

DESIGN OF SQUARE SHAPE CROWN MICROSTRIP FRACTAL ANTENNA

Hemant Singh Bisht¹, Dr. A. N. Mishra², Sanjeev Budhauiliya³

^{1,2} ECE Department, Krishna Engineering College, India)

³ECE Department, IIMT College, (India)

ABSTRACT

This paper contains the design and fabrication of sierpinski crown microstrip fractal antenna. The analysis is done between ranges of 2GHz to 10 GHz. In this paper, multiple frequency bands of the crown fractal antenna are described. There are eight resonant frequencies appear at 2.69 GHz, 4.62 GHz, 5.78 GHz, 5.9 GHz, 6.24 GHz, 8.71 GHz, 9.63 GHz and 9.76 GHz. In accumulation, on the basis of number of iterations, radiation patterns and return losses, multiple frequency band behavior of the sierpinski crown fractal antenna has been studied. The result for return losses and radiation patterns is simulated by using IE3D software.

Keywords: *Fractals, Iterations, Multiple Frequency Bands, Radiation Patterns, Wide Bands.*

I. INTRODUCTION

In modern wireless telecommunication system and in other Wireless application antennas with low profile, smaller geometry and wider bandwidths are in great demand. Fractal antennas have been demonstrated to enhance antenna properties due to their self similarity behavior. In Recent years interest has been developed in fractal geometries for antenna application with varying degrees of success in improving antenna characteristics [1] [2]. Basically, after the design of self-similar shapes fractal antennas exhibit the frequency independent antenna. In recent years multiple antenna configurations based on fractal geometries have been reported. Fractal geometry permits to design miniature antenna and integrating several telecommunication services into single device.

In this paper, we introduce a new self-similar fractal antenna based on nearly square shape with a circular polarization. This new antenna which is called Crown Square Fractal antenna displays lower first made frequency than a normal nearly square microstrip patch antenna which results in reduced antenna size [1]. The rest of paper is organized as follows- Section II, briefly describes the antenna configuration. Section III, Presents results and discussion, followed by concluding remarks in section IV [1] [2].

II. ANTENNA CONFIGURATION

The antenna is feed with the transmission line feeding technique. The crown microstrip fractal antenna has been constructed through third iteration in this particular case. The iteration from zero stage to third stage is shown in Fig.1. The design is fabricated using glass epoxy material with relative permittivity $\epsilon_r = 4.4$, dielectric thickness $h = 1.66$ mm, where the radiating element is the cooper clad.

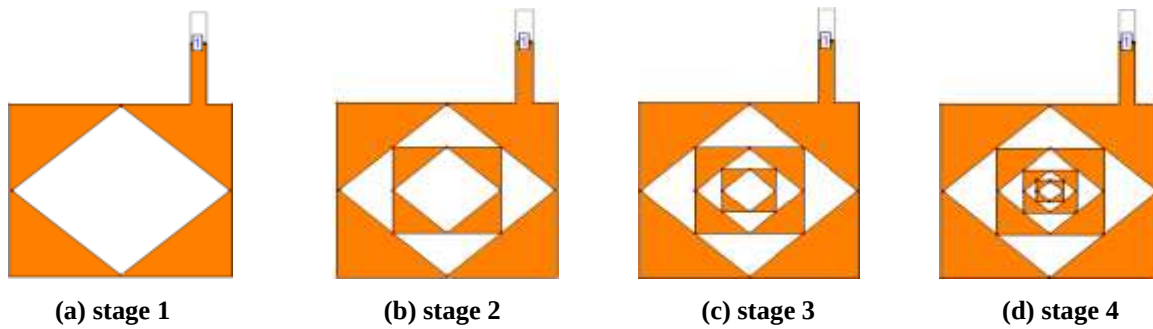


Fig.1: the stages of iteration of crown microstrip fractal antenna

In Fig.1 the design of the crown fractal antenna starts with single element using an equilateral square conductor on a ground dielectric substrate. The operating frequency is 2.4 GHz. Width & length of the crown fractal antenna can be calculated by using equation (1), (2), (3) and (4) [3].

