

A Survey on Design Procedure and Performance of the Different Types of Fractal Antenna

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Abstract— In this paper we had explained the design procedure of the various types of fractal antennas and in the end we had done the performance analysis of the different types of fractal antenna i.e. Sierpinski fractal, Koch fractal (square Koch and triangular koch) and Giuseppe Peano fractal. We had analyzed the return loss, resonance frequency and the gain parameter of the different fractal antenna. A microstrip line feed have been used to excite the different types of fractals. These papers demonstrate the design procedure of various fractal antennas to be used in field of radar, also for the communication process.

Key words: Fractal Geometries, Microstrip, Miniaturization, Multiband/Wide Slot Antenna

I. INTRODUCTION

Patch antenna is a printed resonant antenna of narrow-bandwidth generally used in microwave frequency bands. It was firstly coined out in 1953. The fractal geometries are structures with no specific size constructed from multiple exactly similar segments with different size scales; it was firstly demonstrated by Benoit B. Mandelbrot in 1983. Applying fractal shapes to the patch leads to introduce an antenna with multiband frequency operation due to the capacitive and inductive loads appended to the patch surface. Generally fractal microstrip antenna has perimeter more than conventional patch antenna. Most of fractal microstrip antenna produces maximum radiation at broadside with circular polarization. These antennas are of very very low profile, light in weight, simple and inexpensive to fabricate using modern day printed circuit board technology, compatible with microwave and millimeter-wave integrated circuits (MMIC) fractal antenna is used to enhance gain and bandwidth of antenna. Fractal antennas have the ability to conform to planar and non-planar surfaces. The variety in design that is possible with microstrip antennas probably exceeds that of any other type of antenna element.

II. SIERPINSKI CARPET GEOMETRY

The design and simulation result of Sierpinski Carpet Fractal was first given by R. Mohanamurali and T. Shanmuganatham. First iteration is done by dividing a square patch into 9 smaller squares and by eliminating the centre square. Second iteration is done by dividing the rest of 8 squares into 9 smaller squares. Then removing all the centre squares for each remaining square. The simulation result of the Sierpinski Carpet Fractal antenna shows that after the first iteration the size of patch antenna can be reduced to 30.5% of its original size and for the second iteration the simulation result shows that the size of patch can be reduced to 33.9% of its original size, with the performance parameter of the antenna like reflection coefficient, resonance frequency being unchanged.

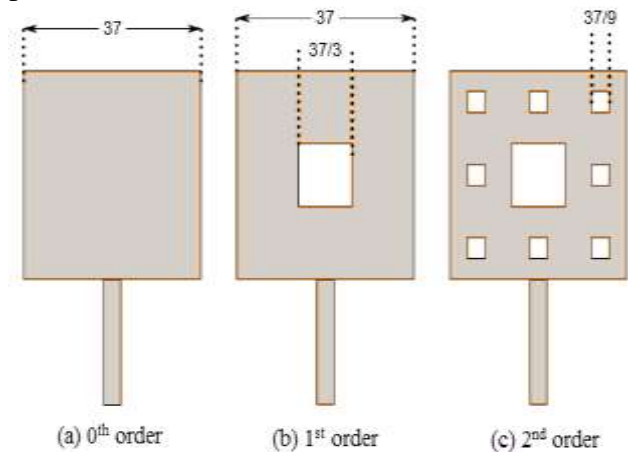


Fig. 1: SCF antenna iterative procedure layout

In Fractal Shaped Sierpinski for enhancing the bandwidth or reducing the size of wide slot antenna, the technique of fractal is applied at wide slot radiator. As the number of iterations increases the numbers of resonance frequency also increases and the lower value of resonance frequency also decreases.

