FISH-SHAPED WLAN MIMO ANTENNA

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ABSTRACT

In this paper, the main aim is to do the simulation of a Fish-shaped WLAN antenna for wireless communication and to analyze various factors like gain, directivity, return loss, radiation intensity for the frequency of 6 GHz. The simulation of this Fish-shaped wlan antenna is carried out in ANSYS HFSS v2020. Results like return loss, radiation pattern, 3D polar plot, sidelobe level, beamwidth, radiated power, accepted power have been obtained using HFSS v2020. This research on Fish-shaped WLAN antenna gives a great view on how it can be designed and used at 6GHz frequency has a peak gain of 2.5014dB. The applications of the designed antenna have been discussed in the future scope. The main advantage of this antenna is it has high immunity to multipath fading

Keywords : Envelope correlation coefficient, FISH shaped antenna, Return loss, Directivity, Radiation pattern

1. INTRODUCTION

1.1 INTRODUCTION TO WLAN ANTENNA

In recent years, with the rapid development of wireless local area networks (WLANs), various antennas of WLAN are widely studied, especially omnidirectional antennas. An advantage of omni-directional antennas is its wide coverage. press CMC in the full band without extra increases in antenna sizes. The proposed antenna can cover the entire frequency range of the WLAN protocol and has good omnidirectional radiation characteristics

1.2 DESIGN EQUATION

1) $w = \frac{c_0}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}}$ = 0.0122

2) $\varepsilon_{r_{eff}} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{w}\right]^{-1/2}$ = 3.172

3) $L = \frac{\lambda}{2} - 2\Delta L$ = 159.342

4) $\frac{\Delta L}{h} = \left(\frac{\varepsilon_r+0.3}{\varepsilon_r-0.258}\right)\left(\frac{\frac{W}{h}+0.264}{\frac{W}{h}+0.8}\right)$ = 0.7968

1.3 ADVANTAGES OF WLAN ANTENNA

The Fish-Shaped WLAN antenna has wide applications and few are listed below

- Wide bandwidth: Fish-shaped WLAN antennas can operate over a wide range of frequencies, making them suitable for the latest Wi-Fi standards.
- Compact size: Fish-shaped WLAN antennas can be made very compact, which makes them ideal for mobile devices and other applications where space is limited.
- High gain: Fish-shaped WLAN antennas can be designed to have high gain, which improves their performance in terms of range and sensitivity.
- Directivity: Fish-shaped WLAN antennas can be designed to have a high degree of directivity, which improves their performance in terms of beamforming and spatial filtering.
- Low profile: Fish-shaped WLAN antennas can be made with a low profile, which makes them ideal for applications where the antenna needs to be hidden number6360or unobtrusive.
- Ease of fabrication: Fish-shaped WLAN antennas can be fabricated using a variety of techniques, making them relatively easy to produce.

- Cost-effectiveness: Fish-shaped WLAN antennas can be made at a relatively low cost, making them an attractive option for budget-conscious applications.

1.4 DISADVANTAGES OF FISH SHAPED WLAN ANTENNA

- When increasing frequency above 6 GHz, then radiation efficiency will be gradually decreased.
- Port distance increases, efficiency also decreases.

1.5 APPLICATIONS OF FISH SHAPED WLAN ANTENNA

- Home and office networking: Fish-shaped WLAN antennas can be used to improve the performance of Wi-Fi networks in homes and offices by providing wider bandwidth and better coverage.

- Public hotspots: Fish-shaped WLAN antennas can be used to improve the performance of public Wi-Fi hotspots by providing wider bandwidth and better coverage.

- Industrial and medical applications: Fish-shaped WLAN antennas can be used in industrial and medical applications where reliable and high-speed wireless data transmission is required.

- Wireless sensor networks: Fish-shaped WLAN antennas can be used in wireless sensor networks to provide long-range communication between sensors and a central hub.

- Automotive applications: Fish-shaped WLAN antennas can be used in automotive applications to provide wireless communication between vehicles and infrastructure.

2. LITERATURE SURVEY

Huang et al.[1] proposed about Broad and Dual-Polarized omni-direction Antenna with good port isolation, omnidirectional patterns in horizontal plane, along with acceptable cross polarization and gain also obtained.

Liang et al.[2] proposed about Broadband Horizontally Polarized Omnidirectional Antenna Array for Base-Station Applications that three wideband planar dipoles are employed as basic elements. Bandwidth of 48.2%.Here gain variation is more relatively large.

Dong et al.[3] proposed about Design of a Wideband Horizontally Polarized Omnidirectional Antenna Mutual Coupling Method.HP omnidirectional antennas has a wideband operating band.Row of director elements is utilized to enhance the radiation in horizontal plane.

Wang et al.[4] proposed about Multiband and Dual-Polarized antenna in 2013 states that directly overlapping with the VP-elements higher frequency band. The cross polarization levels in the azimuth plane for both VP and HP.

Lei et al.[5],proposed the Ceiling-Mount Omnidirectional Antenna proposed that lowest frequencies of operation and top-loading disk located on the top of coupling patch.

