Design of Fractal Microstrip Patch Antenna

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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

I. 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 minituratization [11-12]. Proposed antenna is designed using HFSS software [13].

II. 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 S11<-10dB and 2>VSWR>1. Antenna with different iteration is shown in fig .1.

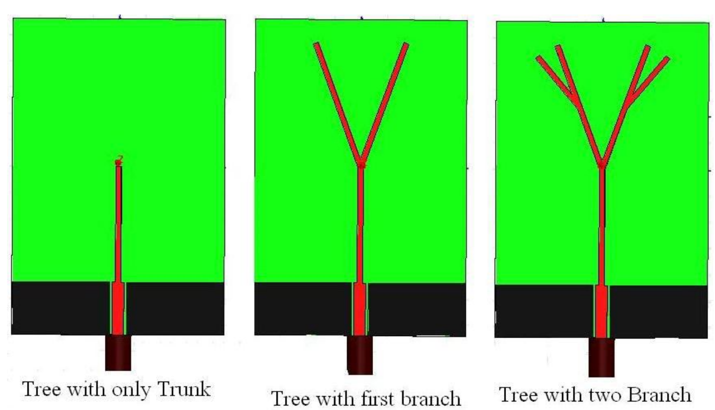

Figure 1. proposed antenna with different iteration

A. Iteration 0 with results

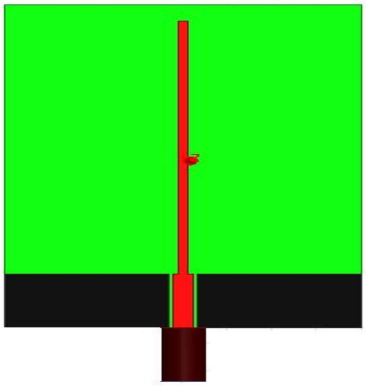

Figure 2. Basic structure

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.

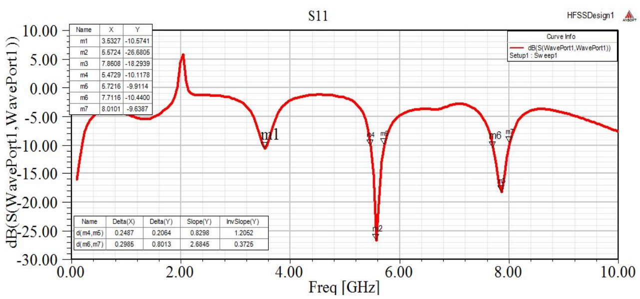

Figure.3. Reflection coefficient

Fig.3 shows reflection coefficient. The antenna is giving return loss of -10.52decibel at 3.58GHz,-26.68decibel a5.57GHz and -18.29 decibel at 7.86GHz resonant frequency

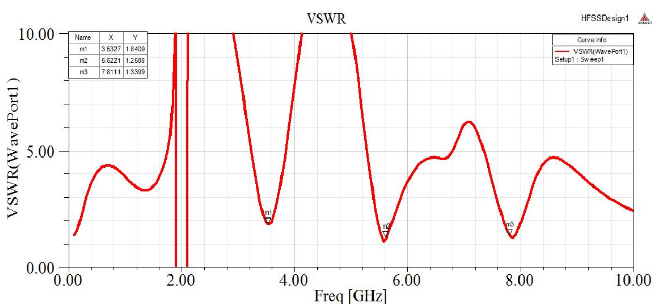

Figure 4. vswr

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.

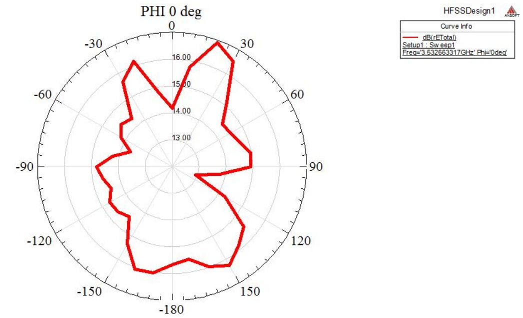

Figure 5. Elevation pattern of an antenna

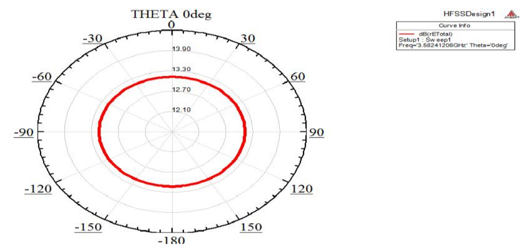

Figure 6. Azimuth pattern of an antenna.

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.

