International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-1, November 2019

Design and Simulation of Horizontally placed H-shaped Fractal Antenna

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Abstract: The design and simulation of horizontally placed H-Shaped Fractal Antenna is presented in this paper using CST Microwave Studio simulation software and the excitation is provided by using Nickel material for feeding in Y direction, wave guide port feeding method is used.. The simulated result shows that by edge cutting the directivity increases, return loss is very less and the voltage standing wave ratio is nearly equal to unity as the number of iterations increases. In generating multiple frequencies., the horizontally placed H shape fractal structure is advantageous. This antenna can be used in the Wi-Fi due to its better performance in Return loss, VSWR and directivity. In this paper four stages of this antenna is designed and simulated, the third iteration of this antenna is fabricated for Return loss and VSWR. The observations are conducted on antenna parameters such as the return loss for the frequency of 9.5 GHz is -27.6 dB and observed nearly equal value for measured results. The VSWR of both simulated and measured results are also same.

Index Terms: CST, returnloss, F-shaped, Fractal.

I. INTRODUCTION

The antenna is used to transmit and receive electromagnetic waves which converts electrical power into radio waves and vice versa. We go for micro-strip antennas, where size of an antenna should be very small. In the process of ultra-high frequency signals micro strip antennas are used. The advantage of this type of antenna is it costs little to make but it has the disadvantage of limited bandwidth. a micro strip antenna can be made without a dielectric substrate. By giving excitation at one end a micro strip patch acts as an antenna. On one side of a dielectric substrate the micro strip patch antenna has a radiating patch and on the other side it has a ground plane. can take any possible shape and is generally made of conducting material such as copper or gold. The shape of the patch is generally square, rectangular, circular, triangular, and elliptical or some other common shape in order to simplify analysis and performance prediction. [7]. In applications, as compared to normal antennas micro-strip antennas have many advantages like small size, light weight, low cost and they can be easily fabricated..

Revised Manuscript Received on November 30, 2019.
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As we vary the thickness and material of substrate, ground plane and patch the return loss, VSWR ,directivity and some other parameters of antenna changes. In the recent years for designing wide band, dual frequency and multi-frequency antennas several fractal geometries have been proposed. B. Mandelbort in 1975 defined the concept of fractal geometry and its iterative structure at different levels [3-9]. The fractal antennas are used in cellular telephone and microwave communications and are very compact, multiband or wideband. [4].The patch antenna size can be reduced by using Fractal geometry. The two properties of fractal antennas are space-filling and self-similarity [5-10]. The self-similarity properties of the fractal shapes can be successfully applied in the design of multiband fractal micro-strip patch antenna. There are a number of fractal shapes like Sipernski Gasket, Minkowski, Hilbert curve and Koch curves. The microstrip antennas have some disadvantages such as low return loss, less bandwidth and low gain. So as to improve characteristics, fractal geometry has been applied [2].For designing wideband and multiband antennas, fractal theories have become an innovative approach [6]. For various wireless communication applications such as ISM, GPS, GSM, Bluetooth, RFID, WLAN, Wi-Fi, Wi-Max in the lower microwave frequency regions from 900MHz to 12GHz the infrastructure of fractal antenna are used [8]. The efficiency of an antenna deteriorates drastically, when its size is much smaller than the operating wavelength. Thus its radiation resistance decreases and the reactive energy stored in its near field increases [4-7]. To determining their operating frequencies the antenna geometries and dimensions are the main factors [8-10]

II. ANTENNA DESIGN

The 1st iteration of proposed antenna has been designed by introducing the H-shaped fractal slots horizontally at both sides of the length of rectangular patch as shown in Fig. 4. We can take By taking all the other dimensions as similar as in 0th iteration of proposed antenna as shown in Fig 1, and by considering the1st iteration as a base geometry , the fractal slots are further cut out from the four corners of the H-shaped fractal slots to get the 2nd iteration of the proposed fractal antenna as shown in Fig. 8. The 3rd iteration is obtained by introducing edge cutting for the four sides of the 2nd iteration is as shown in Fig.12. In this model, the proposed antennas were designed using ground plane & patch of material copper annealed and substrate is of FR4 lossy. In this fractal antenna height h= 3mm and feeding method used is microstripline feeding.

