and ultra wide band (UWB).

As compared to microstrip planar monopole antennas offer wide bandwidth and good radiation characteristics and high radiation efficiency. Planar monopoles with different shapes viz. triangular, circular, square, trapezoid, pentagonal, hexagonal, and elliptical have been reported[1].Planar antennas have been reported to provide multi frequency operations, having a height of only about 0.05 times the wavelength of the lowest operating frequency and having omnidirectional radiation for all operation bands [2]. The bandwidth of circular monopole antenna is larger than all monopole antenna.

One technique to construct a multiband antenna is by applying fractal shape into antenna geometry. The monopole type sierpinski antenna offers multiband characteristics.

II. FRACTAL ANTENNA

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"[3].

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.

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 [4]. 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 [5]. 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[6].
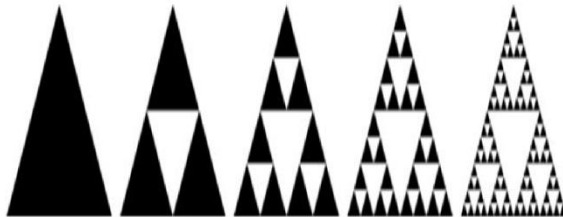

Fig No.1 Sierpinski Gasket

III. ANTENNA DESIGN

In this paper the design starts with a circular patch with radius R= 14mm, h= 1.6mm, ϵ_r= 4.4 and loss tangent= 0.019 with ground plane L_g x W_g = 30mm 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 a hollow space is created. Then midpoints ofthe sides of the triangle arejoined together and another triangle is constructed which is half sized of the large triangle. This process divides the larger triangle to three scaled down (half sized) versions. The table 1 shows the dimension of triangle inside the circle is as follows:

Size of first triangle	25x24 mm
Size of second triangle	12x13mm
Size of third triangle	6x5mm

Table No.1 Antenna configuration

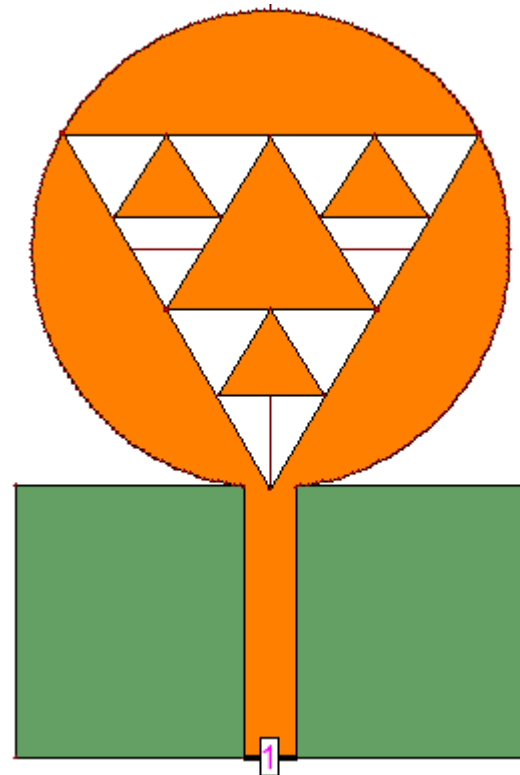The proposed antenna structure is as shown in the figure below.

Fig No.2 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. Figure 3 shows the S parameter of proposed antenna design. Table no.2 of frequency band is as shown below.
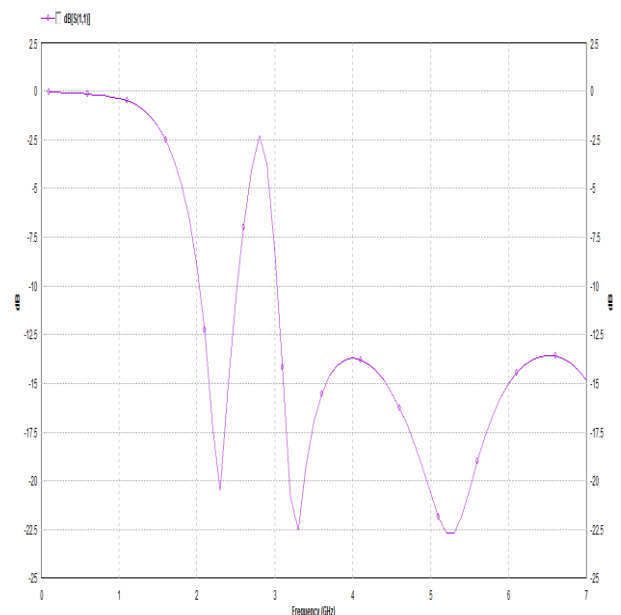

Fig. 3 S11 Parameter of Sierpinski Gasket antenna

First band	2.1-2.6GHZ
Second band	3.1-3.6GHZ
Third band	5.1-5.6GHZ

Table No. 2 Frequency Band of Proposed antenna

V. CONCLUSION

Sierpinski gasket antenna with a circular patch using microstrip line for multiband is designed in IE3D and fabricated on FR4. The dual band and triple structures have been realized on FR4 substrate with triangular geometry. The result demonstrates that the proposed antenna with circular patch resonate at frequency band 2.1-2.6GHZ, 3.1-3.6GHZ and 5.1-5.6GHZ. The proposed antenna has a good return loss. Sierpinski Gasket geometrical structures have been investigated for multiband applications. A thick dielectric substrate also plays vital role in increasing the bandwidth.

VI. REFERENCES

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