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Design and Simulation of a Multiband Microstrip MIMO Antenna with Nine Model for Various Applications

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ABSTRACT: To intensify the magnitude and reliability of the radio communication with multiple antenna system and also known as Multi input and multi output Antenna. MIMO offers bettered signal range, reduced bit rate, lower power consumption, reduced interference. Multi Input Multi Output is an antenna technology for wireless communication in which multiple antennas are used at both the source and the destination contemporaneously over the same radio channel by exploiting multipath propagation. The use of microstrip patch Antenna is increasing in demand due to it slighter in weight, low volume, low cost, low profile, lower in dimension and ease of fabrication and conformity. Microstrip antenna are also used in the fields of RFID (radio frequency identification), mobile communication and healthcare. Some communication- grounded operations of microstrip patch antenna are radio altimeters, command and control systems, remote sensing and environmental instrumentation. Micro strip MIMO is a complex technology by exercising multiple antennas to overcome multipath fading propagation problem. The other name of Microstrip antenna termed as patch antenna. In this design multi band novel nine shaped microstrip MIMO antenna is proposed.The antenna that we proposed is capable of operating at different frequencies. The major parameters associated with an antenna are Reflection coefficient (S11), Gain, Directivity and VSWR and the proposed antenna must improve the gain, directivity and should be less size.

KEYWORDS: Multi Input Multi Output (MIMO), Reflection Coefficient (S11), Gain, Directivity, Voltage Standing Wave Ratio (VSWR).

I.INTRODUCTION

The transmission of information and data to various distances without the help of wires, cables or any other forms of electrical conductors is possible through wireless communications. Wireless communication is a wide term that incorporates all procedures and steps of connecting and transmitting between two or more devices or systems using a wireless signal through wireless communication technologies.

Mobile Communication is the use of technology which make us to communicate with others in various locations without the effect of any physical connection (wires or cables). Mobile communication makes our life better, and it saves time and effort. Antenna designing is one of the most fundamental part in mobile communications. The microstrip antennas are increase in demand due to its less weight ,compact size and cost effectiveness. These microstrip antennas has its application both in mobile communications and satellite communications and different types of wireless communications. The multi input multi output Is a wireless technology that increases the data capacity of a RF radio by using multiple transmitting and receiving antennas. This MIMO antenna can be used in various IoT and car applications. Our proposed 9 shaped microstrip antenna is designed using epoxy FR4 substrate the FR4 substrate is used because of its wide availability.

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LTE Stands for long term evolution And it is known as third generation partnership program By telecommunications started in 2004.The rapid increase of mobile data usage and Emergence of new applications have motivated the third generation partnership project (3GPP).High data rate , Low latency and packet Optimized radio access technology supporting flexible bandwidth deployments are the goals of LTE.

In this project we proposed a novel multi band microstrip MIMO antenna. The antenna that we proposed is capable of operating at different frequencies. The major parameters associated with an antenna are gain ,reflection coefficient ,Directivity ,return loss and VSWR and the proposed antenna has improved gain ,directivity and reflection coefficient and it is also small in size. The performance of the design antenna was evaluated based on the terms like gain, radiation pattern ,Impedance, return loss and VSWR. The design and stimulation of the antenna was performed using Ansys HFSS software 17.2 version. Our proposed antenna is designed with the goal to support packet switched traffic With the seamless mobility and great quality of service.

II. METHODOLOGY

The proposed nine shaped model has been designed in a simulation tool known as HFSS (High Frequency Structure Simulator), which tells about the parameters of antenna , type of the substrate choosen with proper dielectric constant. HFSS (High Frequency Structure Simulator) is a powerful electromagnetic simulation software tool developed by Ansys for the design and analysis of high- frequency electronic components and systems. HFSS uses finite element analysis (FEA) to simulate electromagnetic fields and predict the behaviour of various structures, such as antennas, microwave circuits, and printed circuit boards.. Here the microstrip antenna is nine shaped. The antenna geometry has a size of 28 x 37 x 1.6 mm^3. The substrate that we choosen is FR4 epoxy. It is choosen because of low cost and wide availability. The width of ground and substrate is same but length varies as per design.

In microstrip technology the antennas are designed on the compact substrate material with a radiating element, feed line and ground material. In this antenna design the firstly the FR4 substrate taken with dimensions according to the application and area of use. Mostly the height of substrate material is 1.6mm and 2.3mm as per availability in market.