The feeding point for all iterations is same and thickness of feeding point is 3.75mm on X axis and the feeding is given in Y direction. Nickel material is used for feeding. By using the dimensions of rectangular patch length=40mm and width=30mm resonant frequency of 2.49GHz has been calculated by using the equations 1 to 5. The four iterations of H fractal antenna are shown in Figs of 1, 4,8,12 below.

Table I. Dimensions of substrate, patch and feed line

Parameter	Geometry	Dimensions
W_S	Substrate width	40mm
L_S	Substrate Length	60 mm
W_P	Patch Width	30 mm
L_P	Patch Length	40 mm
W_F	Width of Feed Line	3.5mm
L_F	Length of Feed Line	3.75mm

A. Calculation of Resonant Frequency

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\left(\frac{h}{w}\right)\right]^{-\frac{1}{2}} \quad (1)$$

$$L_{eff} = L + 2\Delta L \quad (2)$$

$$\Delta L = 0.412 * h \frac{(\varepsilon_{reff} + 0.3)}{(\varepsilon_{reff} - 0.258)} \frac{\left[\frac{w}{h} + 0.264\right]}{\left[\frac{w}{h} + 0.8\right]} \quad (3)$$

C or V=3*10^8 m/sec and Ɛr =4.5 (4)

$$f_r = \frac{1}{2L_{eff}\sqrt{\varepsilon_{eff}}\sqrt{\mu_o \varepsilon_o}} \quad (5)$$

Where, c = Velocity of light in free space
h = height of the Substrate
$\mathcal{E}_r$= Relative permittivity
W = Patch Width
L = Patch. Length
L_{eff} = Effective length.
$\mathcal{E}_{eff}$ = dielectric constant. (Effective)
ΔL= Extension Length.
For the values ,L=40mm,
W=30mm
Ɛr =4.5(FR4 lossy)
F_r= Resonant frequency=2.49GHz