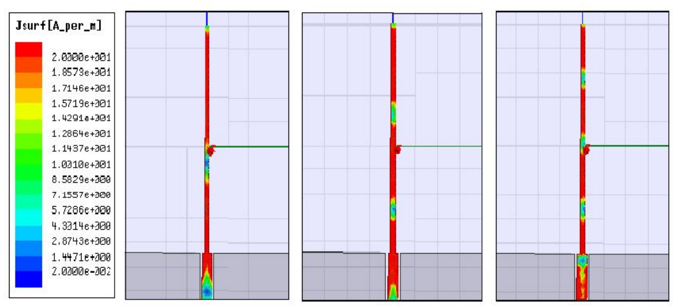

Figure 7. Current distribution

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

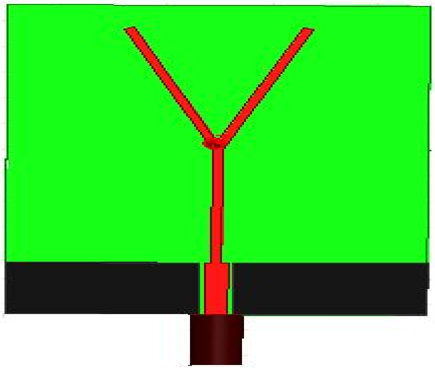

Figure 8. First iteration

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.

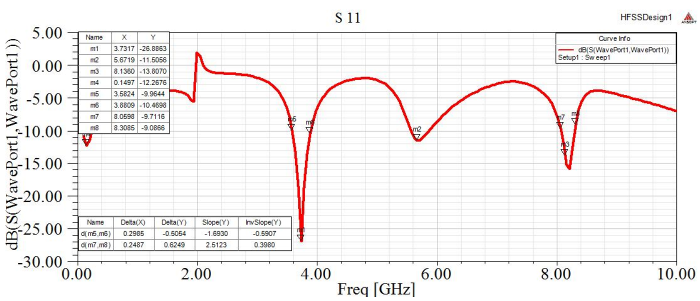

Figure 9. Reflection coefficient

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.

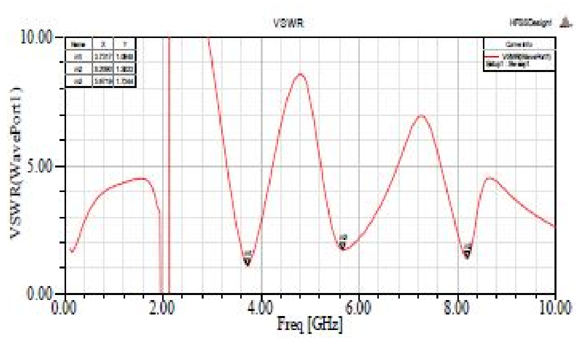

Figure 10: vswr

Figure 10.

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

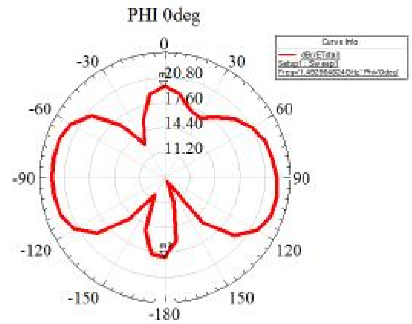

Fig.11 Elevation pattern of an antenna

Figure 11.

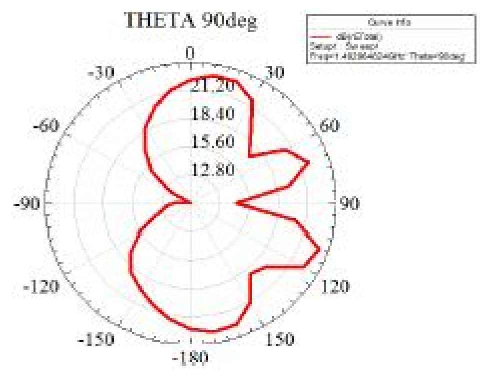

Fig.12 Aazimuth pattern of an antenna.

Figure 12.

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

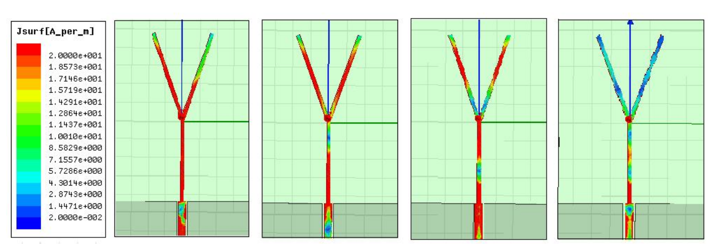

Figure 13. Current distribution

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 cur\rent 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

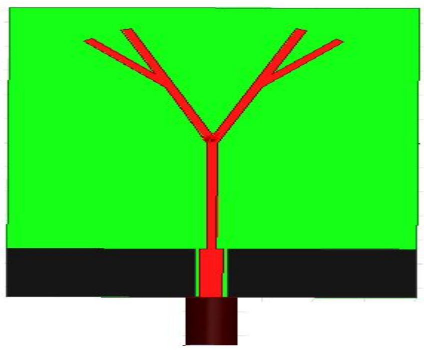

Figure 14. Second iteration

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.

