

# Design and Development of Fractal Microstrip Patch Antenna for 5g Communication

**Gaikwad Pooja Mohan**

*M.E. (Electronics and Telecommunication Engineering)*

*Bharti Vidyapeeth College of Engineering, Kolhapur, Maharashtra, 416013, India.*

**Prof. Dr. Suhas S. Patil**

*(Electronics and Telecommunication Engineering)*

*Bharti Vidyapeeth College of Engineering, Kolhapur, India.*

## Abstract

In this paper a rectangular shape microstrip patch antenna is designed by using fractal technology for 5G communication of mobile phone. By using fractal technology compactness, multiband frequency and impedance matching is obtained. Antenna resonates at frequency 3.73GHz, 5.82GHz, and 8.85GHz. This antenna is useful for WLAN, WSN, Wi-Fi/Wi-Max, and Hiper LAN2, KU-Band. These antenna properties such as radiation pattern, current distribution, VSWR, S11 are studied to get better performance. The microstrip antenna is designed using HFSS software.

**Keywords:** CPW feed, microstrip patch antenna, fractal, S11, VSWR, Current distribution, Radiation pattern, gain

## INTRODUCTION

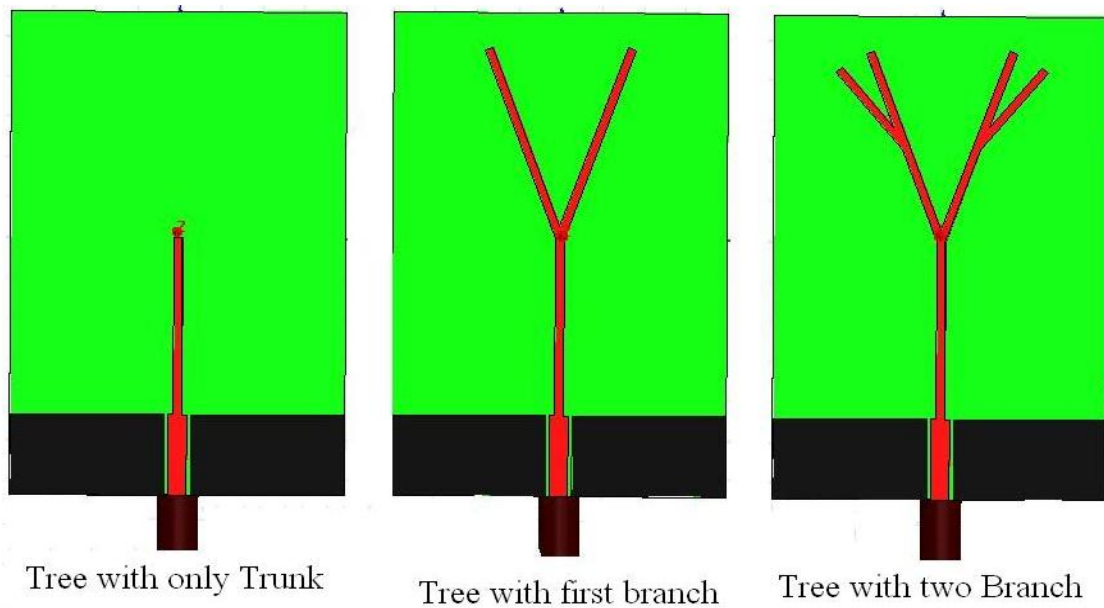
Now a day in modern telecommunication system antenna plays an important role. Antenna with compact size and multiband application is essential requirement of communication system. To fulfill this requirement fractal technology is useful. Fractal geometry is self similar in structure, which is divided into parts, each part of reduced scale. By using fractal technology on patch patch size is decreases and frequency band

increases[1]. Mobile phone technology has dramatically changed. Today the mobile wireless technology has experience 4G or 5G wireless technologies so current research in mobile wireless technology concentrates on advance implementation of 4G and 5G technologies, which is revolution and evolution from 0G to 4G. But the performance of 0G to 4G generation is not able to solve unending problem of poor coverage area, bad interconnectivity, poor quality of service, flexibility. So to fulfill these limitation 5G have to be developed[2].