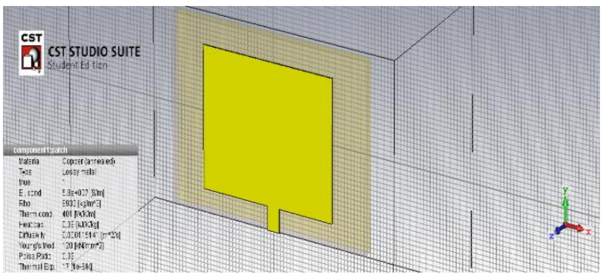

Fig.1. 0th Iteration

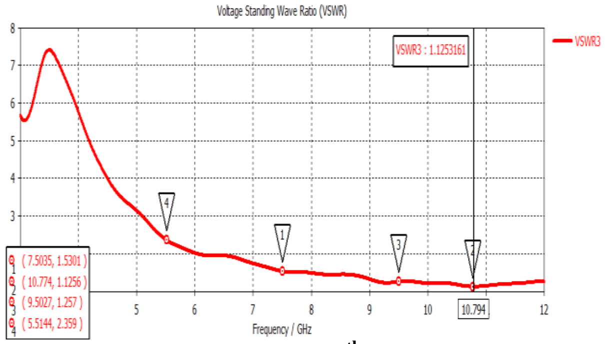

Fig. 2. Returnloss in dB for 0th iteration at different frequencies

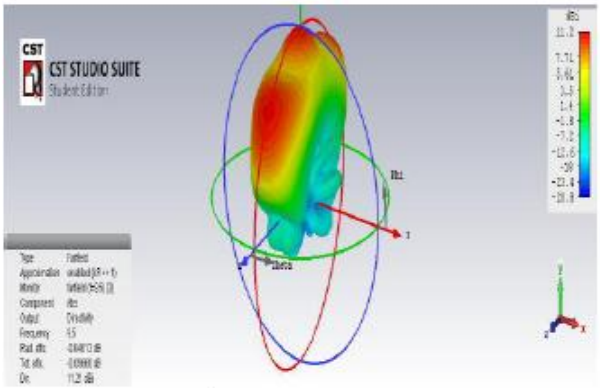

Fig. 3. Directivity of 0th iteration at 9.6GHz frequency

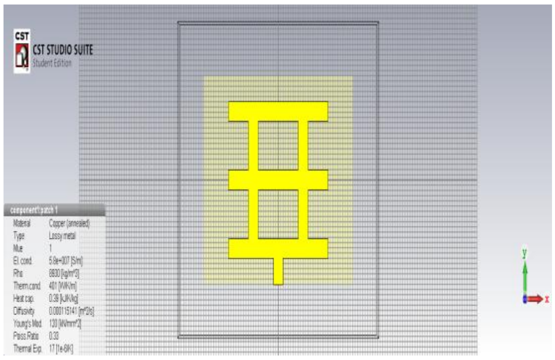

Fig. 4. Ist iteration

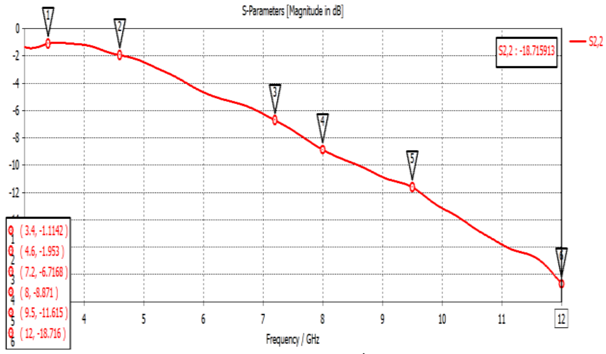

Fig. 5. Returnloss in dB for 1st iteration at 7.2GHz frequency

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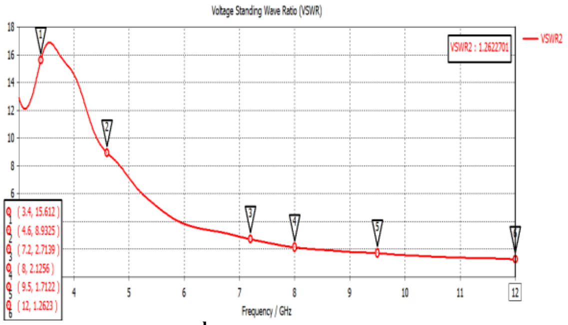


