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A Compact Coplanar Feed Slotted Antenna for Wireless Applications

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Abstract— A Compact and geometrically low profile multiband microstrip coplanar antenna exclusively used for wide range of wireless applications like Wi-Fi, Wi-Max, WLAN, RADAR, RFID Reader, X-WAV, Hiper LAN2, etc…., is proposed. A basic rectangular microstrip patch fed by microstrip feed line forms iteration 0 structure. Over that iteration 1, 2 and 3 are made by adding successive squares at each corners of the previous iteration with coplanar feeding. Radiation characteristics of proposed antenna are simulated using mentor Graphics IE3D Simulator. Its radiation characteristics such as Return loss, VSWR, Elevation pattern, Azimuth pattern, Gain, Directivity, Efficiency etc…, are analyzed and compared.

***Index Terms*—Fractal, IE3D, Wi-Fi, Wi-Max**

I. Introduction

To meet the current trends in the field of modern communication systems, it is essential to design a compact antenna which suits for different wireless applications. Fractal antennas [6-8] are the best suitable radiating structure. Fractal is a new class of geometry that was proposed by "Mandelbrot". The physical construction of the fractal is not possible only objects with a limited number of iterations can be built. These objects are usually referred to as pre fractals. These Fractal increases the electrical length of the antenna without affecting the radiation characteristic of conventional antenna [5]. Self similarity and Space filling properties of fractal antennas is utilized in the design of antennas with notable characteristics like multiband behaviour and miniaturization.

Self similarity means that an object is build of sub units and sub units on multiple levels which tries to figure out the structure of entire object. Space filling means it uses long electrical length into small dimensions [9-11].

Sierpinski carpet antenna based on fractal geometry is low profile antennas, moderate gain and can be operated at multiband of frequencies leads to a multi functional structure. This type of wideband antenna displays high self similarity and symmetry.

II. Antenna Design

The basic structure of Sierpinski antenna is built from a regular Microstrip patch [2] and runs through several iterations to generate multiband characteristics. The basic structure of the square patch is $54x54mm^2$ as shown in Fig1. The substrate thickness is 1.6mm, the loss tangent is 0.02 and the material used for the antenna is FR4 with dielectric constant 4.4[8]. The coplanar feeding method was used.

A. Zeroth Iteration

The zeroth iteration for Sierpinski carpet antenna is a general square of 54x54mm [8]. A Coplanar feed structure is used.

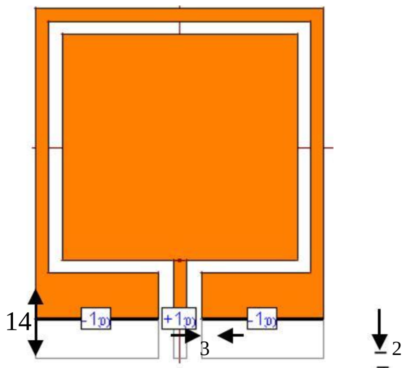

Fig. 1. Zeroth Iteration
(Note: All dimensions are in mm)

B. First Iteration

First iteration of Sierpinski carpet fractal antenna structure is designed by dividing a square in to 4 smaller squares [20]. Then the square at the upper left corner is eliminated which results in 3 squares.

Then the new area [4] of the square fractal is

$$A = a^2 - (a/2)^2$$
$$= (3/4)\, a^2 \text{ sq.units}$$

Hence the antenna area is reduced by 25%.

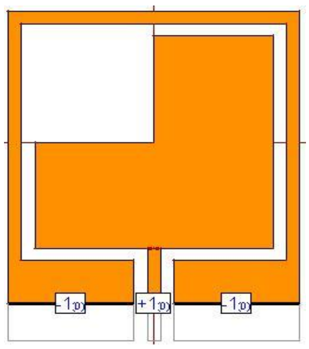

Fig. 2. First Iteration

C. Second Iteration

The second iteration of Sierpinski Carpet Fractal antenna structure was designed by divided each remaining three square into twelve smaller squares [13-

14]. Then remove the entire each square upper left corner. Hence the antenna area is reduced by 50%.