5G networks provide number of services for the user by improving bandwidth, data rate and features. Such as high resolution, interactive multimedia, voice, video, internet[3-5]. But the main reason is to increase the need of 5G technology is it reduces the size of an antenna, it is light in weight so it reduces size of an antenna[6]. During the movement of the user handheld device gain radiation pattern and input impedance change, the antenna used for the handheld device is a crucial element which can improve or limit the system performance in term of beam width and bandwidth and efficiency. Therefore antenna should be design carefully. For this one type of antenna which can fulfill the wireless system requirement is the microstrip patch antenna. The microstrip patch antenna has low profile, it is light in weight, easy to fabricate, and it has high flexibility[7-10]. This antenna is designed by using fractal technology because it has better input impedance matching, operate at wideband/multiband, so instead of use many antenna only one antenna can perform over huge frequency range with minaturization [11-12]. Proposed antenna is designed using HFSS software [13].

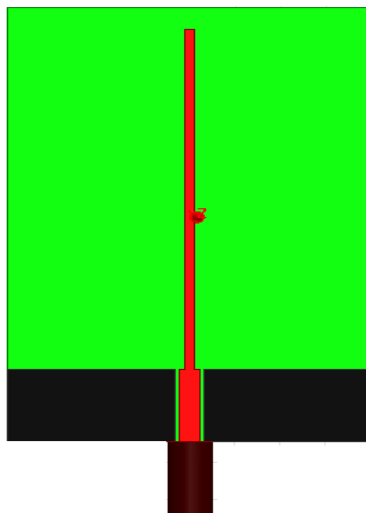
### **STRUCTURE OF AN ANTENNA**

The antenna is simulated using An soft HFSS simulating software. FR-4 dielectric material is used having loss tangent of 0.02, relative permittivity of 4.4, permeability of 1 and conductivity 0. Designed dielectric material have dimension such as length 40mm, 60mm and height of 1.6mm. CPW feed is used to design proposed antenna. It is very popular feeding technique. As figure shows this feed structure consist of metallic strip in between two parallel ground plane on the surface of the dielectric substrate. G1 having size such as width -18.4mm and length 10.4mm. G2 have width 18.4mm and length 10.4mm. Feed line strip have width 2.2 and length is 10mm. Antenna resonates at frequency 3.73GHz, 5.82GHz, and 8.85GHz with  $S_{11} < -10\text{dB}$  and  $2 > \text{VSWR} > 1$ . Antenna with different iteration is shown in fig .1.



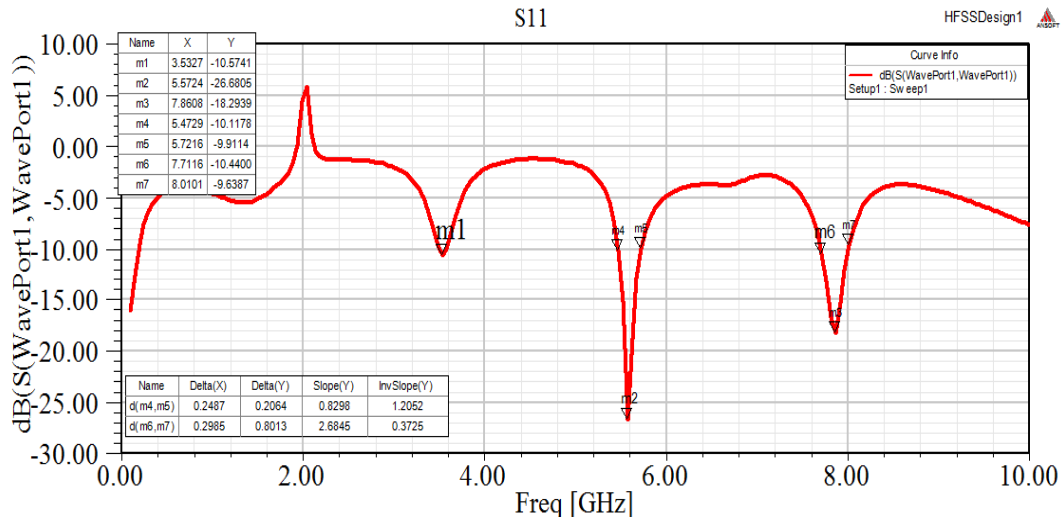
**Figure 1:** proposed antenna with different iteration