Fig. 6. VSWR for 2nd iteration at different frequencies

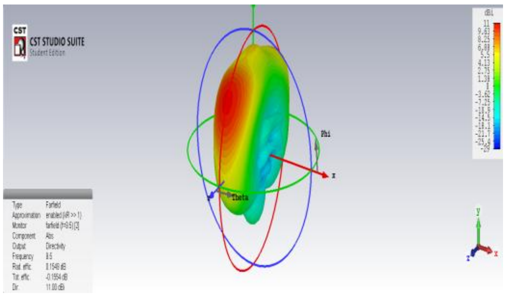


Fig. 7. Directivity of 1st iteration at 9.5GHz frequency

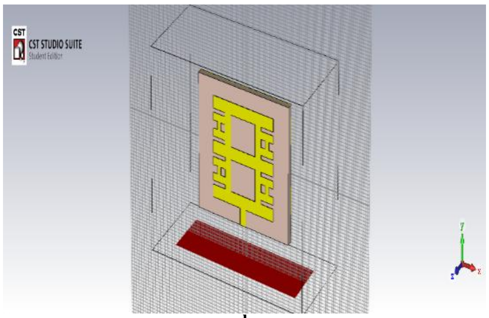


Fig. 8. 2nd iteration

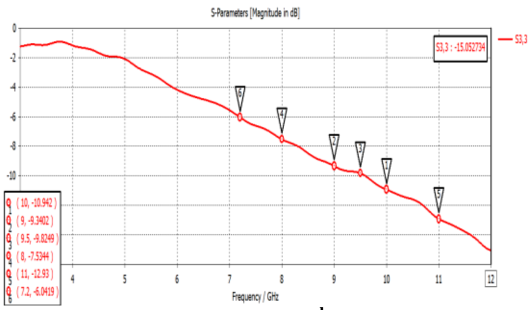


Fig. 9. Returnloss in dB for 2nd iteration at different frequencies

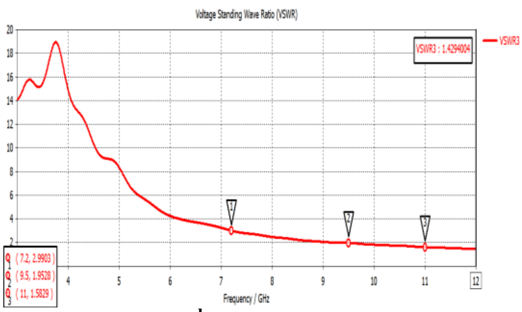


Fig. 10. VSWR for 2nd iteration at different frequencies

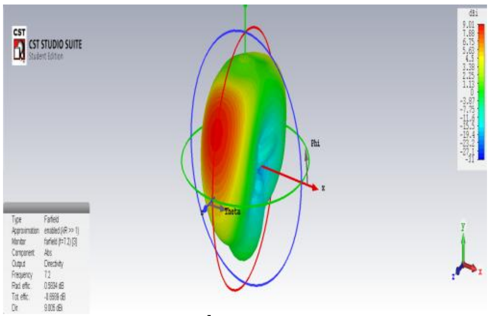


Fig. 11. Directivity of 2nd iteration at 9.5GHz frequency

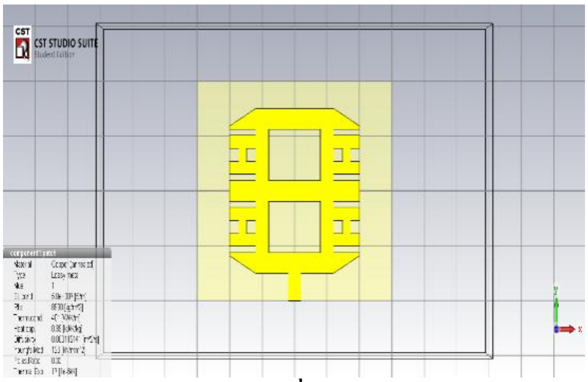


Fig. 12. 3rd iteration

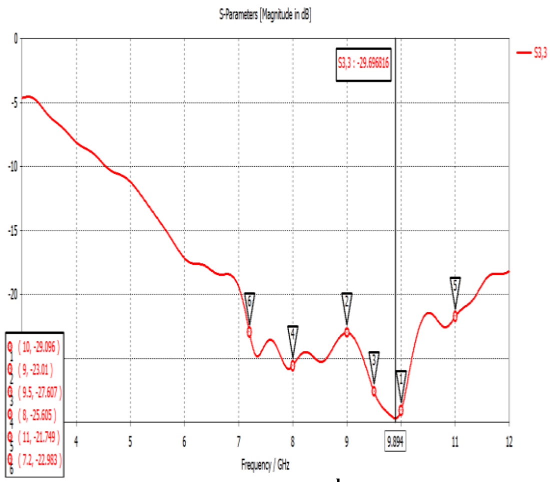


Fig. 13. Returnloss in dB for 3rd iteration at different frequencies

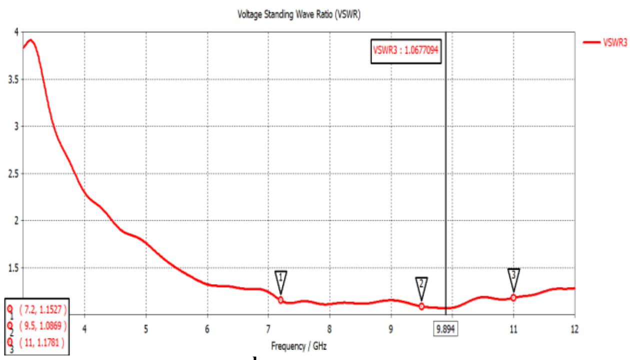


Fig. 14. VSWR for 3rd iteration at different frequencies

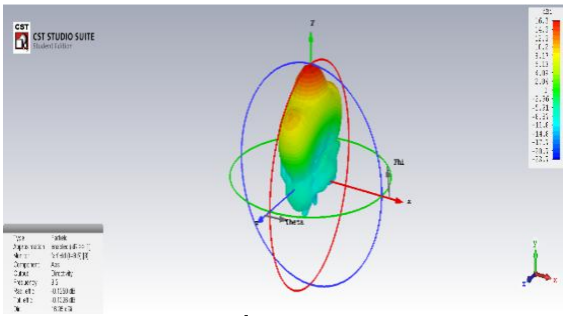


Fig. 15. Directivity of 3rd iteration at 9.5GHz frequency

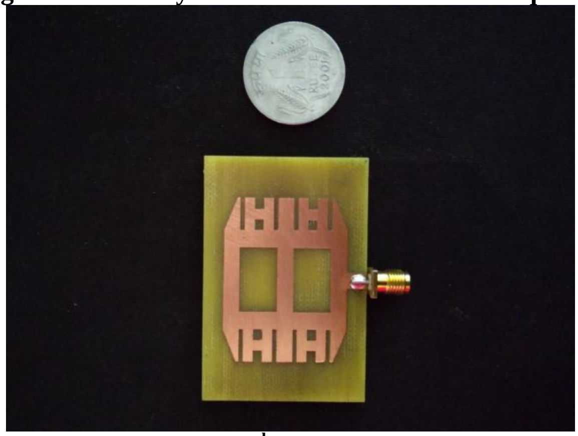
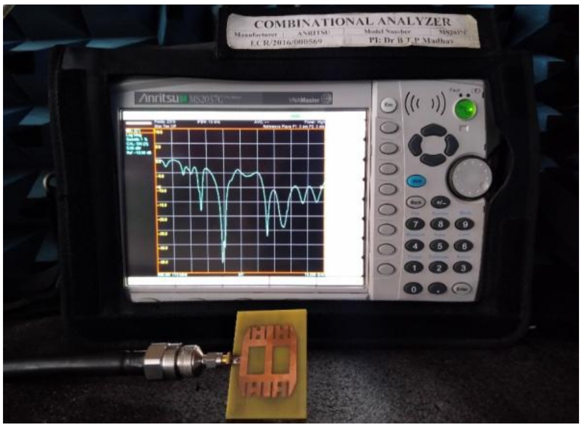


Fig. 16. Fabrication of 3rd iteration of H-shaped Fractal antenna

III. EXPERIMENTAL SET UP FOR 3RD ITERATION OF H-SHAPED FRACTAL ANTENNA



IV. MEASURED RESULTS

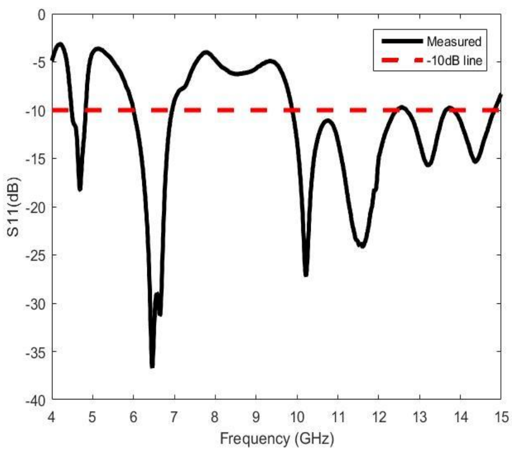


Fig. 17. Returnloss curve of 3rd iteration of horizontal H Fractal antenna

