Review on Fractal Antennas for Wireless Communication

Shinde Poonam
Department of Electronics and Communication Engineering
VPCOE, Baramati, Maharashtra, India

M. M. Jadhav
Department of Electronics and Communication Engineering
VPCOE, Baramati, Maharashtra, India

Abstract- With the growth of wireless communication systems and growing significance of other wireless applications, multiband and low profile antennas are in higher demand for both commercial and military applications. There are moreover numerous applications like personal communication systems, satellite communication system, WLAN and Radar applications, which use Multi-band and wideband antennas.AS number of slots etched on patch is directly proportional to the frequency bands so fractal antenna is one of the candidates for multiband antenna. Fractal antennas have valuable applications in cellular telephone and microwave communications. But as size of antenna decreases bandwidth support also decreases. So it is essential to have small size with high bandwidth. Fractal antennas have attractive solutions for using a single small antenna operating in several frequency bands. This paper describes the concepts and techniques for reducing the size of an antenna by the use of fractals. Fractal antennas are a legitimately new research area and are possible to have a capable future in many applications. .

Keywords – fractal antenna, minkowski, iteration factor, compact size, microstrip antenna

I. INTRODUCTION

Dr B. Mandelbrot invented the term Fractal. Fractal represents broken or irregular fragments. He investigated the relationship between fractals and nature using findings made by Gaston Julia, Pierre Fatou, and Felix Hausdorff [1]. The geometries of fractal antenna can be defined and created using an iterative process that indicates the self-similarity Structures. These can be categorised in two types: Deterministic and random such as the Sierpinski gaskets and the von Koch snowflake, those are created by several scaled down and repeated copies of themselves, random fractals also have elements of randomness that permits simulation of natural phenomena [2]. Many fractals exist in nature and have various properties like recursive, infinite, space filling and self-symmetry. Due to these properties fractals have more resonant frequency which gives lower return loss Fractal concept has been useful to many branches of science and engineering, including fractal electrodynamics for radiation, propagation and scattering[3].

II. LITERATURE SURVEY

Amanpreet Kaur , Gursimranjit singh describes the theories and techniques for decrease the size of an antenna through the use of fractals. Fractal antennas can obtain radiation pattern and input impedance comparable to a longer antenna, thus take less area due to the many curves of the shape. Fractal antennas are a justly new research area and are probable to have a hopeful future in many applications [1].

Sarita Verma, Aishwarya Verma , provide a comprehensive review of recent developments in the field of fractal antenna engineering. First they give brief introduction about fractal antennas and then proceed with its designs and algorithms. Finally, they will discuss recent work done in the area of fractal antennas [2].

Steven R. Best compares the radiation pattern characteristics of the Sierpinski gasket and the modified Parany gasket and evaluated from a practical perspective [4].

V. V. Reddy and N. V. S. N. Sarma introduce the structure for triband CP radiation by employing optimized asymmetrical Koch fractal curves as boundaries of a square patch and embedded rectangular slot.[5]

III. GEOMETRIES OF FRACTAL ANTENNA

Fractal geometries can easy to defined and created using an iterative process that leads to self-similar and self-affinity structures. Many fractals found in nature as shown in following figure 1 [3].

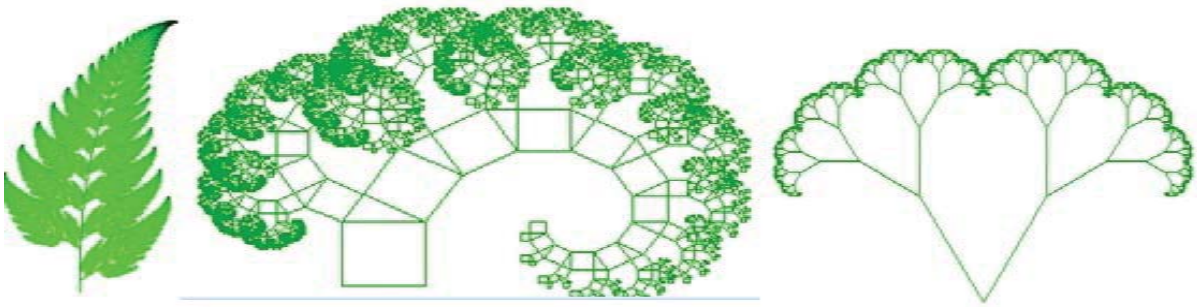

Figure 1.Fractal shapes found in nature

1) SIERPINSKI GASKET FRACTAL GOMETRY

Sierpinski gasket triangle is a deterministic fractal. It has properties that are common to all fractals like reappearance, which mean whatsoever part of the triangle we take, if we magnify it, we will discover exactly the same triangle in it .The deterministic construction for the Sierpinski gasket. We start with an equilateral triangle. Then the midpoint of each side is use as the vertices of a new triangle, which we then take out from the original. We continue with this process, for each remaining triangle, we remove the middle leaving behind three smaller triangles as shown in figure 2[1].