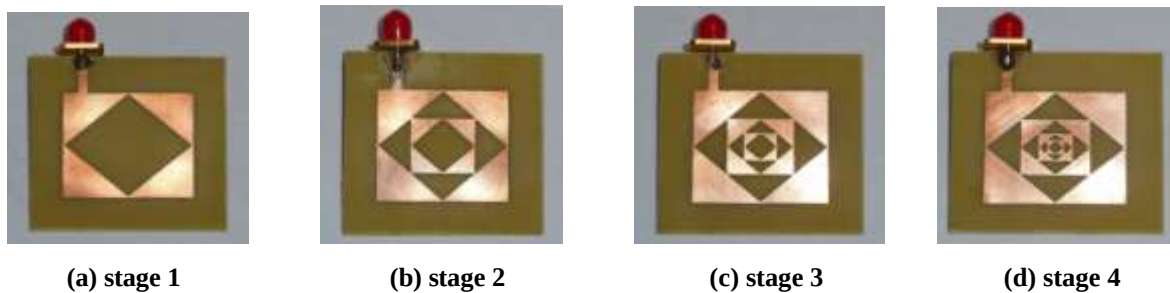


Fig.2: the physically implemented iterated stages of crown microstrip fractal antenna

In Fig.2 physically implemented iterated stages of crown microstrip fractal antenna with a SMA connector mounted on the top of the structure are shown-

$$W = \frac{c}{2f_r \sqrt{\epsilon_r + 1}} \quad \text{..... (1)}$$

$$\epsilon_{eff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left(\frac{1}{\sqrt{1 + \frac{12h}{W}}} \right) \quad \text{..... (2)}$$

$$\Delta l = .412h \times \frac{(\epsilon_{eff} + 3) \left(\frac{W}{h} + 2.62 \right)}{(\epsilon_{eff} - 258) \left(\frac{W}{h} + 8.13 \right)} \quad \text{..... (3)}$$

$$L = \frac{c}{2f_r \sqrt{\epsilon_{eff}}} - 2\Delta l \quad \text{..... (4)}$$

- f_r = Resonant frequency
- ϵ_r = Dielectric constant of the substrate
- ϵ_{eff} = Effective dielectric constant of the substrate
- W = width of substrate
- L = length of substrate
- Δl = fringing field
- h = height of substrate
- c = velocity of light in free space

Thus, a square with hollow square whose center is the intersection of four medians of the square shown in Fig.1(a). Now, for first iteration, again a small square with a square with a hollow square whose center is the intersection of four medians of the square shown in Fig.1 (b). Same process will continue for the second and third iteration as shown in Fig.1 (c) & (d).

III. RESULTS AND DISCUSSION

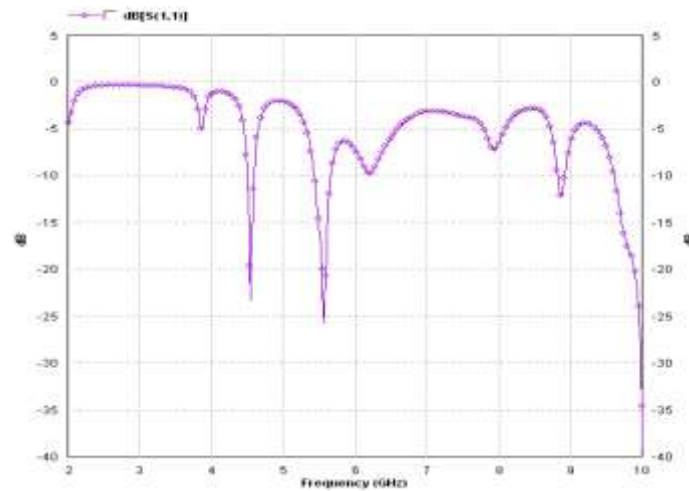


Fig.3: Simulated Return Loss Graph for Base Shape of Crown Fractal Antenna

It may be noted from Fig.3, the return loss -23.2 dB, -25.75 dB, -13 dB and -20 dB with frequency 4.49 GHz, 5.49 GHz, 8.83 GHz and 9.87 GHz respectively are obtained from simulation.