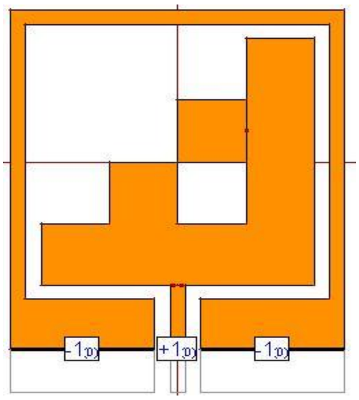

Fig. 3. Second Iteration

D. *Third Iteration*

The Third iteration of Sierpinski Carpet Fractal antenna structure was designed by dividing each remaining nine squares into thirty six smaller squares. Then remove the small squares in the upper left corner of all to form twenty seven small squares. Hence the antenna area is reduced by 75%

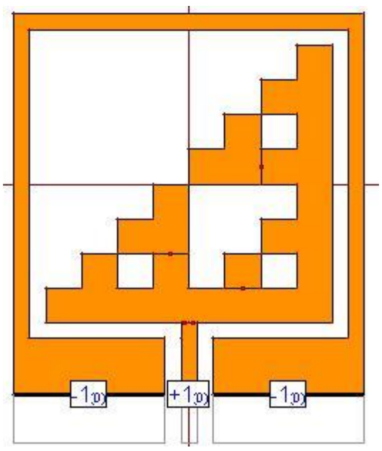

Fig. 4. Third Iteration

III. RESULT AND DISCUSSION

Initially the square was designed and simulated. Then Sierpinski carpet fractal geometry is used and three iterations were performed and simulated using IE3D [12] software. For optimization, simulations have been repeated at various feed positions.

A. *Return loss for Zeroth Iteration*

The Fig.5 shows the simulation results of zeroth iteration. The square patch resonates at different frequencies of 1.36 GHz, 2.64GHz, 3.0 GHz, 3.81 GHz, 4.83 GHz, 5.43 GHz, 6.0 GHz with the return loss of -20 dB, -14dB, -13dB, -30dB, -28dB, -12dB, -17dB respectively as shown in fig6.

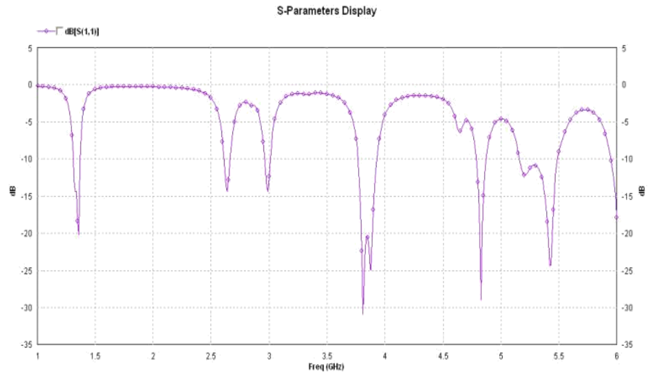

Fig. 5. Return loss of Zeroth Iteration

B. *Return loss for First Iteration*

The first iteration of the Sierpinski Carpet fractal antenna is performed and its simulated results are shown in figure 6. After first iteration, the Sierpinski carpet antenna resonates at multiband Characterstics for different frequencies namely 1.06 GHz, 2.65 GHz, 2.81 GHz, 3.88 GHz, 4.57 GHz, 5.01 GHz, 5.37 GHz and 6.0 GHz respectively.

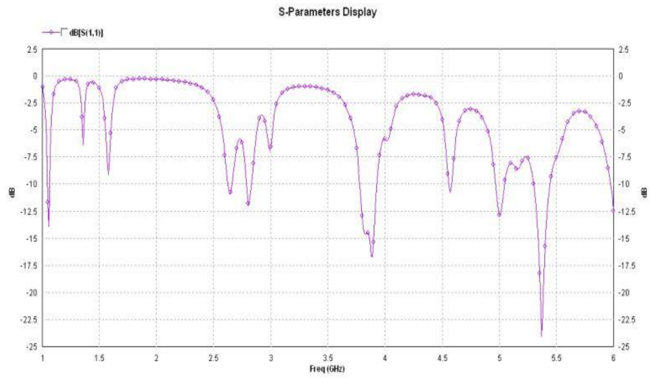

Fig 6. Return loss of First Iteration

C. *Return loss for Second Iteration*

Sierpinski carpet antenna has gone through the second iteration to exhibit at four different frequencies namely 2.84 GHz 3.26 GHz, 5.38 GHz and 5.84 GHz with the return loss of -12 dB, -21 dB,-20 dB and -14 dB respectively as shown in Fig.7.

