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Fractal MIMO Antenna for 5G WLAN and WIMAX Application

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Abstract: *In the last few years' growth in wireless communication domain is tremendous. From the year 2007 requirement of mobile cellular increases five times of telephones. But some service provider's companies are felt the importance of an efficient network and in the equally efficient design. the enhanced technology of 2G, 2.5G, 3G, & 4G networks increases the effect of many services on network efficiency and it has become more critical sometimes. In network designing scenarios have developed with not only 2G or 3G networks but also with the evolution of 3G to 4G and 5G networks. Here we are going to design a fractal Antenna having which can able to give up to the 6 GHz Frequency. Using this fractal technology and number of resonating frequencies increases with increases in iteration as we add 3 iterations. The proposed patch antenna shows good radiation pattern, high frequency and good gain up to 4.46 dB. For this we use CST- Studio Software.*

Key Word*: Fractal Antenna, 5G-Technology, Polygonal (decagon), Frequency 3-6 GHz, Return-loss,*

I. Introduction

The process of transferring of information or messages from one place to another is known as Communication. When electromagnetic waves or radio waves are utilized for the wireless communication purpose, then it is called Radio Communication. Electromagnetic waves consist of electric and magnetic fields which are always perpendicular to each other and travel in a required perpendicular direction. So we require Antenna to radiate or receive electromagnetic waves. An Antenna is one of the most important part of communication for wire as well as wireless. It is defined as a metallic device which radiates or receives radio waves and elevated conductors which couples or matches the transmitter or receiver to free space and also forces electromagnetic waves into free space which travel in space with velocity of light. It is used in 1G to 5G technology. There are so many types and shapes of this Antenna which are used for specific purposes. Our aim is to design Antenna that is used for 5G, WIMAX and WLAN fields.

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II. Material And Methods

Wireless networks such as WLAN and WIMAX are extensively used nowadays to link electronic devices within close proximity. However, in areas such as supermarkets, office buildings, schools, and public places, wireless local area networks (WLAN) are used increasingly frequently. It operates using a wireless distribution method inside a defined area. The 802.11 standard is used in nearly all current WLAN networks. There are many types of antennas design that are proposed and used in MIMO (multiple input and multiple output) design, however, printed circuit antennas are widely used for a various reason that is low cost of manufacture, easy to manufacture and making, and easy to integrate with small size terminals [6]. This paper presents a fractal antenna design operating at multi-band for WLAN system is presented, then based on the results of this antenna are working properly.

Study Duration: June 2020 to May 2021

Sample size: 10-sides polygonal Antenna having 10 side with 10mm of each side and the overall radius is 15mm.

Sample size calculation: The antenna should be built on a grounded substrate made of FR4 material with a dielectric

constant of 4.4. The feeding method for Microstrip lines is The antenna's feeding has been chosen. The antenna was examined for the required information. The simple circular shaped Microstrip eventually reveals resonant frequencies.

Figure No 1: Antenna design having Iteration

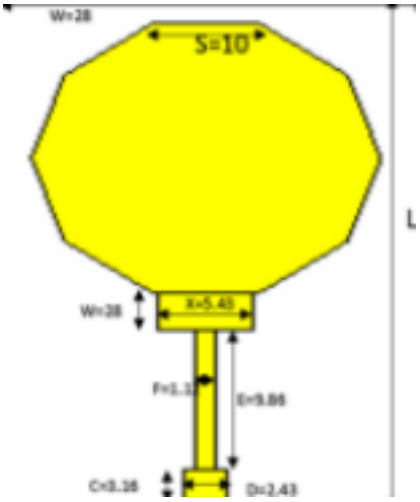
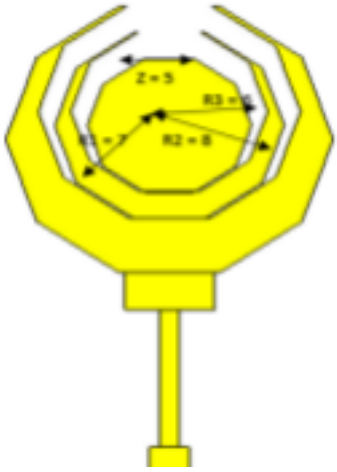