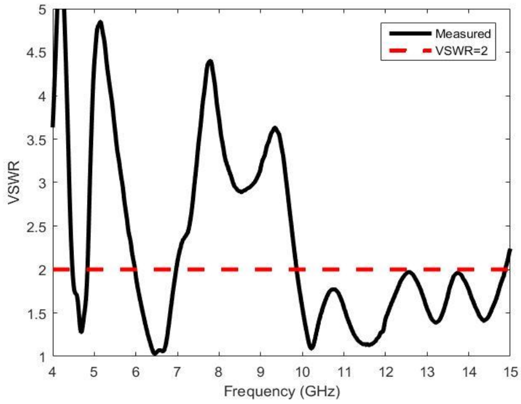


Fig. 18. VSWR curve of 3rd iteration of horizantal H Fractal antenna

Table 2: Comparison of horizontal H fractal antenna for both simulated and measured results

Geometry	Parameter	Simulated		Measured	
H shape 0th Iteration	Frequency(GHz)	7.5	9.6	–	–
	Return loss(dB)	-13.5	-18.5	–	–
	VSWR	1.5	1.2	–	–
H shape First Iteration	Frequency(GHz)	7.2	9.5	–	–
	Return loss(dB)	-6.7	-11.6	–	–
	VSWR	2.7	1.7	–	–
H shape Second Iteration	Frequency(GHz)	7.2	9.5	–	–
	Return loss(dB)	-6	-9.8	–	–
	VSWR	2.9	1.5	–	–
H shape Third Iteration	Frequency(GHz)	7.2	9.5	6.8	10.2
	Return loss(dB)	-23	-27.6	-32	-28
	VSWR	1.1	1.1	1.1	1.2

V. RESULT AND DISCUSSION

The zero to third iterations are shown inFigs.1,4,8,12,Figs.3,5,6,7,9,10,11,13,14,15 shows the simulation results for four iterations of H fractal antenna, parameters such as return loss, VSWR and directivity. Fig. 16 shows the fabrication, the experimental set up also shown above. Fig. 17,18 shows measured resuts for the parameters such as return loss, VSWR curves for third iteration of H fractal antenna. From all the above four iterations ,the third iteration gives the better results of return loss and VSWR for both simulated and measured as shown in Fig.13,14 (simulated results) and Fig.17,18. (measured results).