By consolidating all, the results are obtained as follows:

Table : 1 Literature Survey analysis

Reference	Return loss	Isolation loss	Gain	Efficiency
Lei Zhou [5]	5.8 GHz	NA	1.9-2.5 dB	71%
Liang Hua Ye[2]	2.7 GHz	NA	1.24 dB	NA
Ze Dong Wang[3]	3.54 GHz	NA	<1.2 dB	70.2%
Xi-Wang Dai[4]	2700 MHz	25dB	1.4-2.2 dB	35%

From the above table it is clear that, Lei Zhou et al. work has more advantages in terms of gain as well as efficiency. Hence this work has done slight modification on it, and the procedure is given in the subsequent sections.

3. DESIGN METHODOLOGY

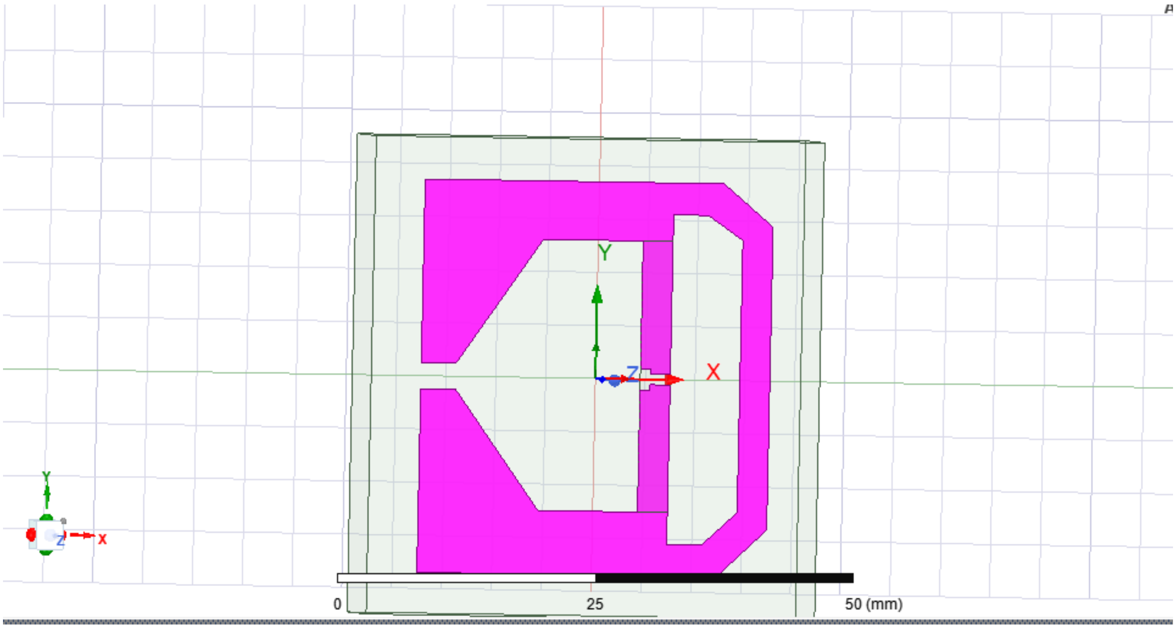


Fig 1 1D modeler window of HFSS

- The design of the patch antenna is as follows:
- X-size of the box = 45 mm.
- Y-size of the box = 47 mm.
- Z-size of the box = 1.6mm.
- A FR4 Epoxy Duroid is selected as the material.
- An excitation is provided to the port.

By consolidating all , the 2x2 array antenna is designed as shown in Figure 2.

Table 1: Design parameters

Design Parameters	Value
Operating Frequency (GHz)	6
Length of patch (mm)	45

Width of patch (mm)	47
Height of Substrate (mm)	1.6
Dielectric Constant (ε_r)	4.4