Figure No 2: Antenna



This is a basic Polygonal Antenna having 10 side with 10mm of each side and the overall radius is 15 mm Which waveform is shown in figure. In this we use Copper loss medium base that helps to get a good radiation pattern. Input Impedance is given to the patch here that showing in the yellow color region. Then one by one Iteration is given to the antenna as shown in fig. 1. The Microstrip patch antenna's substrate dimensions are 28 mm x 36 mm and thickness is 1 mm depict the suggested system's steady evolution. For the same area, use the same antenna is the basic antenna structure for the developed antenna, as shown in Fig. II a.

Table no 1 - Antenna Dimension:

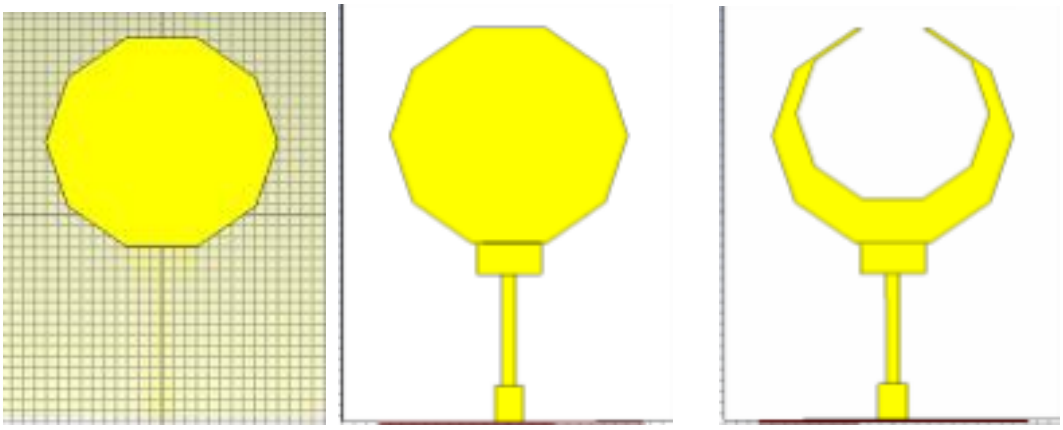
Sr.No	1	2	3	4	5	6	7	8
Parameters	L	W	S	X	F	E	C	D
Dimension	37	28	10	5.4	1.12	9.86	3.16	2.43

Procedure methodology:

In this research "super wideband "antenna we are driven by two desires: First constraint on antenna dimension to be reduced as small as possible and second thing is single antenna can work for multiple wireless applications or services. Performance parameters of fractal antenna repeat periodically, the effect of iteration depth is on fineness of antenna. Therefore finite iteration can not be frequency independent. As per the analysis it will be apparent that, there is need to be develop such antenna system able to fast access of internet as well as wireless communication .By considering increasing compactness of electronic systems component, there is a need of embedding two or more narrowband systems together. It is more difficult thing to achieve antenna which works on multiple frequencies. Use of fractals in antenna is relatively new concept, two or more narrow band frequencies are combined. The proposed Fractal Antenna will be working on Seven different frequency bands (S-band) 0.89 - 0.96GHz, 1.71 - 1.88GHz 2.44-2.45GHz, 1.7 - 1.9GHz, 2.68 - 6.45GHz, 5.15 - 5.25GHz and 8 - 12GHz Application. Within these frequency bands, different

applications are covered as shown in following For integrated wireless applications, MIMO techniques were used because to access multiple frequency need to use multiple frequency radiator antenna arrays. But in this research work no need to use antenna array. We have design a monopole fractal antenna for multiple frequency band ,as compare to other antenna it require minimum space so we can easily integrate into portable devices .The important performance parameters of antenna such as antenna Size, Gain, VSWR, Bandwidth, radiating power and Radiating Efficiency, these properties of fractals are to be more efficient for multiband exploited in order to develop a new class of antenna factors . In case of fractal antenna subtracting a central inverted part from a main shape of antenna get Fractal antenna. After the subtraction method, each one being proportional to originator we get fractal antenna.