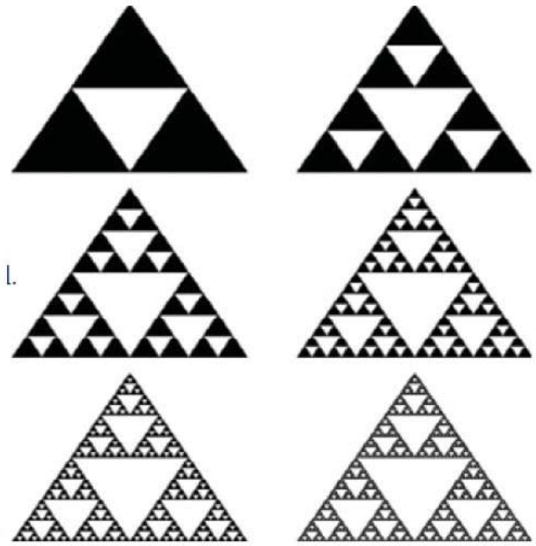

Figure 2.Several stages in the construction of a Sierpinski gasket fractal

2)VON KOCH SNOWFLAKE FRACTAL GOMETRY

Koch snowflake is created by adding smaller and smaller triangles to the original structure in an iterative way. This procedure is clearly established, where the first few stages in the construction of Koch snowflake geometry are shown in figure 3[2][5].

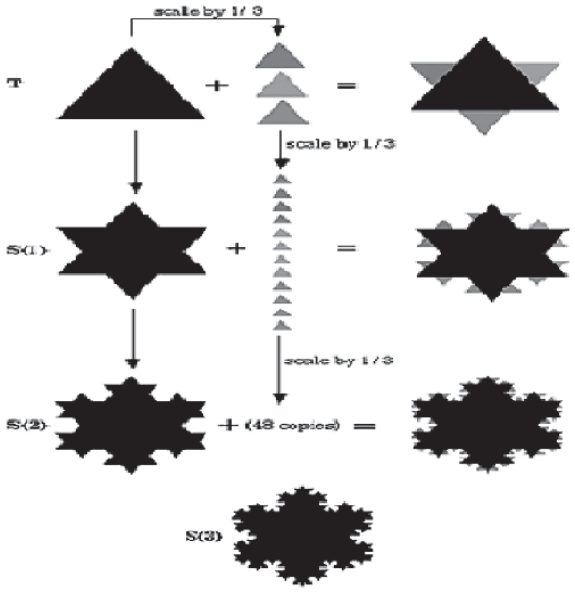

Figure 3.First few stages in the construction of a Koch snowflake.

3) MINKOWSKI FRACTAL GOMETRY

Minkowski fractal has a square shape in which each of four straight sides of square is replaced with generator and we applied cut of iteration width by scaling 1\3 of each straight sides of square at every iteration and the depth is adjust at optimization to get accurate results. Few steps in construction of Minkowski geometry is shown in figure 4.

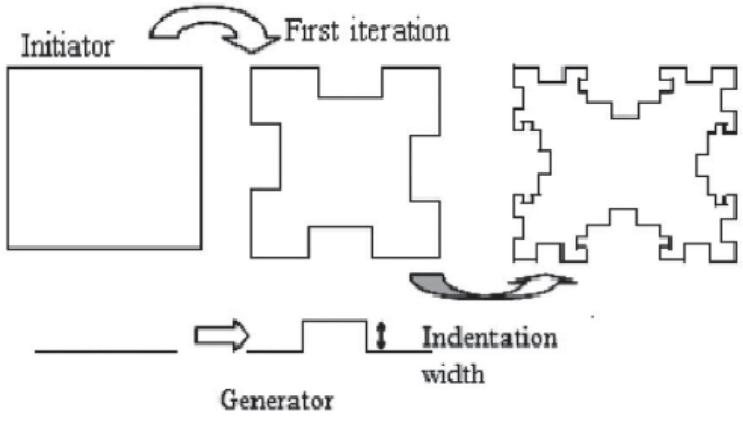

Figure 4.Several stages in the construction of a Minkowski fractal.

IV. APPLICATIONS OF FRACTAL ANTENNAS

There are many applications that can profit from fractal antennas, discussed below are some concepts where fractal antennas can mark a real effect. The rapid development in the wireless communication area has bounced a need for compact integrated antennas [1]. The space saving capacities of fractals to competently fill a limited

amount of space make distinct advantage of using integrated fractal antennas over Euclidean geometry. Examples of these types of application include personal hand-held wireless devices such as cell phones and other wireless mobile devices such as laptops on wireless LANs and networkable PDAs [2]. Fractal antennas can also supplement applications that include multiband transmissions. This area has many options ranging from dual-mode phones to devices integrating communication and location services such as GPS, the global positioning satellites. Fractal antennas also reduce the area of a resonant antenna, which could lower the radar cross-section (RCS). This advantage can be exploited in military applications where the RCS of the antenna is a very critical parameter.

V. ADVANTAGES

The Small size with multiple frequency bands is on prime advantage of fractal antenna. Along with this it also has many advantages such as Better input impedance, Wideband/ Multiband support (one antenna can be used instead of many). Consistence performance over huge frequency range, Added inductance and capacitance without components. Instantaneous spectrum access. Consistent performance over huge frequency range.

VI. LIMITATIONS

There are some limitations of fractal antennas they are as follows:
Gain loss, Complexity, Numerical limitations, The benefits begin to diminish after a few iterations.

IV.CONCLUSION

From the discussion, we have examined the many key profits of fractal in antenna designing, with increasing number of iterations of fractal, resonant frequency increases which results in lower return losses. We get multiband and broadband frequency response by using fractal geometry.

Further work is required to catch an understanding of the connection between the performance of the antenna and the fractal dimension of the geometry that is used in its structure. This needs to study many more examples of fractal geometries which are applied to antennas. And to get a better understanding of the fractal dimension of the geometries such that connections can be drawn about this dimension and the performance of the antenna.

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