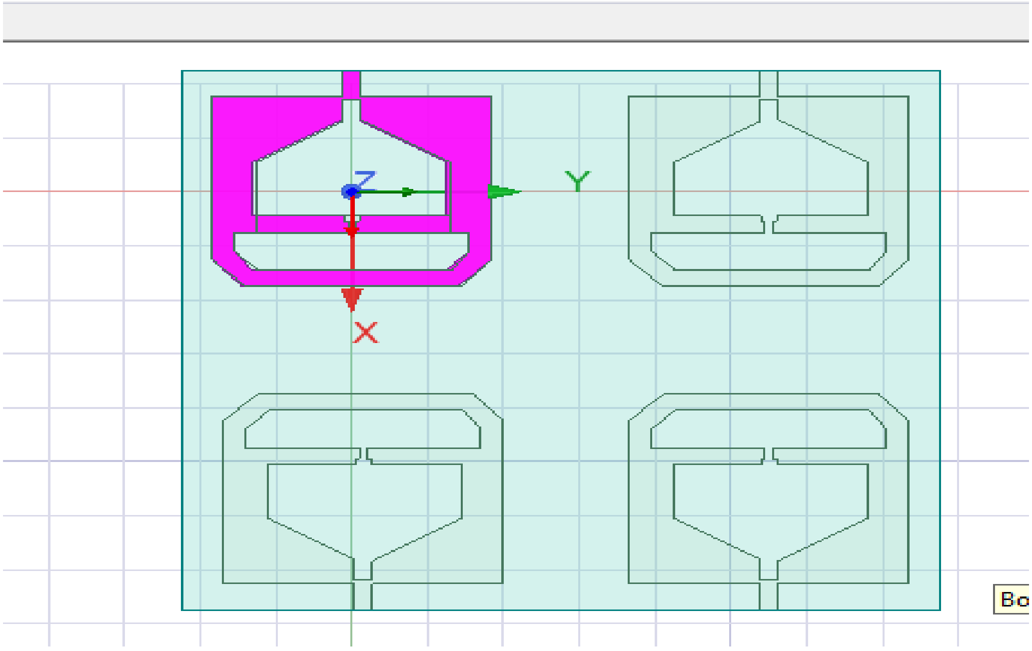


Fig 2 Geometry of the Fish-shaped WLAN antenna

4 Results and discussion

This section deals with simulation results obtained from Fish-shaped WLAN antenna.

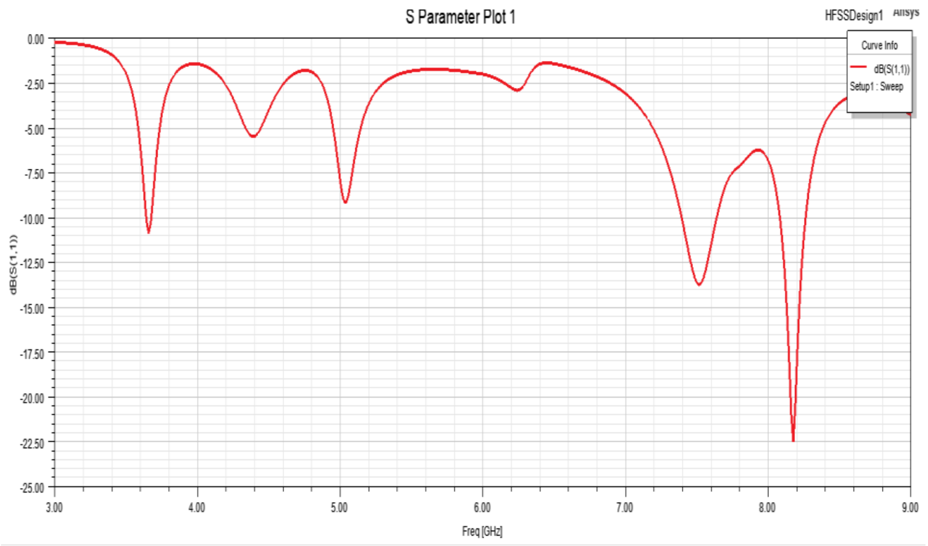
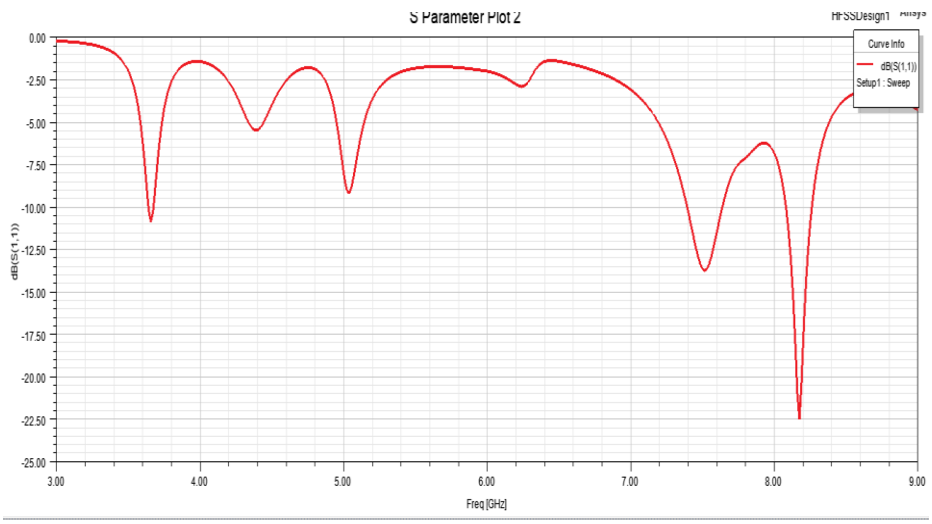
4.1 Return loss