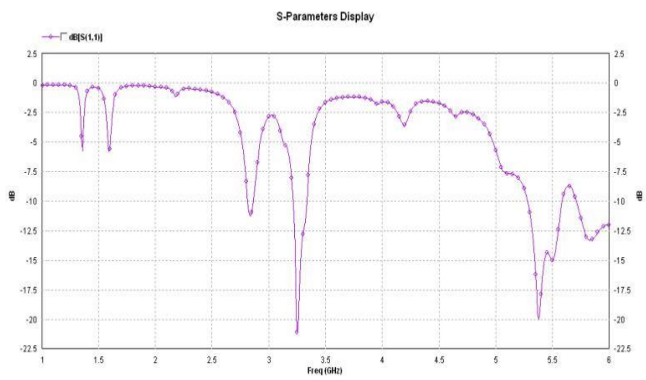

Fig 7. Return loss of Second Iteration

D. Return loss for Third Iteration

Sierpinski carpet antenna has gone through the third iteration to exhibit the multiband characteristics at 2.29 GHz, 3.29 GHz, 3.67 GHz, 3.83, 4.38 and 5.31 GHz with the return loss of -10 dB, -35dB, -19 dB, -10 dB, -20dB, and -18dB respectively as shown in Fig.8.

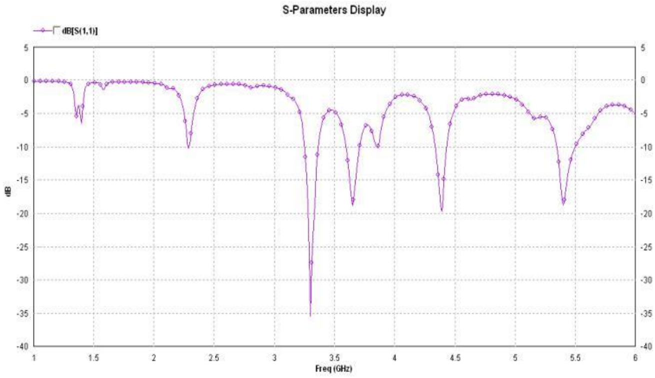

Fig 8. Return loss of Third Iteration

E. VSWR Display

The system are perfectly match if the VSWR equals to 1:1 where there is no power reflected and all the energy are absorbed at their input terminal. [1-3].

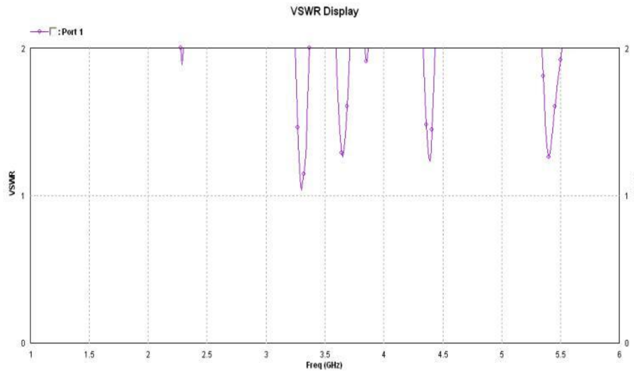

Fig 9. VSWR Display

F. Gain Display

From Fig.10 we can observe that the Peak Gain [1-3] of antenna is 4dBi at 3.58GHz.

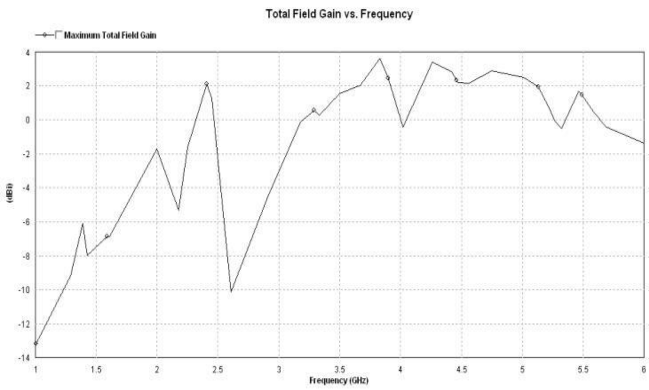

Fig 10. Gain vs. Frequency Display

G. Directivity Display

The Peak Directivity of the proposed antenna is 8 dBi at 3.58 GHz shown in Fig. 11.

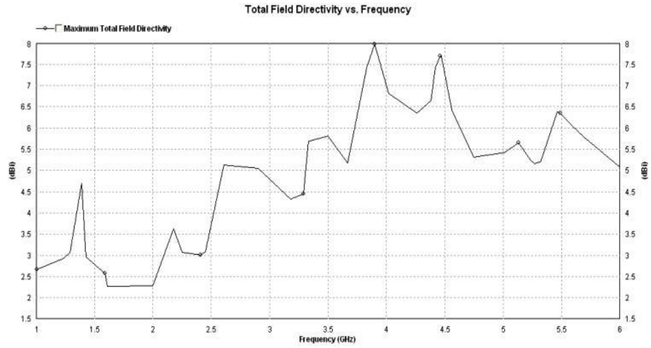

Fig 11. Directivity vs. Frequency measurement

H. Efficiency Display

The proposed antenna efficiency is almost near to 100% and the radiation efficiency is around 80% as shown in Fig. 12.