Figure No 3 : Antenna 1 **Figure No 4:** Antenna 2 **Figure No 5**: Iteration 1



This is a basic Polygonal Antenna having 10 sides with 10mm of each side and the overall radius is 15mm which waveform is shown in figure. In this we use Copper loss medium base that helps to get a good radiation pattern. Input Impedance is given to the patch here that showing in the yellow color region. Then one by one Iteration is given to the antenna as shown in fig. II e. This is a First Iteration that gives better frequency to us. This reduced the return loss of the Antenna that is showing in the waveform which is magnitude vs frequency 3.5GHz. But we need to add more Iteration in the Antenna to get specific result. So that We perform the following Iteration that is Second and Third Iteration. is shown in fig. II f, (II g .

Figure No 6: Iteration 2 **Figure No. 7:** Iteration 3

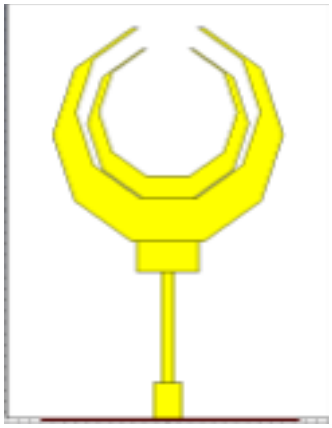


Fig. II f: Iteration 2

Fig. II g: Iteration 3

The simulated results were performed by using CST software shows the simulated S parameters for the proposed antenna array. the reflection coefficients of four antennas are less than -6 dB (3:1 VSWR) in the desired frequency 3.1 to 6.8 GHz , indicating that acceptable impedance matching is obtained. The transmission coefficient between antennas are presented in antenna design, it shows a dip (about -15 dB) at about 3.5GHz and less than -12dB at about 4.9 GHz and is less than -10 dB for frequencies in the operational band., which is acceptable for Smartphone applications .For the antenna efficiency shown antenna design, it is all above 50% in the operation band. The obtained ECC of the four antennas is presented in the final antenna. The obtained ECC is all much less than 0.1 in the design antenna operation band, which is good for the MIMO operation. The result shows that the proposed antenna array is suitable for practical MIMO operation.

Statistical analysis:

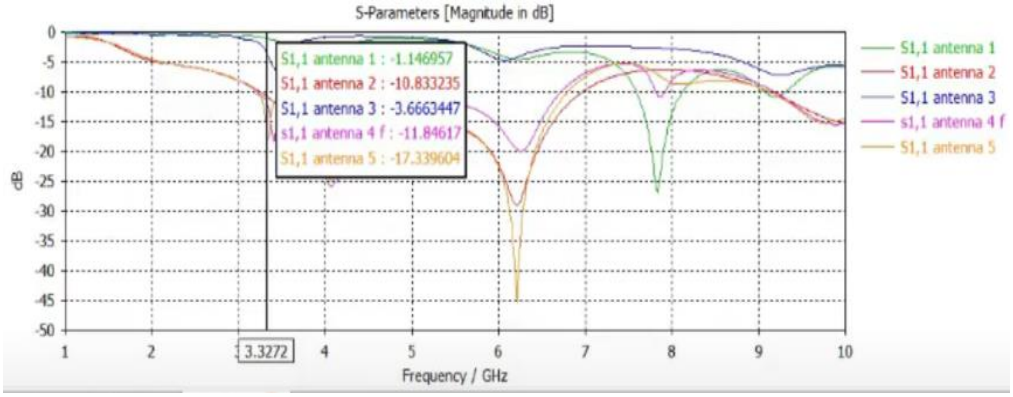
In this project we used CST-STUDIO Version-18 Software that gives complete idea about the output of 5G bandwidth. The Fractal MIMO Antenna is Design using Computer simulation tool (CST) studio software. The antenna impedance bandwidth is adjusted by tuning length and width of feed line (Lf × Wf), which is the main source terminal for current injection. The proposed antenna structure has been designed for compactness and the substrate of thickness 1.6 mm, dielectric constant and loss tangent 0.0009 with a compact electrical area of (L × W) mm^2 is 0.179(λ_0) 2 where λ_0 = lowest operating wavelength. The exploded view of fractal radiator is depicted in Fig. II c. Proposed design methodology starts with the evolution of iterations shown in Fig. II d.