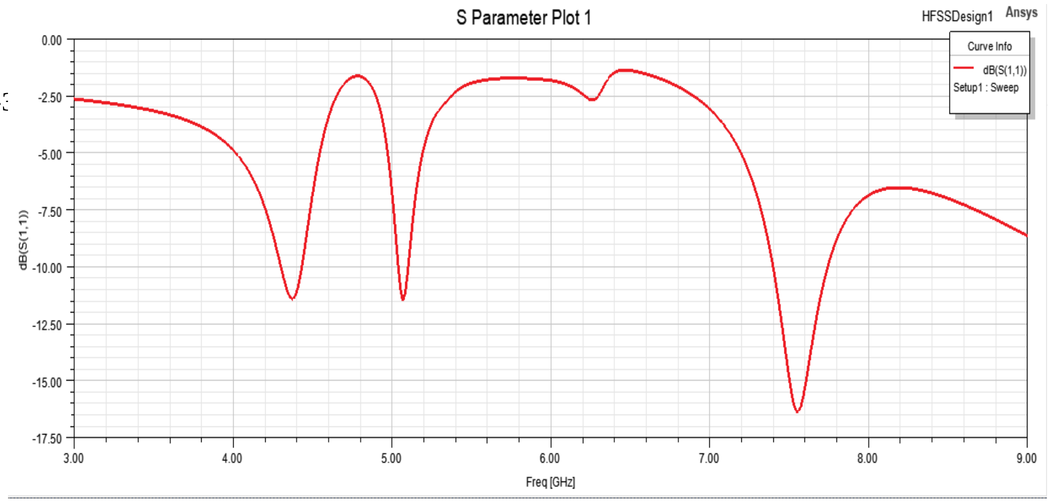
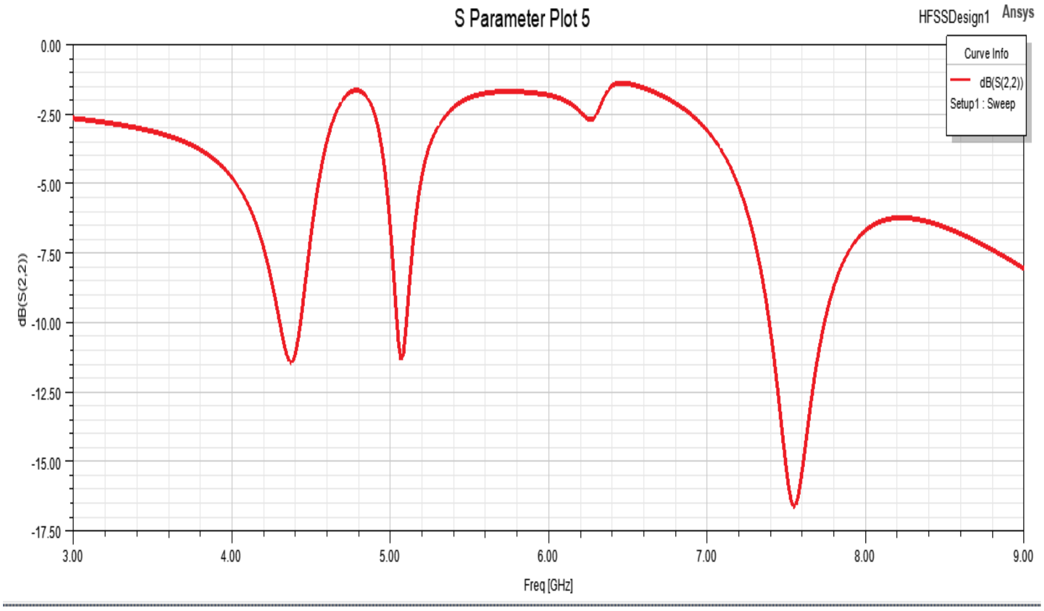
Return loss is the power loss in the signal that is reflected or returned in a transmission line or optical fiber by discontinuity. With an inserted device in the line or with the mismatch in the terminating load, this discontinuity can happen. Return loss is given by the equation,