**A. Iteration 0 with results**



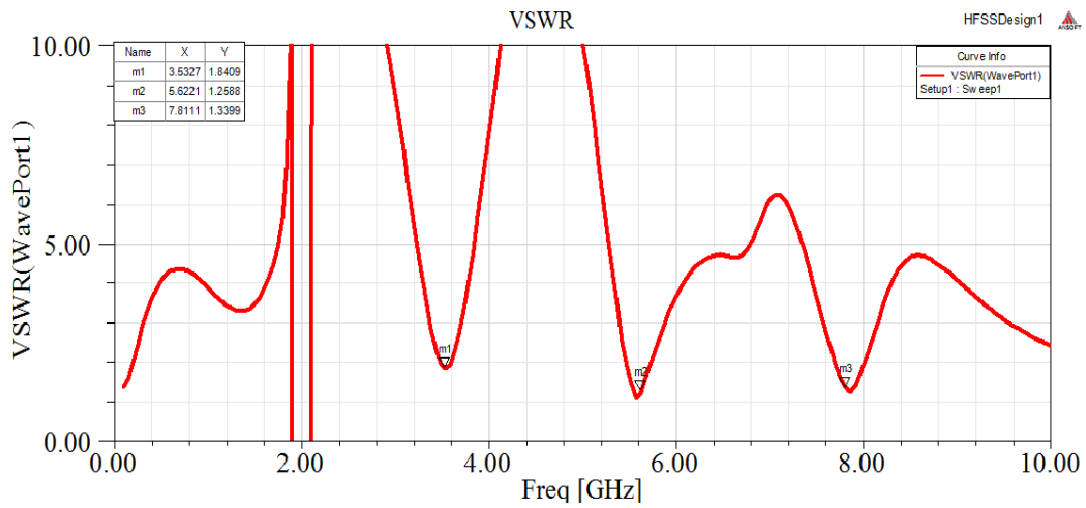
**Figure 2:** Basic structure

Fig.2 shows basic structure of an antenna structure of a microstrip patch antenna . Lower side of an antenna have width is of 1mm, length is of 22 mm and height is of 0.1 mm. Upper side of an antenna have width is of 1mm, length is of 25 and height is of 0.1mm.



**Figure.3:** Reflection coefficient

Fig.3 shows reflection coefficient. The antenna is giving return loss of -10.52decibel at 3.58GHz,-26.68decibel at 5.57GHz and -18.29 decibel at 7.86GHz resonant frequency



**Figure 4:** vswr

Fig.4 shows the VSWR characteristics of an antenna. 1.84 VSWR is obtained at 3.53GHz, 1.25 VSWR is obtained at 5.62GHz, 1.33 VSWR is obtained at 7.81GHz.

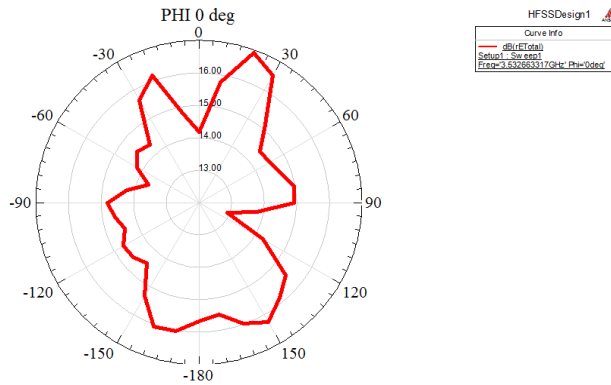


Figure 5: Elevation pattern of an antenna

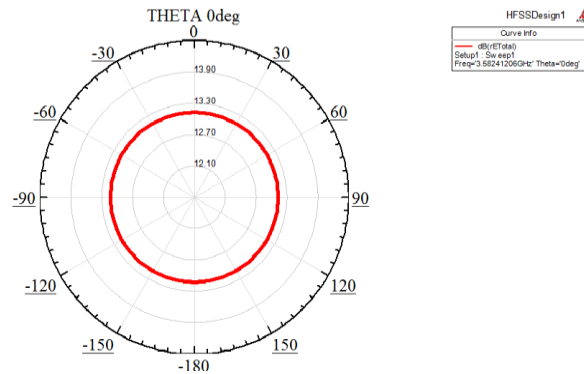


Figure 6: Azimuth pattern of an antenna.

