Sierpinski Square Carpet Fractal Microstrip Antenna for WLAN Application

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Abstract **- The paper presents the designs of a Sierpinski square carpet fractal microstrip patch antenna. The properties of the fractal have been used in order to design a less profile, better gain, light weight and narrow bandwidth antennas. Advanced wireless communication systems require antennas with lesser dimensions and wider bandwidth. The fractal antennas are preferred due to small size, light weight and multiband. In the designed antenna used FR4 glass proxy substrate having thickness of 1.6mm with dielectric constant Er of 4.4 and microstrip feeding line. The proposed antenna is 5.2GHz of size 18x14mm^2.This antenna is suitable for wireless application such as WLAN, Details of the simulated results of the individual iterations is presented and discussed.**

Keywords — Fractal microstrip patch antenna (FMPA), WLAN, VSWR, bandwidth, Gain, Return Loss.

I. INTRODUCTION

With the fast development of the wireless communication system the upcoming technologies need very small, compact and multiband antennas. To give the wireless technologies like Wi-Fi and WiMAX and other highly developed applications through the antennas by using Fractal geometry applied to the microstrip antennas. By using the fractal technology on the microstrip antennas we can get numerous advantages like wide band operation by possibility of generating multi-frequency, less power consumption many more. There are many applications that can advantage from fractal antennas. A fractal is "a rough or fragmented geometry shape" that is generated by starting with very simple pattern that grows through the application of rules. Each fractal is collected of several iterations of single elementary shape. The iteration can be continuing much more, thus forming a shape with in a finite boundary but of infinite length or area. The research work to define the fractal geometry on microstrip antenna to improve the bandwidth, and size reduces.

II. ANTENNA DESIGN

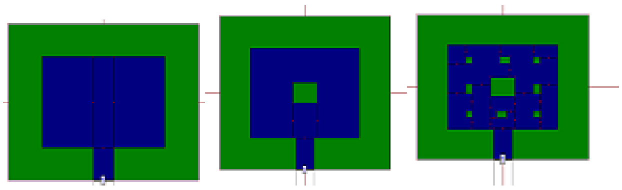
The three essential parameters are required for the design of a patch antenna at particular resonant frequency, fr; the dielectric constant of the substrate, εr; and the thickness of the substrate, $\boldsymbol{h}$. The design frequency of 5.2GHz is chosen for wireless application such as WLAN. The design specifications of the fractal microstrip antenna as listed in Table 1

TABLE I. DESIGN SPECIFICATIONS.

Antenna	*specifications*
Substrate	FR4
Relative permittivity	4.4
Dielectric loss tangent	0.0245
Height of the substrate	1.6mm
Operating frequency	5.2GHz
Feeding method	Microstrip line feed

The dimensions of the proposed antenna L=18mm, W= 14mm, Lg= 28mm, Wg= 24mm and microstrip line feeding length (L_f) =10mm,W_f = 3mm.

The design of antenna starts with a basic patch microstrip antenna. Further iterations are performed in the basic structure to form the proposed antenna structure. Sierpinski square carpet fractal geometry is used here for designing of the antenna. In which square slots are introduced in its second iteration. The steps taken for each iterations is as below.



(1) (2) (3)

Fig(1) Base antenna Fig(2) Ist iteration Fig (3) IInd iteration

III. RESULTS AND DISCUSSION

The IE3D simulation engine by Zeland software has been used to design the antenna to understand the behavior and determine the parameters.

A. Return Loss

Result shows that, antenna provides a return loss (S11 parameter) of -13.1dB at 5.2GHz

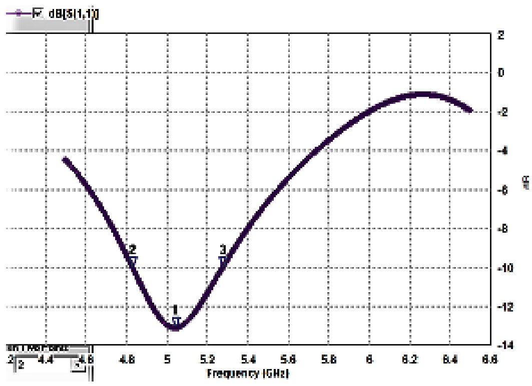


Fig 4. Stimulated return loss S11 versus frequency

B. VSWR

The VSWR graph shows that antenna satisfies the VWSR criterion.