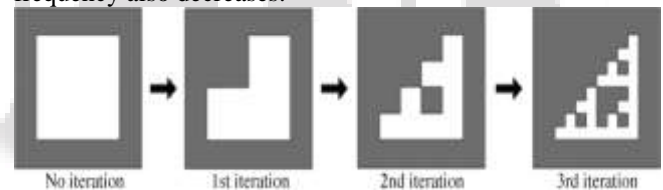


Fig. 2: The Iterative stages of wide slot SCF

III. MINKOWSKI CURVE FRACTAL

In the modern communication systems antenna size is the main obstacle during the designing, where antenna geometry plays a vital role in enhancing the bandwidth and size reduction of the overall system. MKF geometry has been proposed by Chen and Chang to reduce the size and increase the radiation efficiency of the antenna. A substrate of 2.2 dielectric constant and 1.6 mm thickness has been used. Coaxial cable of 50 Ω impedance has been used as a feeder. In the telecommunication sector, there are many devices that possess multifunction capacities such as satellite systems, radio determination applications, broadband wireless access, navigation systems and many other applications. In order to meet the capabilities of these devices they should be provided by a multiband antenna. The simulation result of the antenna shows that the size reduction of 49% and 62% can be achieved for the 3rd and 4th order of iteration respectively.

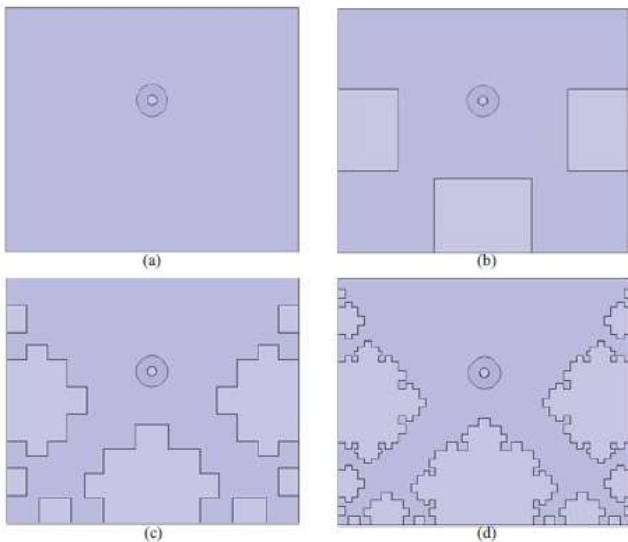


Fig. 3: Minkowski Curve Fractal Configuration

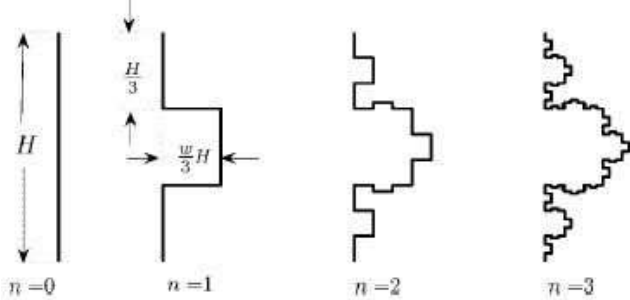


Fig. 4: Design stages for Minkowski Curve Fractal

IV. GIUSEPPE PEANO FRACTAL

Basically this antenna is design for miniaturization and for multiband operation which can be achieved by fractal geometry. The property of self-similarity of fractal geometries is used to achieve multiband operations from fractal antennas and their space-filling property is used for the antenna miniaturization. Further we can achieve miniaturization of the antenna by slot cutting at the corners of the fractal antenna. The bandwidth enhancement can be achieved by providing the suitable airgap in between the ground and the substrate on which the patch is mounted. The resonance frequency of the Giuseppe Peano fractal get lowered than the conventional patch antenna due the fact that the current patch increases in fractal antenna.

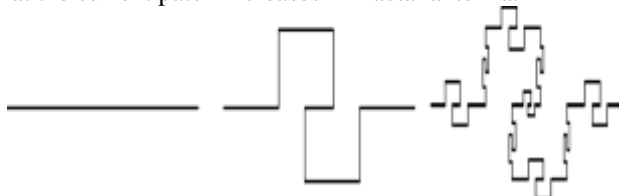


Fig. 5: Initiator and generator of Giuseppe Peano Fractal.