III. Result

SIMULATION RESULT FOR CONVENTIONAL FRACTAL ANTENNA:

It works based on the method of wireless distribution within a limited area. Most modern WLAN networks based on the 802.11 standard, with the operation frequencies at the three GHz-bands: (2.401-2.495), (5.150-5.350) and (5.725-5.825). The antennas of modern wireless communication system forced techniques with the new challenges such as small size, high efficiency, multiple frequencies operation, low cost**.**

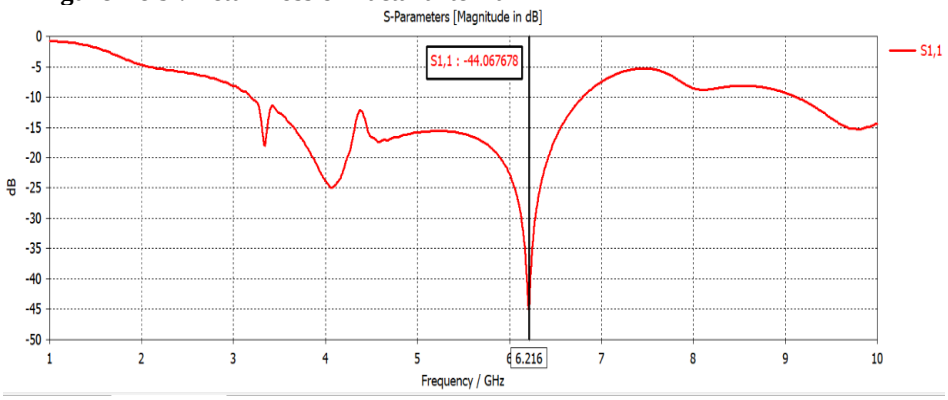
Figure No 8: S parameters of the antenna



Return loss:

It's a metric for how well power is delivered from a transmission line to a load like an antenna. The better the load and line are matched, the higher the power ratio. In decibels, the return loss is the inverse of the size of the reflection coefficient. Return loss is provided by RL = $10\log10.P_{in}/P_{ref}$ dB, which is a positive number because power is proportional to the square of voltage.

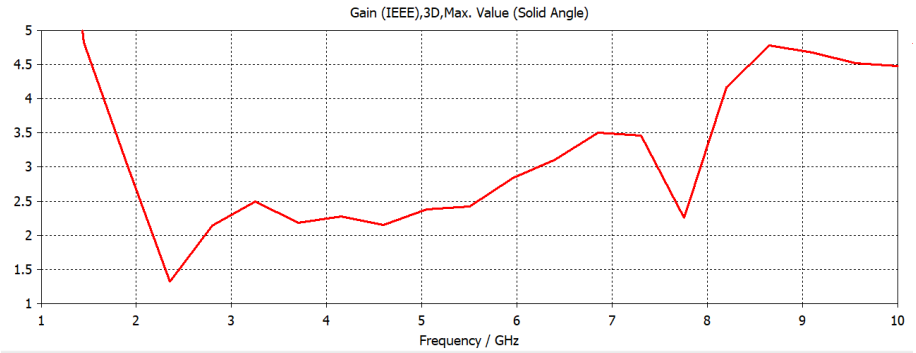
Figure No 9 : Return loss of fractal antenna