TABLE 1

Frequencies at which minimum return loss occur for base shape

Frequency	4.49 GHz	5.49 GHz	8.83 GHz	9.87 GHz
Return loss	-23.2 dB	-25.75 dB	-13 dB	-20 dB

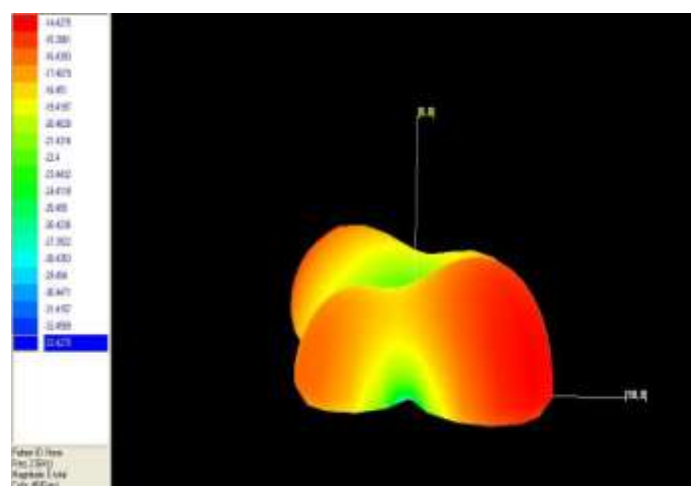


Fig. 4: Radiation Pattern for Base Shape in 3D

In Fig.4 radiation pattern for base shape is shown in 3- dimension.

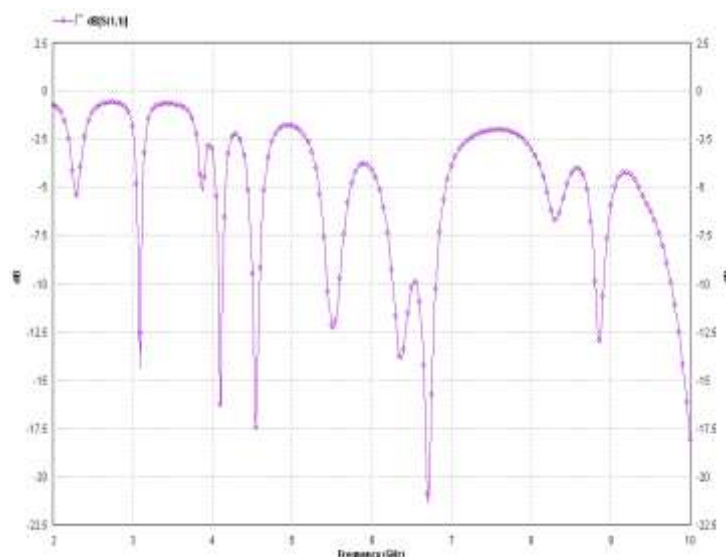


Fig.5: simulated return loss graph for first iteration of crown fractal antenna

In Fig.5, the simulated return loss graph for first iteration of crown fractal antenna is shown. It may be seen from Fig.5, the return loss -14.2 dB, -16.6 dB, -17.5 dB, -12 dB, -21 dB, -12.7 dB and -17 dB with frequencies 3.15 GHz, 4.11 GHz, 4.54 GHz, 5.47 GHz, 6.64 GHz, 8.9 GHz and 9.82 GHz respectively are obtained from simulation.

TABLE 2

Frequency at which minimum return loss occur for first iteration

Frequency	3.15 GHz	4.11 GHz	4.54 GHz	5.47 GHz	6.64 GHz	8.9 GHz	9.82 GHz
Return loss	-14.2 dB	-16.6 dB	-17.5 dB	-12 dB	-21 dB	-12.7 dB	-17 dB

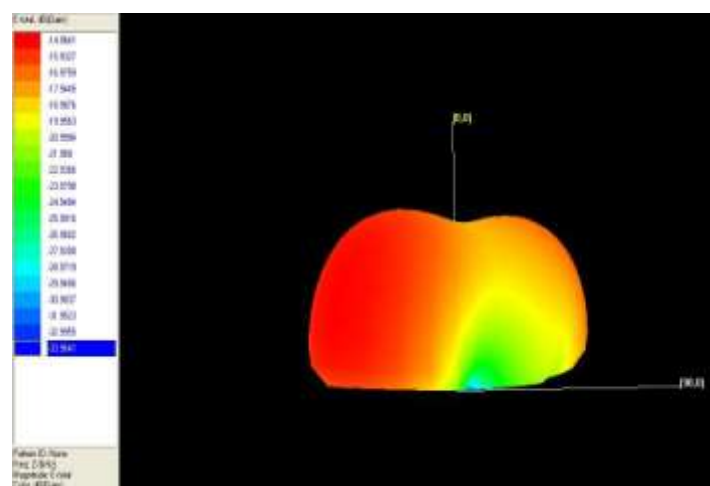


Fig.6: radiation pattern for the first iteration of crown fractal antenna in 3D

In Fig.6, the radiation pattern in 3-dimension for the first iterative form of base shape of crown fractal antenna is shown.