The azimuth and elevation radiation pattern is obtained for resonant frequency 3.58GHz. The nature of radiation pattern is bidirectional for E-plane and omnidirectional for H-plane.

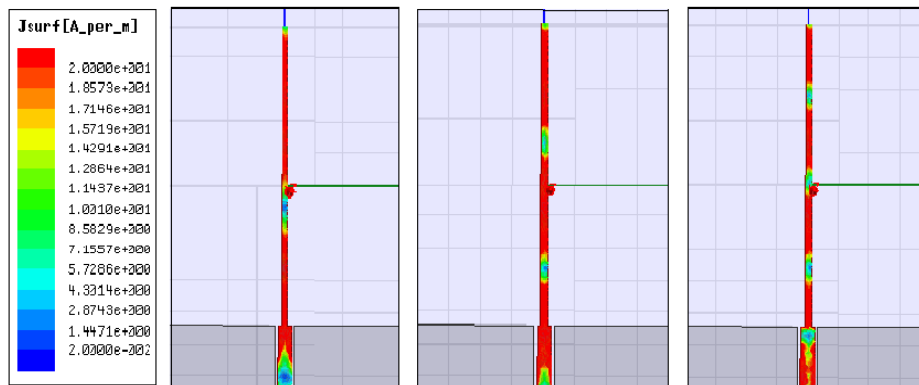
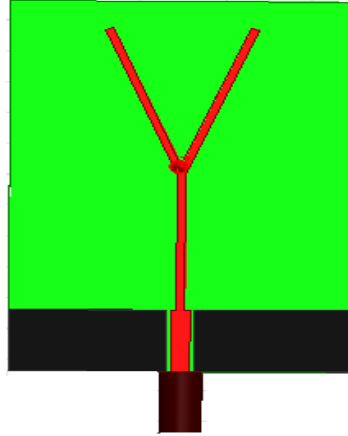


Figure 7: Current distribution

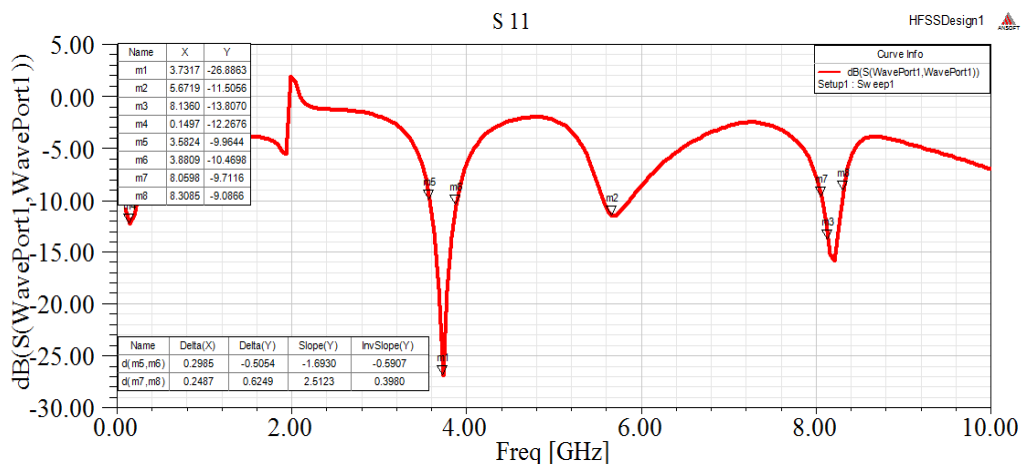
Fig.6 Shows current distribution of an antenna. Single trunk has three resonant frequencies. The current concentration decreases as the range of frequency decreases. Whereas the current is concentrated at feed for all three resonating frequencies is lower at 3.58GHz and higher at 5.62GHz.