Gain:

It shows how much signal is transmitted in the direction of peak radiation to that of an isotropic source. A transmitting antenna gain of 4.46dB means that the power received far from the antenna will be 4.46dB higher than what would be received from a lossless isotropic antenna with the same input power. Similarly, a receiving antenna with a gain of 3dB in a particular direction would receive 4.46dB more power than a lossless isotropic antenna. Since an antenna is not able to make power, increasing gain in one direction will decrease propagation in another. The gain of our MIMO antenna is around 4.46dB. Gain = Efficiency* Directivity.

Figure No 10: Gain of the suspended antenna.



Bandwidth:

The bandwidth of an antenna mention to the range of frequencies over which the antenna can operate correctly. Outside this frequency range of frequencies the antenna impedance becomes a poor match to the frequency transmission line and transmitter (or receiver).and the bandwidth is 552 MHz at 6.2GHz.

Figure No 11 : Bandwidth of the antenna .

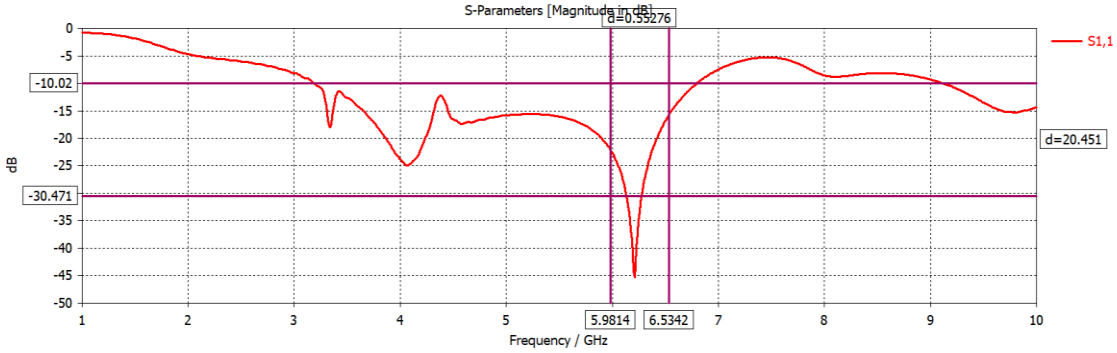
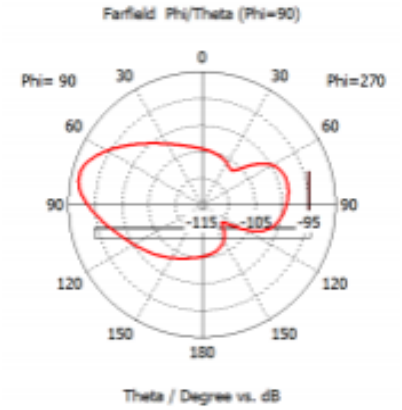