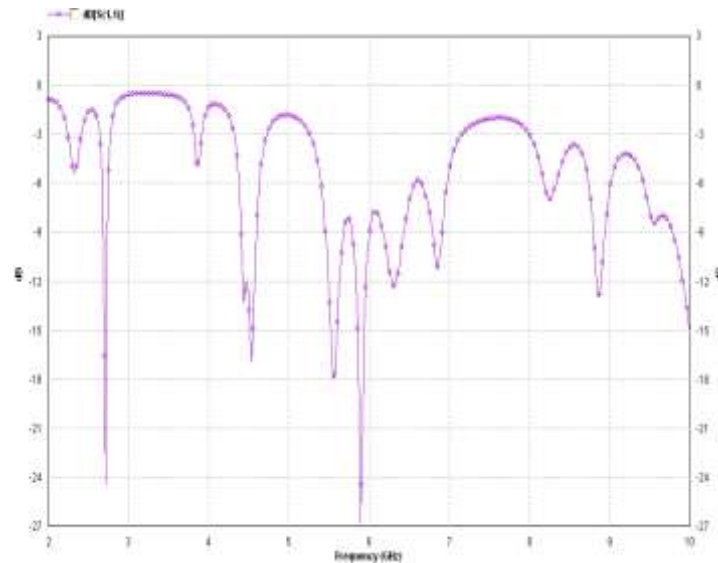


Fig.7: simulated return loss graph for second iteration of crown fractal antenna

In Fig.7, the simulated return loss graph for the second iteration of crown fractal antenna is shown. It may be observed from Fig.7, the return loss -24.7 dB, -17.1 dB, -18 dB, -26.8 dB, -12.1 dB, -11.7 dB, -12.3 dB and -13 dB with frequencies 2.79 GHz, 4.56 GHz, 5.68 GHz, 5.81 GHz, 6.39 GHz, 6.74 GHz, 8.72 GHz and 9.86 GHz respectively are obtained from simulation.

TABLE 3

Frequency at which minimum return loss occur for second iteration

Frequency	2.79 GHz	4.56 GHz	5.68 GHz	5.81 GHz	6.39 GHz	6.74 GHz	8.72 GHz	9.86 GHz
Return loss	-24.7 dB	-17.1 dB	-18 dB	-26.8 dB	-12.1 dB	-11.7 dB	-12.3 dB	-13 dB

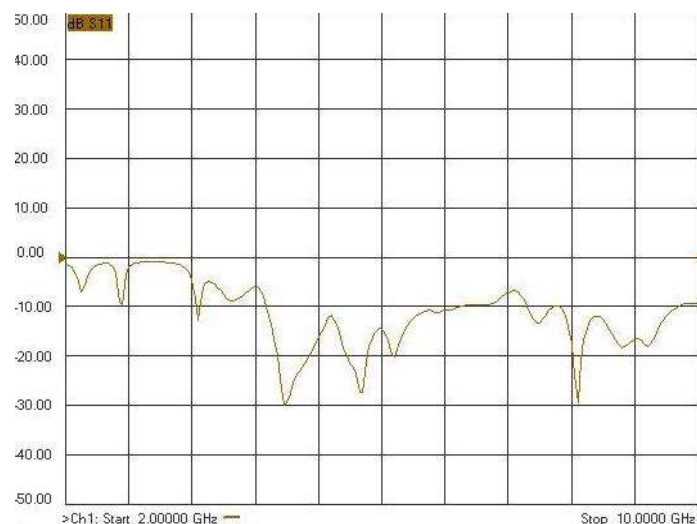


Fig.8: tested return loss graph for second iteration of crown fractal antenna

In Fig.8, the tested return loss graph for second iteration of crown fractal antenna. It may be seen from Fig.8, the return loss -10 dB, -13.2 dB and -13 dB with frequencies 2.71 GHz, 3.68 GHz and 7.97 GHz respectively are obtained from testing. Whereas minimum return loss -30 dB and -29.31 dB for wide band from 4.51 GHz to 6.93 GHz and for wide band from 8.2 GHz to 9.71 GHz respectively are obtained from testing.