### B. Iteration 1 with results



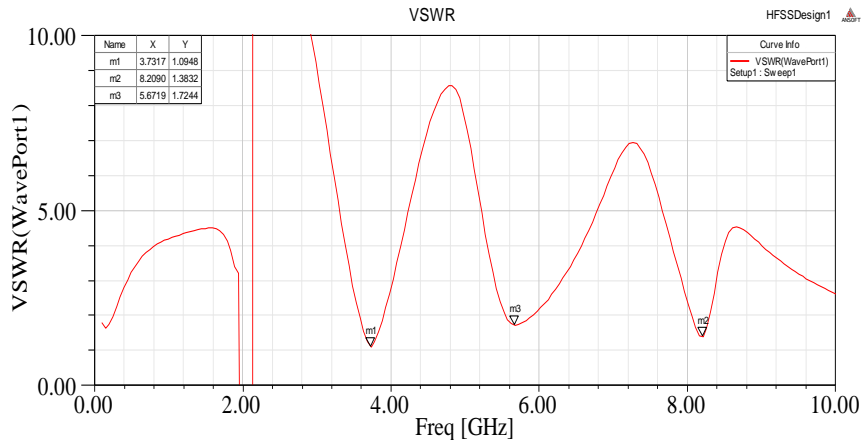
**Figure 8:** First iteration

Fig.8 Shows first iteration of antenna structure. Lower side of an antenna have width is of 1mm, length is of 22 mm and height is of 0.1 mm. Upper side of an antenna have width is of 1mm, length is of 25 and height is of 0.1mm. Upper part of 25 mm is rotate at 20 degree and -20 degree.



**Figure 9:** Reflection coefficient

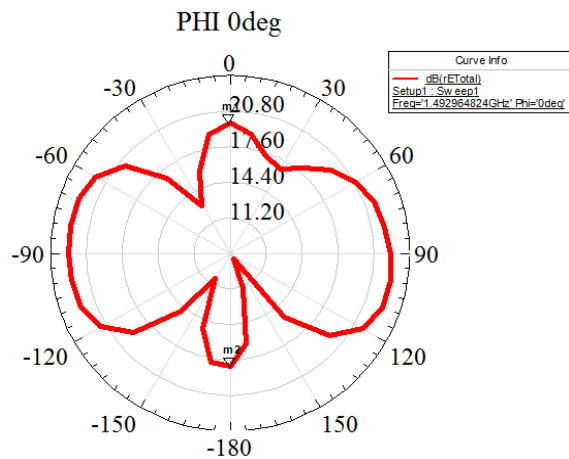
Fig.9 Shows reflection coefficient. The antenna is giving return loss of -26.88 decibel at 0.149 resonant frequency, -11.50 decibel at 3.731GHz, -13.80 decibel at 5.671GHz and -12.26 decibel at 8.13GHz resonant frequency.



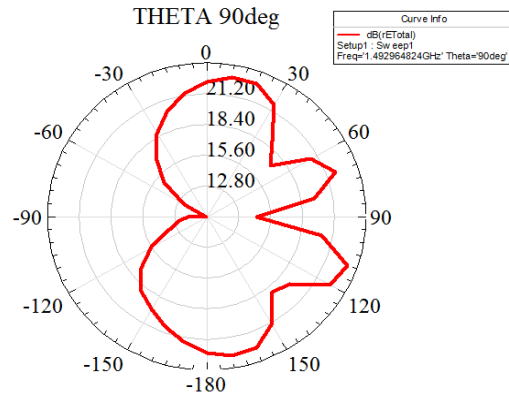
**Figure 10:** vswr

Fig. 10 shows the VSWR characteristics of an antenna. 0.14 VSWR is obtained at 0.149GHz, 1.09 VSWR is obtained at

3.73GHz, 1.38 VSWR is obtained at 5.67GHz, 1.72 VSWR is obtained at 8.13GHz.