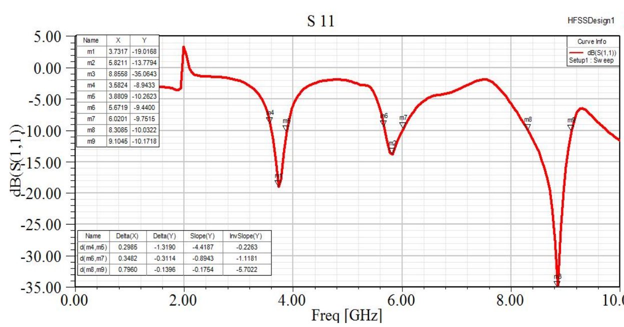

Figure 15. Reflection coefficient

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 .

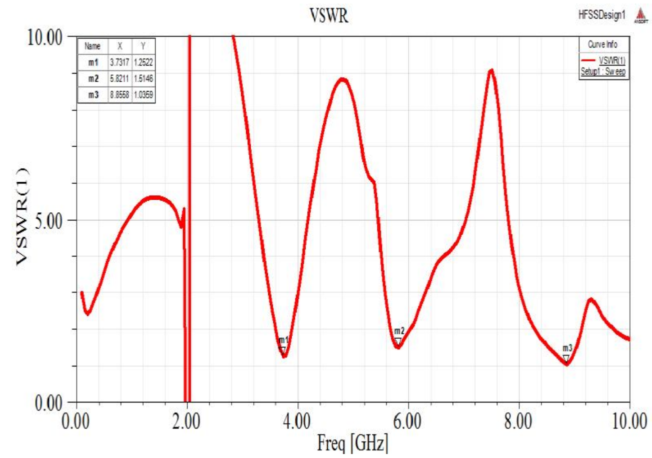

Figure 16. VSWR

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.

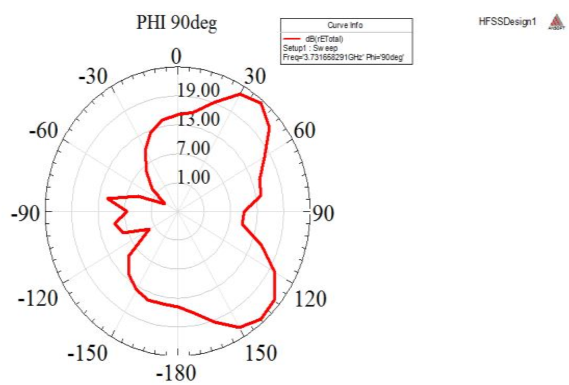

Figure 17. Elevation pattern of an antenna

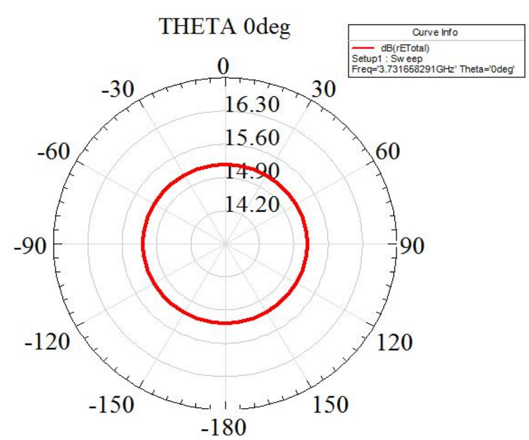

Figure 18. Azimuth pattern of an antenna.

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.

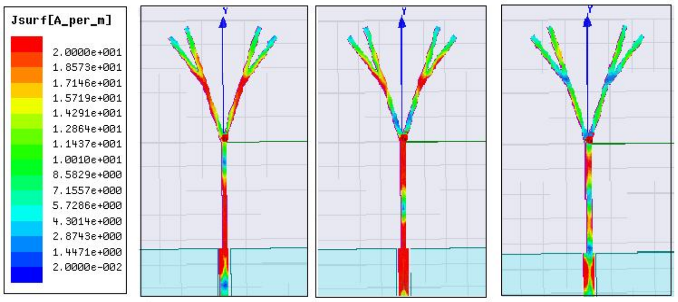

Figure 19. Current distribution

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.

III. 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.

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