TABLE 4

Frequency at which minimum return loss occur for second iteration

Frequency	2.71 GHz	3.68 GHz	4.51 GHz to 6.93 GHz (wide band)	7.97 GHz	8.2 GHz to 9.71 GHz (wide band)
Return loss	-10 dB	-13.2 dB	-30 dB	-13 dB	-29.31 dB

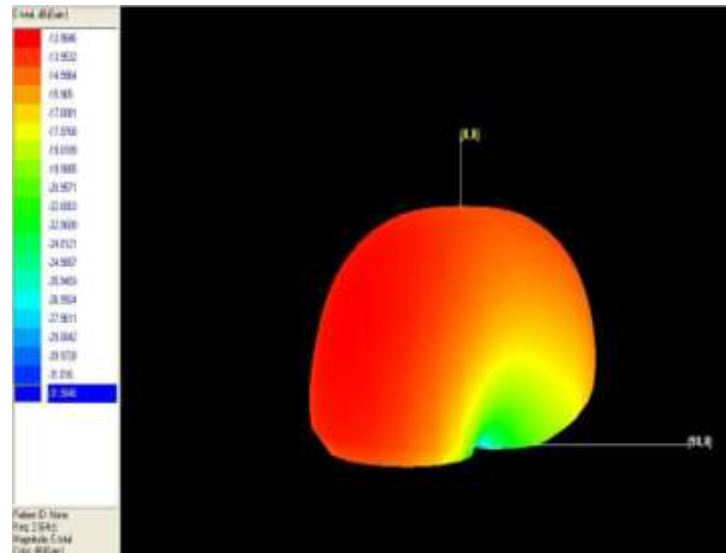


Fig.9: Radiation Pattern for the Second Iteration of Crown Fractal Antenna in 3D

In Fig.9, the radiation pattern in 3-dimension for the second iterative form of base shape of crown fractal antenna is shown.

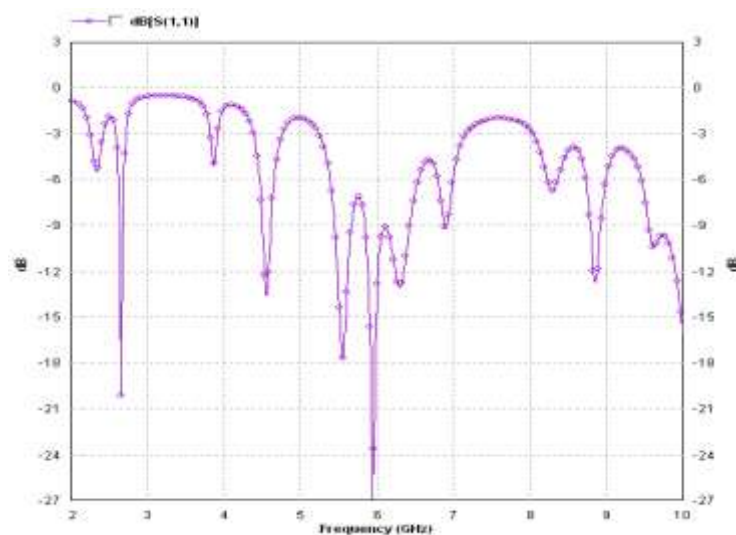


Fig.10: Simulated Return Loss Graph for Third Iteration of Crown Fractal Antenna

In Fig.10, the simulated return loss graph for the third iteration of crown fractal antenna is shown. It may be observed from above Fig.10, the return loss -20.2 dB, -13.8 dB, -17.8 dB, -27 dB, -13 dB, -12.9 dB, -10.3 dB and -13.8 dB with frequencies 2.69 GHz, 4.62 GHz, 5.78 GHz, 5.9 GHz, 6.24 GHz, 8.71 GHz, 9.63 GHz and 9.76 GHz respectively are obtained from simulation..

TABLE 5

Frequency at which minimum return loss occur for third iteration

Frequency	2.69 GHz	4.62 GHz	5.78 GHz	5.9 GHz	6.24 GHz	8.71 GHz	9.63 GHz	9.76 GHz
Return loss	-20.2 dB	-13.8 dB	-17.8 dB	-27 dB	-13 dB	-12.9 dB	-10.3 dB	-13.8 dB