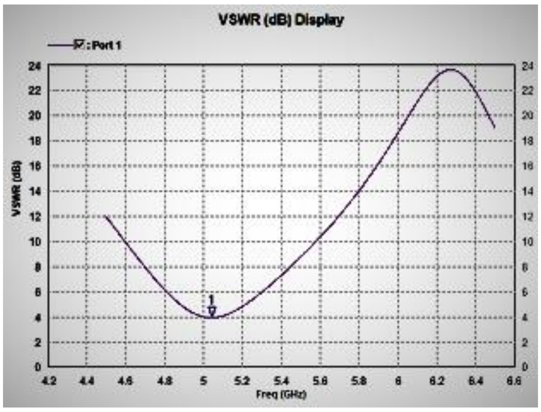


Fig 5. VSWR Graph

C. 3D Pattern

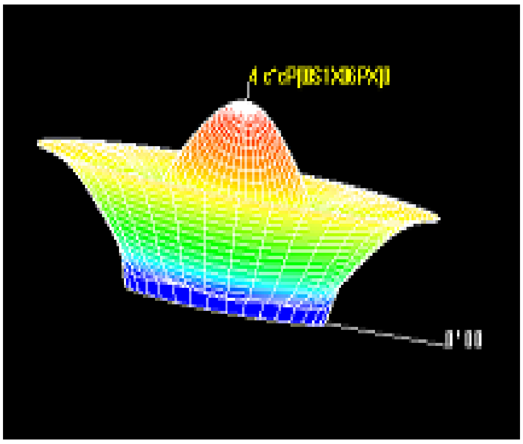


Fig 6. 3D Pattern

D. 2D Pattern

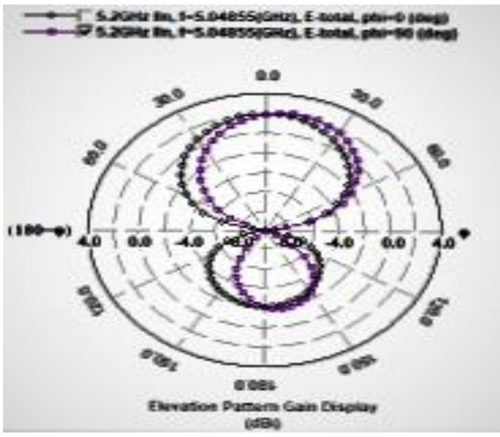


Fig. 7. 2D PATTERN

TABLE II. RESULT COMPARISON BETWEEN BASE ANTENNA WITH FRACTAL ANTENNA

iteration	*Resonance frequency (GHz)*	*Return loss (dB)*	*Bandwidth (MHz)*
0 iteration	5.2	*-11.40*	*318*
1 iteration	5.06	*-12.33*	*384*
2 iteration	5.04	*-13.1*	*447*

We have seen all the Figs we can say that the results of return loss is decreased (from - 11.40dB to 13.1dB) in order to increases the number of iterations and also we have been observed simulated values of gain, directivity and VSWR by using simulation software .i.e. IE3D. Bandwidth is enhanced from (318, to 447) MHz for 0 to 2nd iteration respectively.

IV. CONCLUSION

The Fractal antenna has been constructed and Simulated for WLAN application. In this designed antenna we have seen increased bandwidth as the increasing the numbers of iterations, in the same way we have observed the improvement of the many parameters are VSWR, Directivity & return loss etc.

Before I finish we can wrap up that the size of the antenna is reduced by using the sierpinski square fractal on the microstrip antenna . In this paper antenna size reduction 30% is achieved. The antenna can be reduced by taking number of iteration by the factor of $(4)^n$ here n is the number of iterations.

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