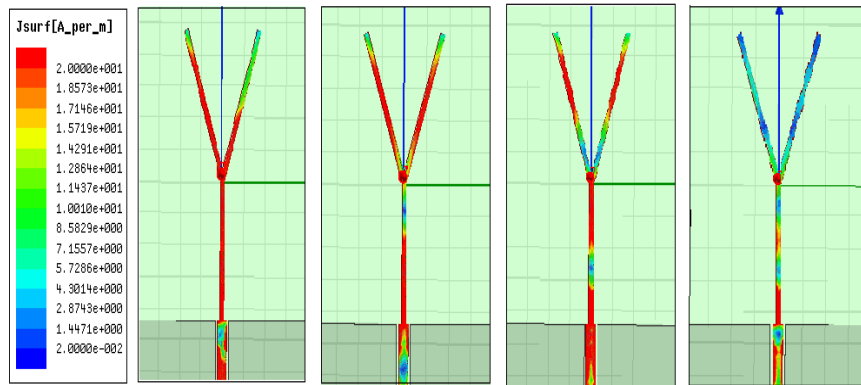


**Fig.11** Elevation pattern of an antenna



**Fig.12** Aazimuth pattern of an antenna.

The azimuth and elevation radiation pattern is obtained for resonant frequency 0.149GHz. The nature of radiation pattern is bidirectional for H-plane And E-plane

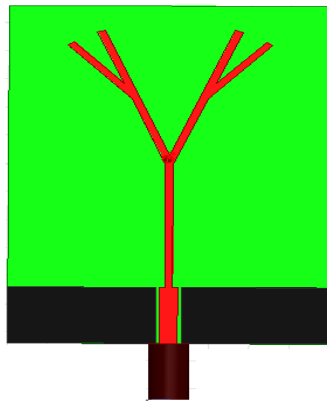


**Fig.13.** Current distribution

First iteration have four resonant frequencies. But it has higher distribution of current at lower frequencies and as the frequency increases the current distribution decreases. Whereas highest current concentration of current is at 5.67GHz frequency. As the fig shows current is strongly distributed at branch and lower side or trunk of an antenna and less at feed.