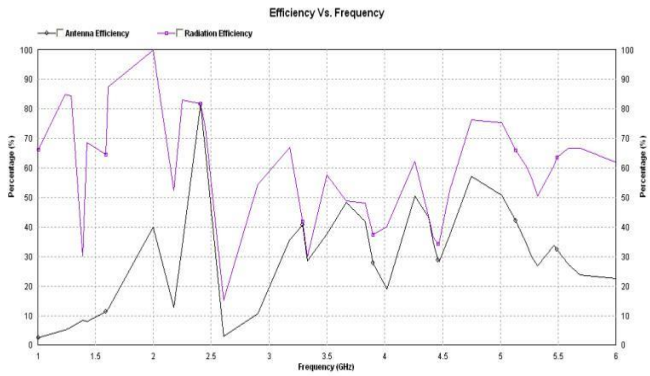

Fig 12. Efficiency vs. Frequency measurement

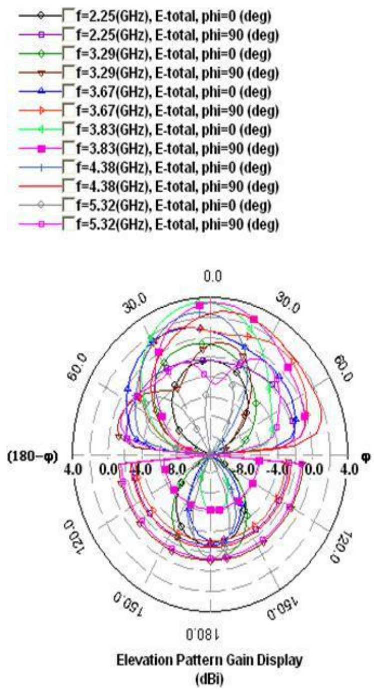

Fig 13. Elevation Pattern Gain Display

I. Radiation Pattern Characterstics

The elevation pattern and azimuth pattern at 2.25 GHz, 3.29 GHz, 3.67 GHz, 3.83, GHz, 4.38, and 5.32 GHz with phi=0 (deg) and phi = 90 (degree) are shown in Fig.13 and Fig.14 respectively.

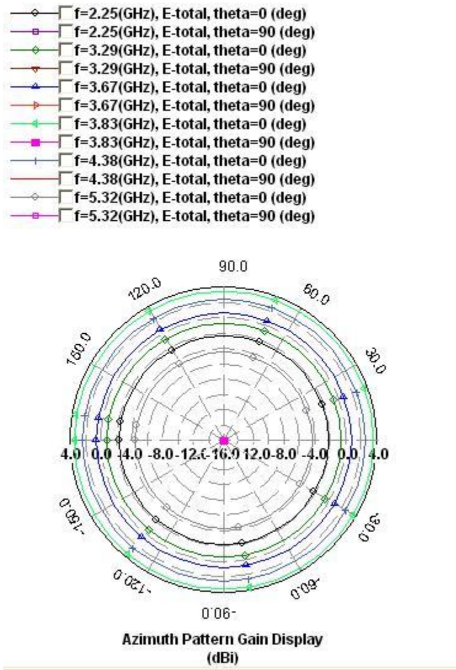

Fig 14. Azimuth Pattern Gain Display

IV. Conclusion

The purpose of fractal structures is to have a multiband frequencies and a wideband compared to the conventional microstrip patch antenna. This is due to the self-similarity properties of the fractal structure. From simulation results, multiband operation is observed for microstrip Sierpinski carpet antenna. The Microstrip Sierpinski carpet fractal shape antenna is designed for multiband operation has been presented in the first paper. The simulated result shows that the antenna is suitable for 2.29/3.30/3.65/3.85/4.40/5.40 GHz wideband applications.

Microstrip Sierpinski carpet antennas is designed and iterated up to third iteration to exhibit desired characteristics. In order to increase the bandwidth further other wide banding techniques such as design with stacked patches, slots on ground plane can be employed. The Miniaturization and multiband capabilities of fractals allows efficient, broadband and multipurpose devices to be packed in a small place.

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