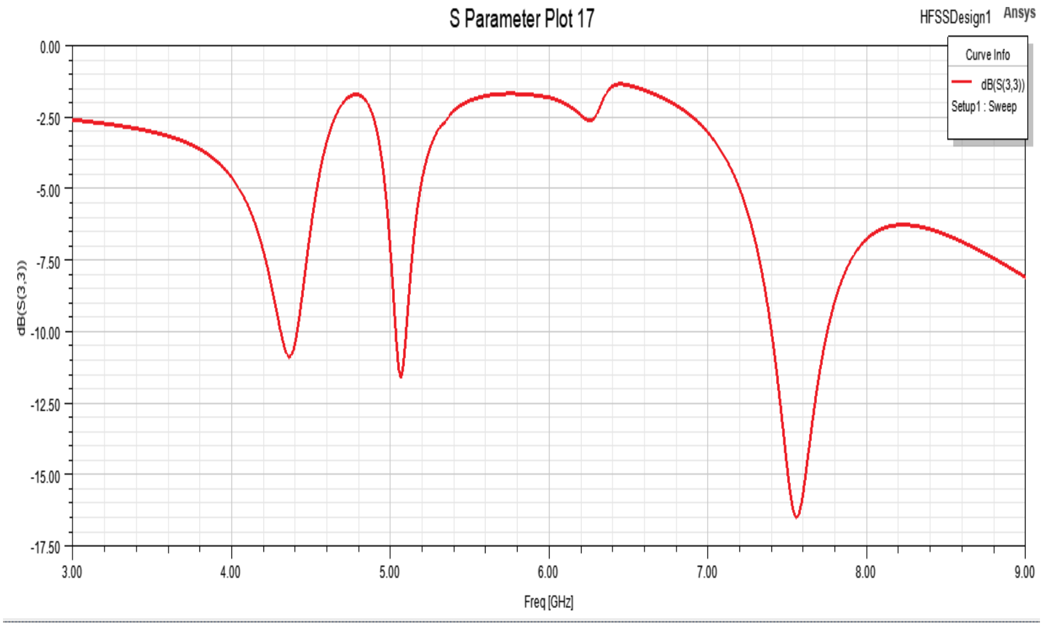
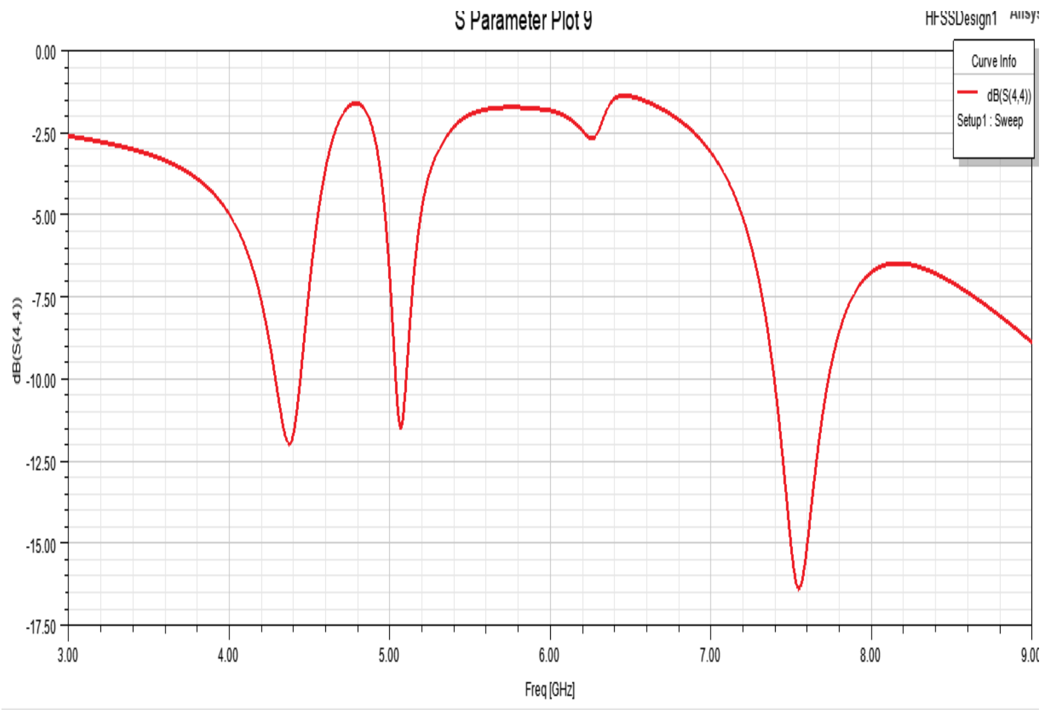
$$\mathbf{RL\ (dB) = 10}\,log_{10}(\mathbf{P_{incident}/P_{reflected}})$$

where, RL (dB) is the return loss in terms of dB
$P_{incident}$ is the incident power
$P_{reflected}$ is the reflected power

Table 3 : Return Loss with Patch Structure

S(1,1)	S Parameter Plot 1
HFSSDesign1
Curve Info
dB(S(1,1))
Setup1 : Sweep
dB(S(1,1))
Freq [GHz]
0.00
-2.50
-5.00
-7.50
-10.00
-12.50
-15.00
-17.50
-20.00
-22.50
-25.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
S(1,2)	S Parameter Plot 2
HFSSDesign1
Curve Info
dB(S(1,1))
Setup1 : Sweep
dB(S(1,1))
Freq [GHz]
0.00
-2.50
-5.00
-7.50
-10.00
-12.50
-15.00
-17.50
-20.00
-22.50
-25.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00

S(2,1)	 S Parameter Plot 1 HFSSDesign1 Ansys Curve Info dB(S(1,1)) Setup1 : Sweep dB(S(1,1)) Freq [GHz]
S(2,2)	 S Parameter Plot 5 HFSSDesign1 Ansys Curve Info dB(S(2,2)) Setup1 : Sweep dB(S(2,2)) Freq [GHz]

S(3,3)	
S(4,4)	

4.2 VSWR

Usually, the standing wave ratio of an antenna is called as the Voltage Standing Wave Ratio (VSWR). The standing wave ratio in terms of current is called ISWR. Squaring the VSWR yields the Power Standing Wave Ratio. The total power reaching the destination end is prevented by impedance mismatch in the transmission line where the radio wave in the cable is reflected back to the source. An infinite SWR is the complete 14 reflection

of power reflected from the cable. SWR meter is the instrument used in the measurement of SWR from transmission lines or cables.
The Voltage Standing Wave Ratio is the measure of loss at the feeder because of mismatch. It normally ranges between 0 to infinite. For practical antennas the value should be less than 2 then the antenna is said to be matched.