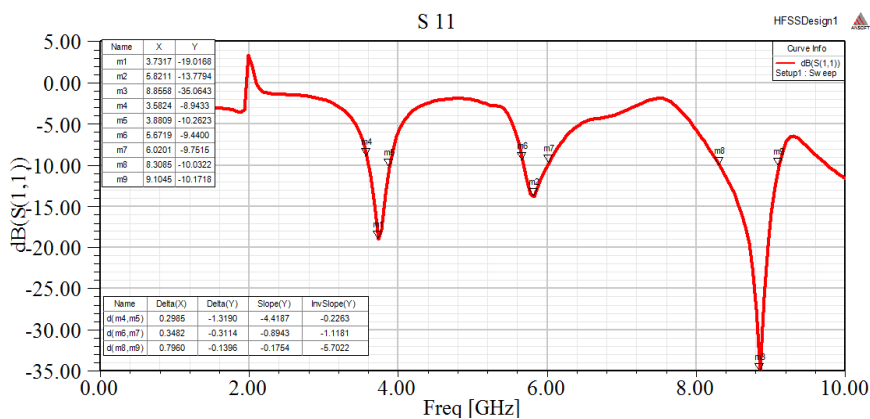


**C. Iteration 2 with results**



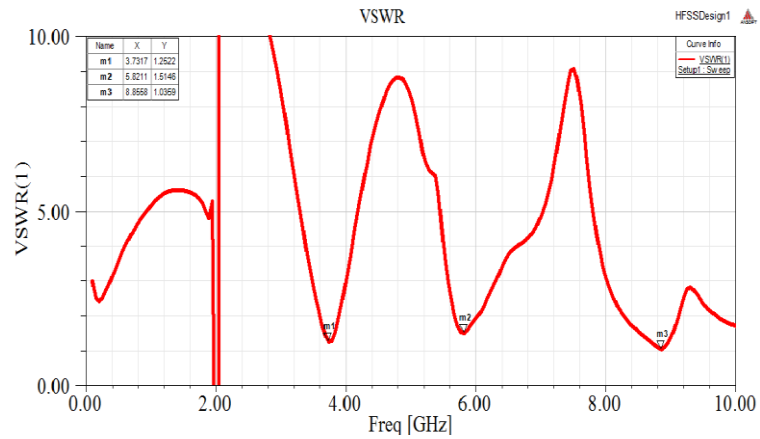
**Fig.14** Second iteration

Fig.14 shows second iteration of antenna structure having rectangular shape . Lower side of an antenna have width is of 1mm, length is of 22 mm. Upper side of an antenna have width is of 1mm, length is of 25 . Upper part of 25 mm is rotate at 20 degree and -20 degree. To add the second iteration in the design additional co-ordinate axis located, where another two branches are added.



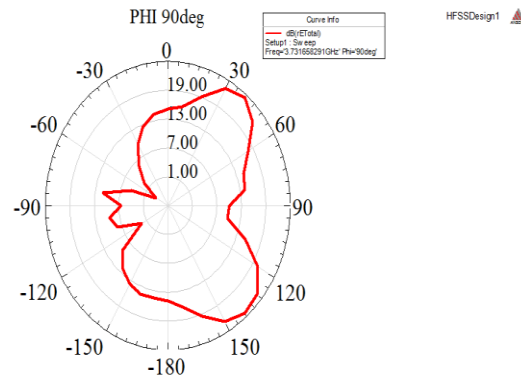
**Fig.15.** Reflection coefficient

Fig.15 shows reflection coefficient. The antenna is giving return loss of -19.01 decibel at 3.731 resonant frequency. The antenna is giving return loss of -13.77 decibel at 5.82GHz,-35.06 decibel at 8.58 GHz .

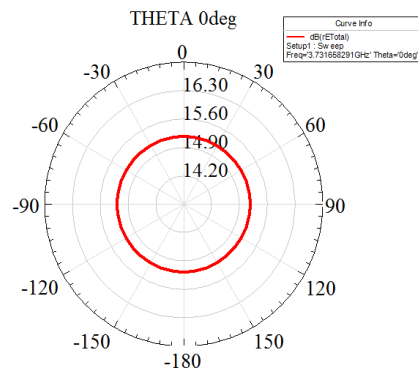


**Fig.16.** VSWR

Fig.16 Shows the VSWR characteristics of an antenna. 1.25 VSWR is obtained at 3.73GHz, 1.51 VSWR is obtained at 5.82GHz, 1.03 VSWR is obtained at 8.85GHz.

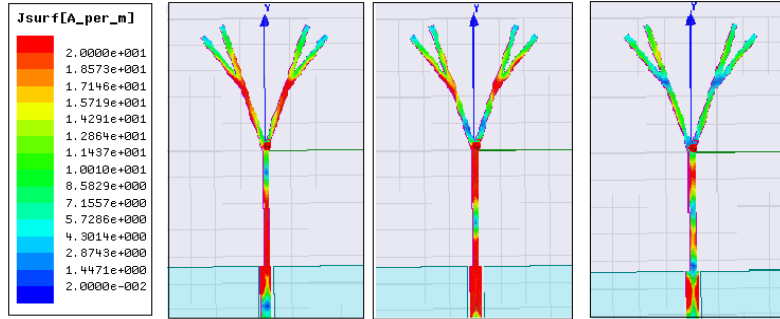


**Fig.17** Elevation pattern of an antenna



**Fig 18** Azimuth pattern of an antenna.

The azimuth and elevation radiation pattern is obtained for resonant frequency 3.731GHz. The nature of radiation pattern is bidirectional for E-plane and omnidirectional for H-plane.