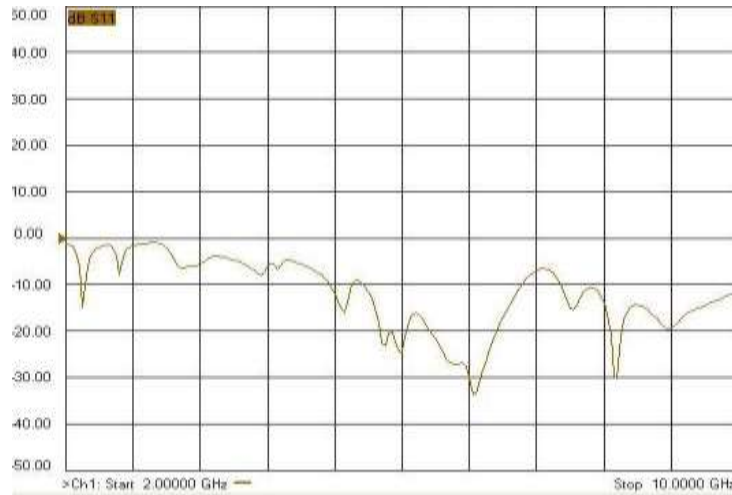


Fig.11: Tested Return Loss Graph for Third Iteration of Crown Fractal Antenna

In Fig.11, the tested return loss graph for third iteration of crown fractal antenna. It may be seen from Fig.11, the return loss -15.2dB and -15.24 dB with frequencies 2.24 GHz and 5.3 GHz respectively are obtained from testing. Whereas minimum return loss -33.7dB and -30dB for wide band from 5.42GHz to 7.38 GHz and wide band from 8.07GHz to 9.85 GHz respectively are obtained from testing.

TABLE 6

Frequency at which minimum return loss occur for third iteration

Frequency	2.24 GHz	5.3 GHz	5.42 GHz to 7.38 GHz (wide band)	8.07 GHz to 9.85 GHz (wide band)
Return loss	-15.2 dB	-15.24 dB	-33.7 dB	-30 dB

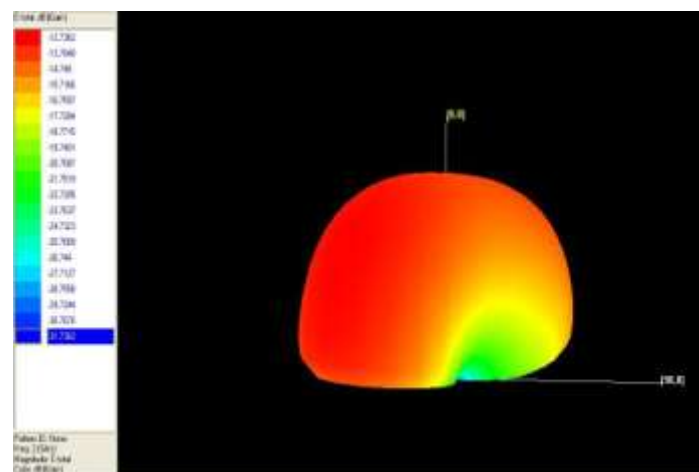


Fig.12: Radiation Pattern for the Third Iteration of Crown Fractal Antenna in 3D

In Fig.12 the radiation pattern is shown for the third iteration of crown fractal antenna in 3-dimension.

IV. CONCLUSION

In this work, a crown fractal antenna has been design and simulated. The multiband frequencies appeared after applied fractal technique. It was observed that as the number of iterations was increased, number of frequency band also increased. For zero iteration four bands occur, for first iteration seven bands occur, for second iteration eight bands occur and for third iteration eight bands occur. This crown fractal antenna can be used for GPS, WLAN, WI-MAX, Cognitive Radio, and UWB.

REFERENCES

Journal Papers:

- [1] Sanjeev Budhaliya, Suneel Yadav & Dr. P.K. Singhal, "Design of modified sierpinski gasket fractal antenna". *Journal of telecommunications Vol.13, issue-01march 2012 pages: 7-13.*
- [2] Rajneesh Chawhan, Dr. P.K. Singhal & Dr. C. Das Gupta, "Design of modified sierpinski carpet fractal antenna". *Journal of telecommunications Vol.7, issue-02march 2011pages:46-52.*

Books:

- [3] Constantine A. Balanis, "*antenna theory, analysis and design*", Third Edition, John Wiley & Sons, INC. Publication.
- [4] Ramesh garg, Inder bahl (pg.439-524)," *microstrip antenna design handbook*", by artech house publication Boston.

Proceedings Papers:

- [5] Wang Yong, Liu. Shaobin, "A New modified crown Square fractal antenna", *IEEE Proceeding year 2008.*