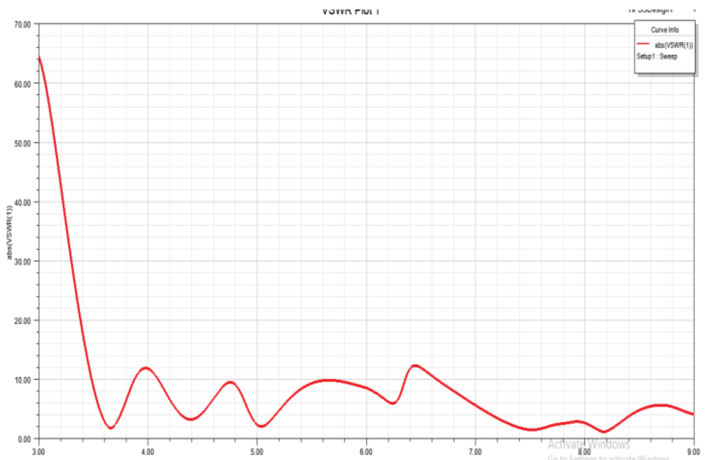
<table>
<tr><td>Operating frequency(in GHz)</td><td>VSWR</td></tr>
<tr><td>VSWR</td><td>
</td></tr>
</table>

Figure 3: VSWR PLOT for Simple Patch

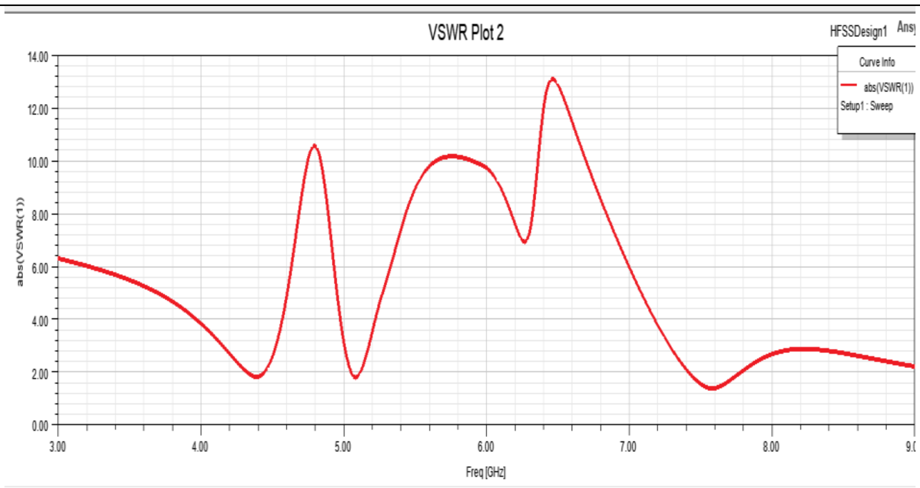
<table>
<tr><td>OPERATING FREQUENCY (in GHz)</td><td>VSWR</td></tr>
<tr><td>7.5
(1-4)</td><td>
</td></tr>
</table>

Figure 4 : VSWR Plot for MIMO structure

4.3 Radiation pattern

Graphical representation of the relative field strength that the antenna transmits or receives is called radiation pattern. It is indicated with side lobes and back lobes. An antenna's radiation pattern can be defined as the locus of all points in which power emitted per unit surface is equal. The reference in this depiction is usually the best emission angle. The directive gain of the antenna may also be represented as a function of direction. The gain is often represented in decibels. A single graph is sufficient if the antenna radiation is symmetrical about an axis a unique graph is enough i.e., for helical or dipole antennas.

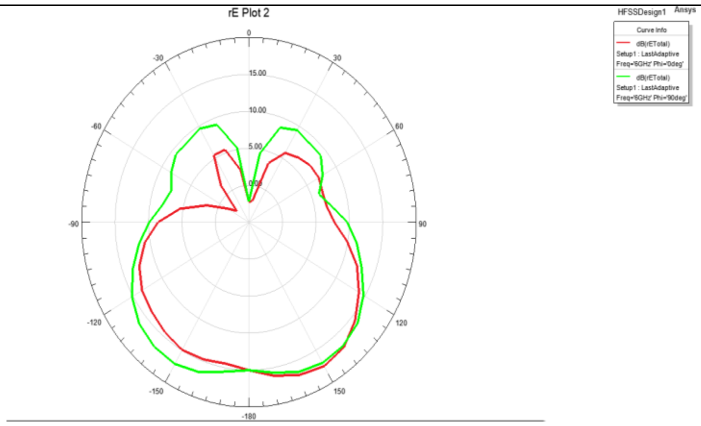
OPERATING FREQUENCY(in GHz)	**Both E and H Field**
6	

Figure 5 Radiation Pattern for Simple Patch Structure

OPERATING FREQUENCY (in GHz)	**WITH E FIELD (Phi =0 degree)**	**WITH H FIELD (Phi=90 degree)**