**Fig.19.** Current distribution

The largest current distributes at middle frequency such as 5.821GHz and smallest current flows at highest resonating frequency. As fig shows current concentration at the trunk of an antenna and at the feed and less current concentrate at branch of all three resonating frequency of an antenna

**Table- 1:** Comparison results of different iterations.

Parameter	Basic Rectangular patch	First Iteration	Second Iteration
No. of resonant frequency	3	4	3
Resonant frequency	3.58GHz, 5.57GHz, 7.86GHz.	0.149GHz, 3.731GHz, 5.671GHz, 8.13GHz	3.73GHz, 5.82GHz, 8.58GHz.
Bandwidth	248MHz, 298MHz	2298MHz, 248MHz	298MHz, 348MHz, 796MHz.
Return loss	-10.5, -26.6, -18.29	-26.8, 11.5, -13.80, 12.26	-19.0, -13.7, -35.06
VSWR	1.84, 1.25, 1.33	1.09, 1.38, 1.72	1.25, 1.51, 1.03
Radiation pattern	Roughly bidirectional	Non Uniform Bidirectional	Uniform Bidirectional
Current distribution	Roughly equal distribution along entire patch	Highly concentrated along trunk except for higher frequency	Highly concentrate along branches of the trunk.

Table.1 shows comparison between basic rectangular patch antenna with different iteration of proposed antennas.

## CONCLUSION

In this paper, antenna is designed with different iterations by using fractal geometry. As size of all three variants kept constant, this paper verifies the space filling, multiband and iterative properties of fractals. Proposed antenna operates in multiband using only one antenna instead of many antennas. Using fractal technology, no of resonating frequency increases with increase in iteration, the range of operating frequency increases hence small increase in bandwidth is also observed. The characteristics of an antenna improves with increase in iterations such as return loss, VSWR, radiation pattern, current distribution.

## REFERENCES:

- [1] Rahul Tyagi<sup>1</sup>, Saurabh Kohli, May 2015. "Design and Development of Square Fractal Antenna for Wireless Application" International Journal of Advanced Research in Computer Science and Software Engineering, Volume 5, Issue 5.
- [2] Meenal G. Kachhava, Ajay P.Thakare. March 2014. "5G Technology-Evolution and Revolution" IJCSMC, Vol. 3, Issue. 3
- [3] Megha Verma; Neha Sundriyal & Jyoti Chauhan, October 2014. "5G Mobile Wireless Technology" International Journal of Research (IJR), Vol-1, Issue-9.
- [4] Swapnil Thorat ,Raj Kumar, April 2012 "Design of Rectangular-Cut Circular Disc UWB Antenna with Band-Notched Characteristics" International Journal of Engineering Science and Technology, Vol. 4 No.04.
- [5] Olumuyiwa Oludare FAGBOHUN "Comparative studies on 3G,4G and 5G wireless technology"
- [6] Abhishek Gupta , Dr.Anupam Gupta , Sarthak Gupta , September 2013 "5G : The Future Mobile Wireless Technology by 2020" International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 9.
- [7] Indrasen Singh, Dr. V.S. Tripathi; . sept-oct 2011. "Micro strip Patch Antenna and its Applications: a Survey", IJCTA, Vol 2.
- [8] T.Jayachitra,V.K Pandey and Anshuman Singh, April 2014, Design of "Microstrip Patch Antenna for WLAN Applications", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 3, Special Issue 3.

- [9] [11] R.Vishnu Priyanka R.Mohanamurali, “Design and Implementation of Multiband Antenna for 5G Wireless Networks”, International Journal of Research in Engineering, science & Technology.
- [10] U. Chakraborty, S. Chatterje, S. K. Chowdhury, P. P. Sarkar, 2011 “ A compact microstrip patch antenna for wireless communication”, Progress In Electromagnetics Research C, Vol. 18, 211,220.
- [11] B.Mazumdar, U.Chakraborty, A.Bhowmik, S.K.Chowdhury & A.K.Bhattacharjee, April 2012, “A Compact Microstrip Patch Antenna for Wireless Communication”,Global Journal of researches in engineering Electrical and electronics engineering, Volume 12 ,Issue 5 Version 1.0.
- [12] An Overview' of Fractal Antenna Engineering Research 'Communications and Space Sciences Laboratory
- [13] Nemanja popržen, Mićo gaćanović. “Fractal antennas: design, characteristics and application” [16] Trupti Ingale, A.A.Trikollikar, Gunjan Rathore, P.C.Latane, January 2015, “Simulation of Rectangular Microstrip Patch antenna” International Journal of Innovative Research in Science, Engineering and Technology Vol. 4, Issue 1.