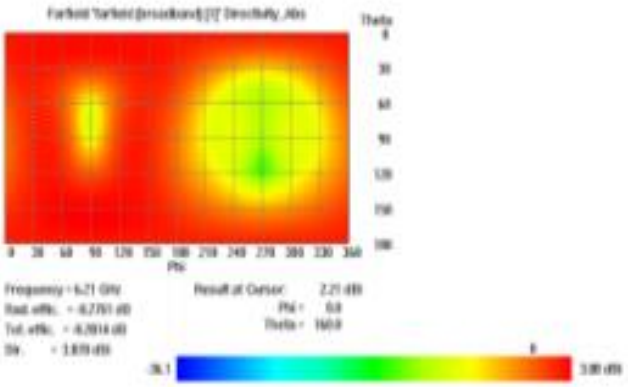
Fig. III d: Bandwidth of the antenna

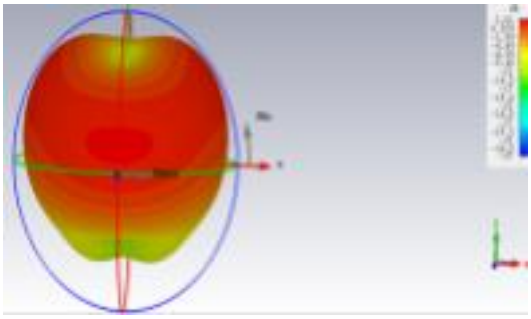
Radiation Pattern:

It is the fluctuation of an antenna's radiated power as a function of distance from the antenna. It's a graph that shows how the antenna's radiation qualities change as a function of spatial coordinates. We often think of spherical coordinates as the ideal. An antenna designed to radiate in a spherically symmetrical pattern. The pattern of radiation is In the far-field, it's decided.

Figure No12 : 2D &3D Radiation pattern of designed fractal antenna.







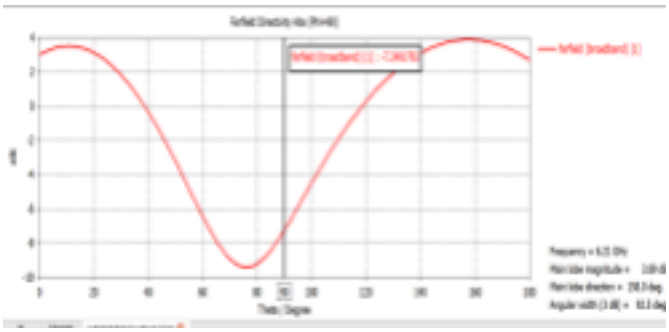


Table No 1: Iterations wise simulated result

Design steps	Resonant frequency	Return loss	VSWR	Bandwidth	Gain
Antenna 1	7.83	-26. 8 db	1.95	567 MHz	1.26db
Iteration 1	4.06,6.24	-26. 8 db	1.95	677 MHz	1.26db
Antenna 2	3.46	-6.62 db	2.531	388 MHz	2.26db
Iteration 2	3.38,4.08,6.23	-11.12 db	1.179	185 MHz	2.9db
Iteration 3	3.3,4.09,6.2	-45. 35 db	1.010	552 MHz	4.46db

IV. Discussion

While the 3rd Generation Partnership Project (3GPP) begins to release more specifications addressing the emerging demands and pushing the industry deeper into the era of 5G, casting doubts among to launch their next-generation 5G products. The design of Antenna is the most confusing and complex part of this process because it is almost entirely depended on the end device form factor and OEMs' preferences. This technology already used in the 4G LTE network

in the form of SU-MIMO and MU-MIMO (Single-user MIMO and Multiple-user MIMO). In 5G, MIMO is a very necessary block to push the cell capacity, communication and downloading data rate to the higher level. While most of the MIMO antenna nowadays focus on the Transmission side where 32 or more logical antenna ports are needed to use. Also, because of the Multiple Access technology in 5G, Bluetooth/WLAN, cellular, etc. are more often to transmit on the signals simultaneously. Antenna coexistence issue can only be more complicated to solve due to its shapes and size. If it is not properly addressed, antenna coexistence can cause issues in either communication range, an unexpected blind spot, or even sporadic connectivity quality drop.

V. Conclusion

A small pentagonal decagon patch antenna has been proposed for the 5G wireless standard. The proposed patch antenna shows good radiation pattern, high frequency and good gain up to 4.46 dB. Using this fractal technology and number of resonating frequencies increases with increases in iteration as we add 3 iterations. Bandwidth, return loss also observed in CST-Studio. The characteristics of an antenna are improved with increase in iterations such as return loss, VSWR, radiation pattern, current distribution and give the frequency range up to 6 GHz which is required for 5G application.

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