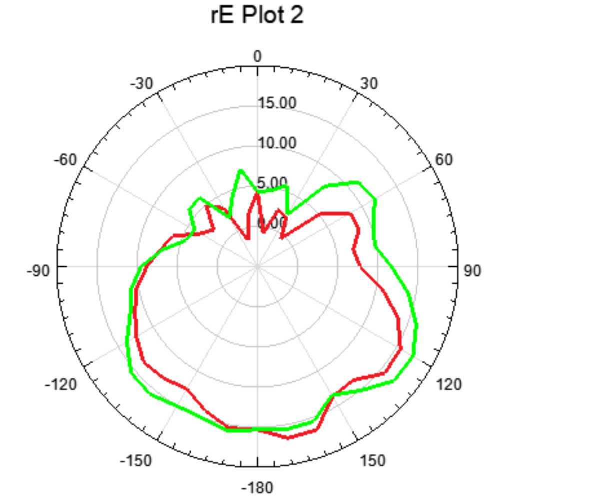
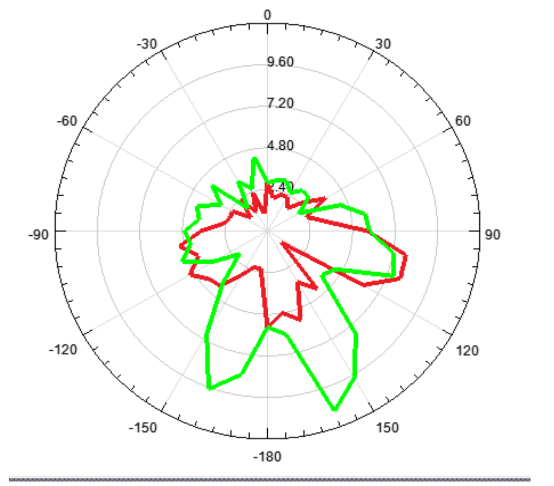
7.5		

Figure 6: Radiation Patterns for MIMO structure

From the above graphs, it is inferred that directivity increases with increase in frequency.

4.4 Antenna gain

The directionality of the antenna is measured by a factor called Antenna Gain or Gain of an Antenna.

Gain can also be given by,

Gain = Directivity × Efficiency

$$G=\frac{(P/S)_{ant}}{(P/S)_{iso}}$$

If the gain is higher, then in that particular direction the signal strength is higher

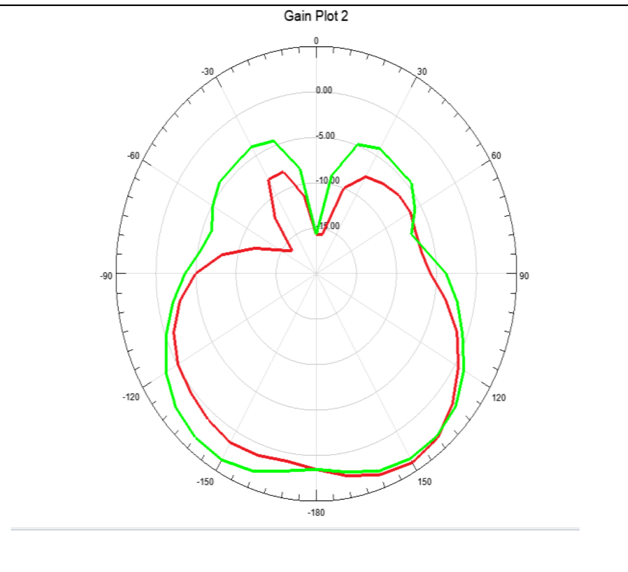
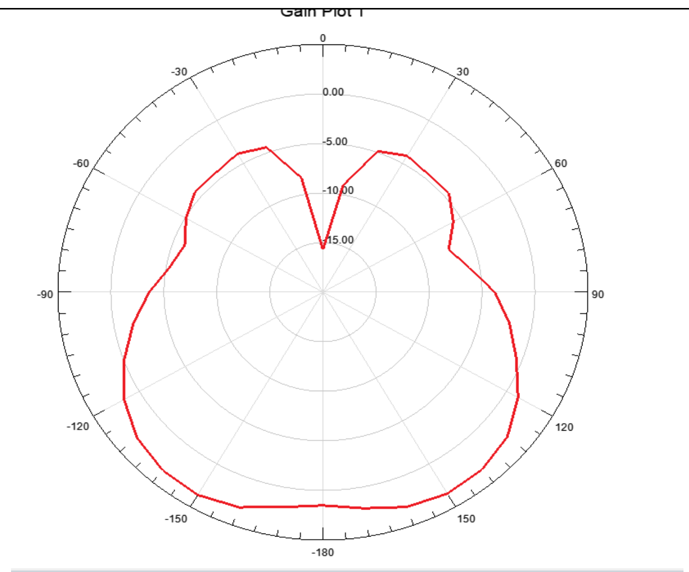
OPERATING FREQUENCY (in GHz)	WITH E FIELD (Phi =0 degree)	WITH H FIELD (Phi=90 degree)
6		

Table 4.7: Antenna gain for Simple patch structure

OPERATING FREQUENCY (in GHz)	WITH H FIELD (Phi=90 degree)