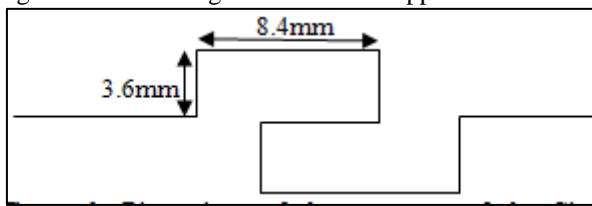


Fig. 6: Dimensions of the generator of the Giuseppe Peano Fractal

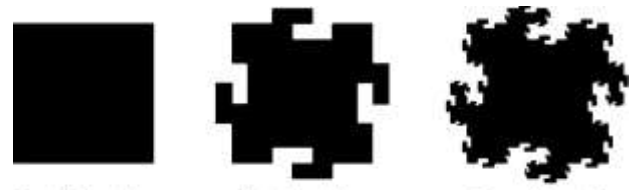


Fig. 7: Implementation of the Peano fractal to the edges of square patch.

V. SOME OTHER FRACTALS

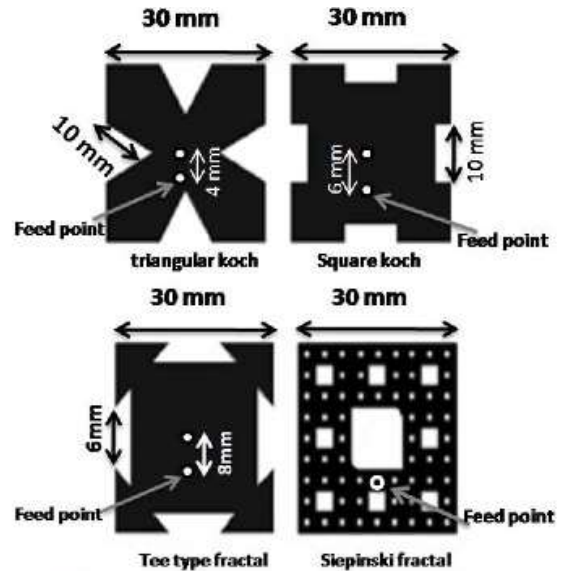


Fig. 8: some common fractal structures.

VI. PERFORMANCE ANALYSIS

The frequency response, s_{11} of the several fractal geometry antenna such as Sierpinski, Tee- type, Giuseppe Peano and Minkowski are drawn and compared in the figure 9. Simulation result shows that the Giuseppe Peano Fractal antenna produces larger value of 10 db return loss for low number of iteration compared to the others fractal antennas.

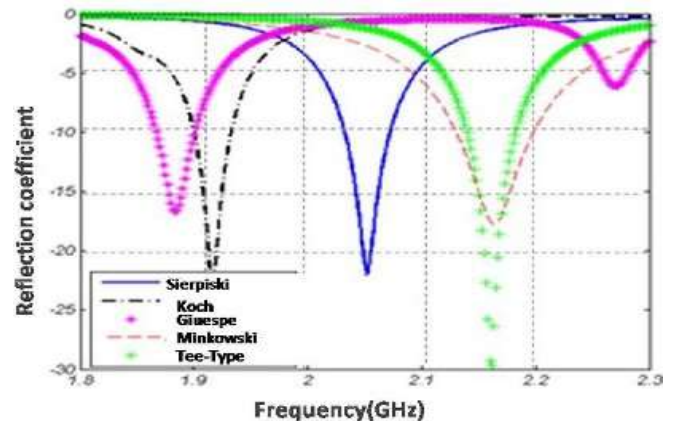


Fig. 9: Comparison of Reflection Coefficient

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