VI. CONCLUSION

The present paper is designed as horizontally H-shaped fractal antenna in which four iterations has been conducted and the different simulated results and simulated results are observed and measured. The value of return loss, gain and VSWR are compared in Table 2. It is observed that on increasing the number of iterations, there is no change in the value of return loss and directivity of 1st ,2nd and 3rd iterations..But only due to edge cutting done in fourth iteration the value of return loss becomes more negative, and unity Voltage Standing Wave Ratio is obtained. It is compared with the results of reference paper[12], the complexity in the design of horizontally H-shaped Fractal antenna is also less., which gives more directivity, very good VSWR (Voltage Standing Wave Ratio)i.e approximately unity and the return loss is also very less. By comparing the simulated results and measured results of 3rd iteration the Return loss at 10GHz frequency of measured and 9.5 GHz of simulated are almost near i.e -27.6dB. The VSWR is also almost near i.e 1.1 at 7.2 GHz frequency for simulated and 6.8GHz frequency for measured. These are useful for WiFi and GPS applications.

REFERENCES

1. "Fractal antennas: design, characterization and applications", by J. Gianvittorio, Master's Thesis, University of California, Los Angeles, 2000.
2. "Small Koch fractal antennas for wireless local area network", by A. Jamil, M. Z. Yusoff and N. Yahya IEEE 978-1-4244-7006-8/10, pp. 104-108, 2010.
3. "Multiband E-shaped Fractal Microstrip Patch Antenna with DGS for Wireless Applications. By I A. Nagpal, S. S. Dhillon JETAE International Journal of Emerging Technology and Advance Engineering, Vol. 2, pp 241244.
4. "Koch curve fractal antenna for Wi-Max and C-Band wireless applications" by S. Yadav, R. Choudhary, U. Soni, A. Dadhich and M. M. Sharma, IEEE 5th International Conference- Confluence The Next Generation Information Technology Summit, pp. 490-494, 2014.
5. "Microstrip Antenna," Antenna Theory, Analysis and Design, Third Edition, John Wiley and Sons by C.A.Balanis, pp. 811-876, 2010.
6. "Miniaturized UWB monopole microstrip antenna design by the combination of Giusepe peano and Sierpinski carpet fractals," by H. Oraizi and S. Hedayati, IEEE Antennas and Wireless Propagation Letters , vol. 10, pp. 67–70, 2011.
7. "Design of Simple Multiband Patch Antenna for Mobile Communication Applications Using New E-shape Fractal." by N. Bayatmaku, P. Lotfi and M. Azarmanesh IEEE Antenna And Wireless Propagation Letters ,vol .10,2011.
8. "A Dual Band Star Fractal Antenna with Slot for Wireless Applications," by S. Yadav, R. Choudhary, U. Soni, A. Dadhich and M. M. Sharma, International Conference on Signal Propagation and Computer Technology (ICSPCT), IEEE, pp. 738-740, 2014
9. "Design of fractal based micro-strip rectangular patch antenna for multiband applications," by J. S. Sivia and S. S. Bhatia IEEE International Advance Computing Conference (IACC), pp. 712-715.
10. "Analysis and design of triple band compact micro-strip patch antenna with fractal elements for wireless applications," by Bharti, S. Bhatia and J. S. Sivia International Conference on Computational Modeling and Security (CMS 2016).
11. "A quad band circular patch antenna with fractal elements for S-band and C-band applications," by Elsevier Procedia Computer Science, Vol. 85, pp. 380-385, 2016.A. Kaur and N. Sharma , International Journal of Computer Applications, Vol. 144, No. 3, pp. 1-4, 2016.
12. "A Design of E-shaped Rectangular fractal antenna by using line feeding technique by Ramandeep Kaur and Narinder Sharma International Journal of Computer Applications(0975 – 8887)Volume 147 – No.3, August 2016G. Ramesh, B. Prakash, B. Inder and I. Apisak, *Microstrip Antenna Design Handbook*, Artech House, Boston, London.