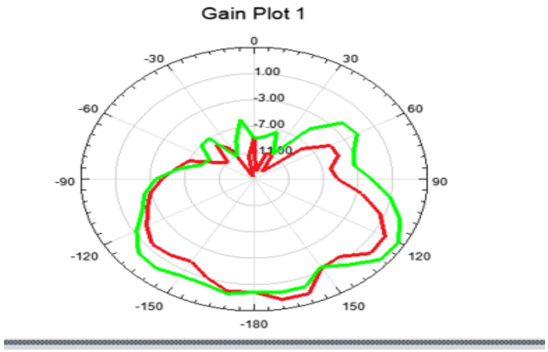
7.5 (1-4)	

Figure 8 Antenna gain for MIMO Structure

From the above graphs, it is inferred that gain increases with increase in frequency.

4.5 Directivity

Directivity of an antenna is given by the ratio of the maximum intensity of radiation to the average intensity of radiation. Maximum intensity of radiation means power per unit solid angle and average intensity of radiation means average over a sphere. Directivity is given by

$$D = 4\pi U/P_{radiated}$$

where, $P_{radiated}$ is the power radiated by the antenna.

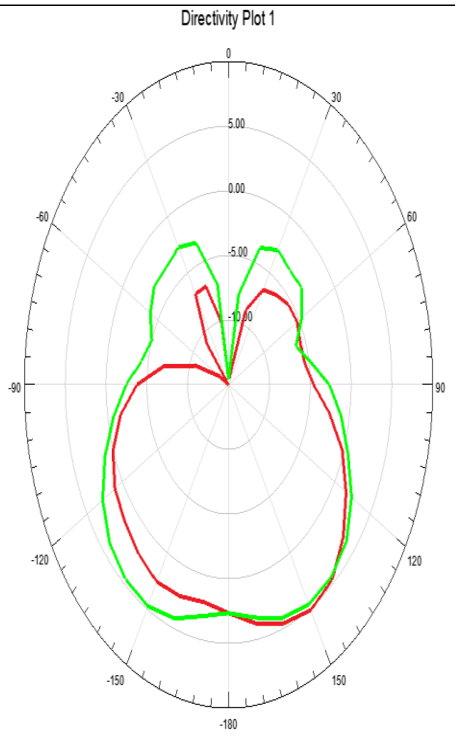
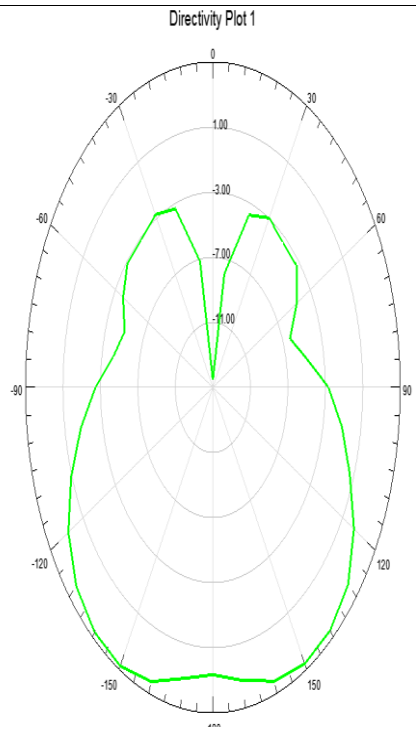
OPERATING FREQUENCY (in GHz)	WITH E FIELD (Phi =0 degree)	WITH H FIELD (Phi=90 degree)
6GHz		

Figure 9 Directivity of Fish-shaped Wlan antenna operating at the frequency of 6GHz

By consolidating all this, the parameters are listed as per Table 3.

Table 3: Parameters of simple patch and MIMO

PARAMETER (6GHz)	VALUE	VALUE

Peak directivity(dB)	3.2583	1.7362
Peak gain(dB)	2.5014	1.2595
Maximum Radiation Intensity (W/rad)	74.38mW/sr	244.49mW
Total efficiency (dB)	0.28687	0.72539
System efficiency (%)	0.28687	0.24449
Radiation efficiency	0.7677	

Table:4: Correlation table with frequency(7.5GHz)

CORRELATION:

Correlation between the ports is tabulated in Table 4.

Table 2 : Envelope correlation coefficient

PORT	CORRELATION (F=7.5GHz)
(1,2)	0.185179
(1,3)	0.461207
(1,4)	0.0013428
(2,1)	0.185179
(2,3)	0.030937
(2,4)	0.142627
(3,1)	0.461207
(3,2)	0.030397
(3,4)	0.006165
(4,1)	0.0013428
(4,2)	0.142627
(4,3)	0.006165

5. CONCLUSION

Fish-shaped antennas are a promising new type of antenna with a wide range of potential applications. They offer a number of advantages over traditional antennas Fish-shaped antennas are particularly well-suited for use in wireless networking applications, such as Wi-Fi and 5G. They can be used to improve the performance of wireless networks in terms of range, speed, and reliability. Fish-shaped antennas are also being investigated for use in other applications, such as radar, biomedical engineering, and industrial manufacturing.

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