After designing of FR4 substrate place the Ground material on bottom side of substrate with given dimensions The modifications in dimensions of ground strucure is varies according to different designs.

1. After completion of Ground struture, constuction of patch antennas are done on the top side of substrate material. The patch is a radiating element, that is made of conductors. In this proposed antenna we taken Copper as patch antenna material. So the shape of patch material is designed into nine shape using HFSS tools.
2. Construct Port between the patch and ground material. The dimensions of port is same as the size of feed line in Z direction.
3. Now design the Radiation box around the antenna and assign boundaries to them.
   i.Perfect E boundary – Ground and Patch material
4. Assign excitation to the port material with lumped port in HFSS software. Now start simulation of this design.

III.DESIGN

Proposed Single Antenna Design : The proposed microstrip patch antenna is Nine model . Basically for the design of an antenna three structures need to be considered like ground plane, substrate and patch. From our design the size of the antenna is 28 x 37 mm^2. The type of substrate choosen is FR4 epoxy. It is choosen based on avilability in market, low cost. The thickness of Substrate is 1.6mm, with dielectric constant of 4.4, and the loss tangent of 0.02. Below figure shows the design of single Nine shaped antenna.The table indicates the components, materials and values of antenna.

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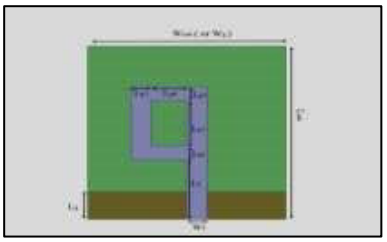


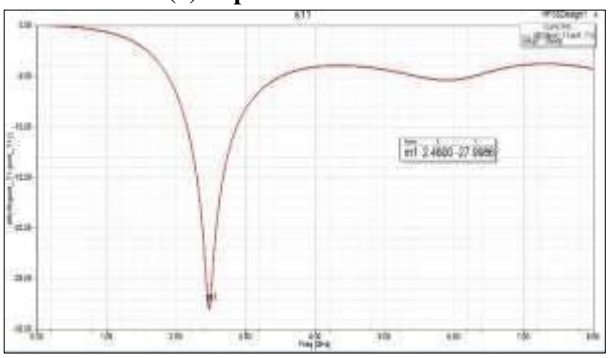
Fig1: Proposed Single Antenna Design

Table 1: Dimensions of Single Antenna

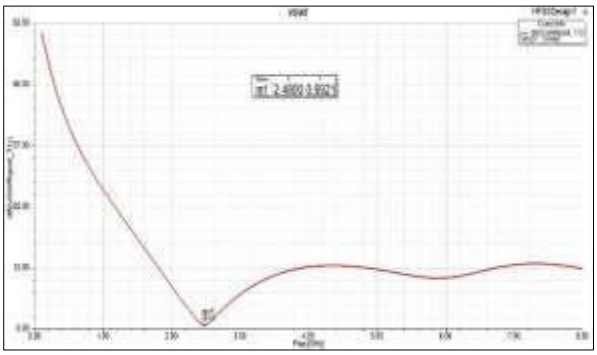
Component	Material	Parameter	Value[mm]
Substrate	FR4	L_{sub}	37
		W_{sub}	28
		H_{sub}	1.6
Ground Plane	pec	L_g	6
		W_g	28
		T	0.05
Patch	pec	L_{p1}	3
		L_{p2}	10
		L_{p3}	3
		L_{p4}	5.4
		L_{p5}	3.06
		T	0.035
Feed Line	pec	W_f	3.06
		L_f	13
		T	0.035

Single Antenna Results:

(a) S parameter



(b) VSWR



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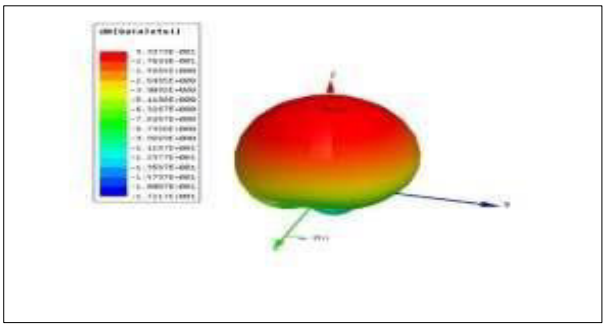
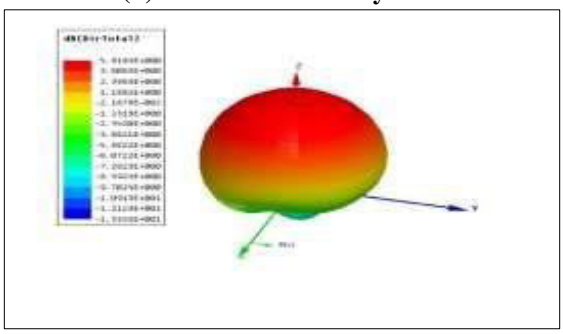
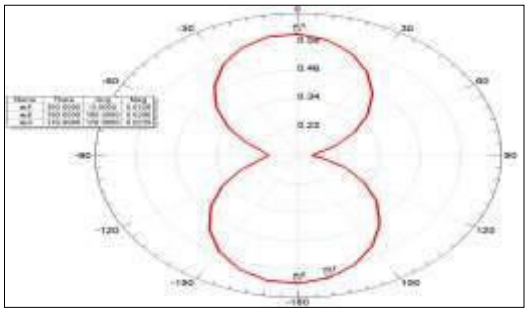
(c) Antenna Gain



(d) Antenna Directivity



(e) Radiation Efficiency



Double Antenna Design:

In mimo antenna system, more than one antennas are designed in the substrate material with considerable distance. In this Double antenna design, the same single nine shaped antenna is placed parllelly to first antenna with a distance of 13mm. By this distance, the mutual coupling between antennas has reduced. So the efficiency and S parameters are increased.

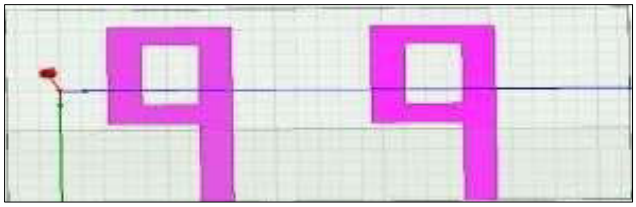


Fig 2: Proposed Double Antenna Design

Table 2: Dimensions of Double Antenna

Component	Material	Parameter	Value[mm]
Substrate	FR4	L_{sub}	56
		W_{sub}	30
		H_{sub}	1.6
Ground Plane	pec	L_g	56
		W_g	6
		T	0.05

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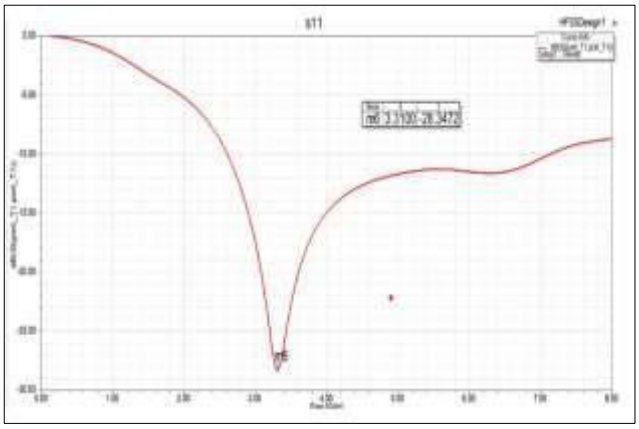
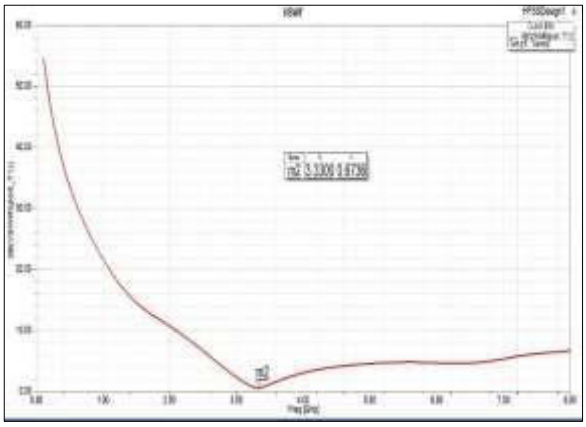
Feed line	pec	W_f L_f T	3.06 12 0.05
Patch	pec	L_P W_P T_P	11.52 16 0.05
Inner patch	pec	L_P W_P T_P	5.4 10 0

Double Antenna Results:

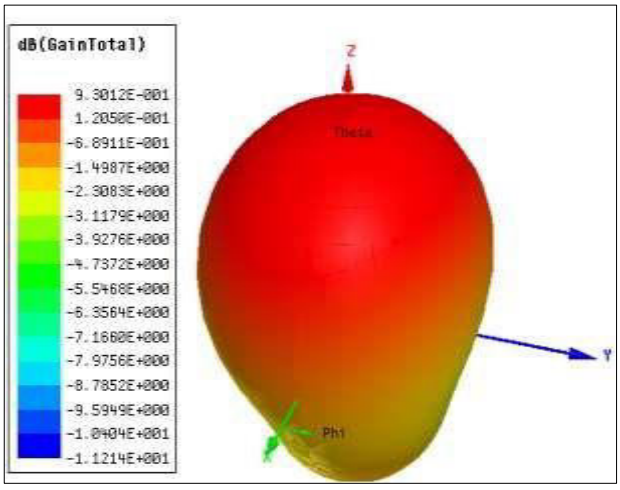
(a)S Parameter



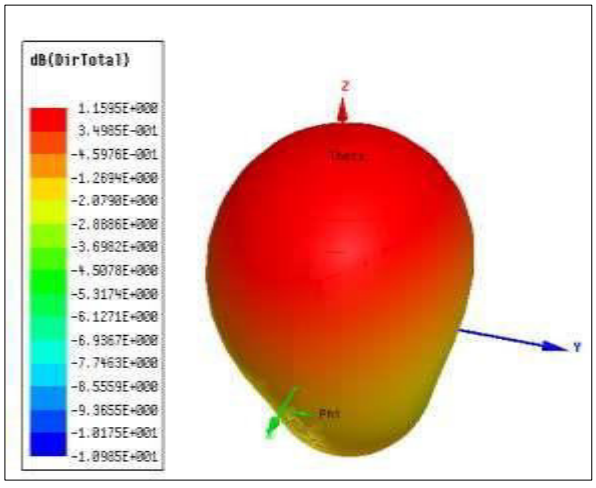
(b) VSWR



(c)Antenna Gain



(d) Antenna Directivity



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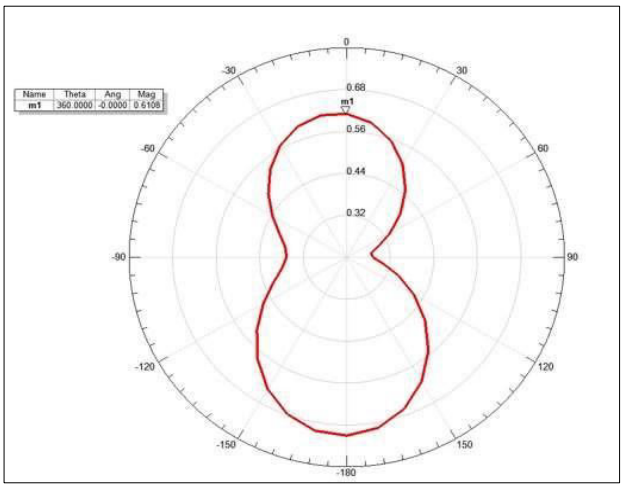

(e) Radiation Efficiency

Orthogonal Antenna Design:

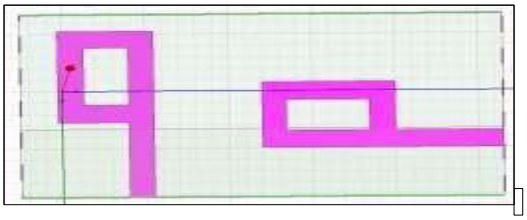

Fig 3: Orthogonal Antenna Design

Table 3: Dimensions of Orthogonal Antenna

Component	Material	Parameter	Value[mm]
Substrate	FR4	L_{sub}	58
		W_{sub}	28
		H_{sub}	1.6
Ground Plane	pec	L_{g1}	23
		W_{g1}	6
		T_{g1}	0.05
		L_{g2}	6
		W_{g2}	22
		T_{g2}	0.05

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Feed line	pec	W_{f1}	3.06
		L_{f1}	13
		T_{f1}	0.05
		W_{f2}	13
		L_{f2}	3.06
		T_{f2}	0.05
Patch	pec	L_{P1}	11.52
		W_{P1}	16
		T_{P1}	0.05
		L_{P2}	16
		W_{P2}	11.52
		T_{P2}	0.05
Inner patch	pec	L_{p1}	5.4
		W_{p1}	10
		T_{p1}	0
		L_{p2}	10
		W_{p2}	5.4
		T_{p2}	0.05

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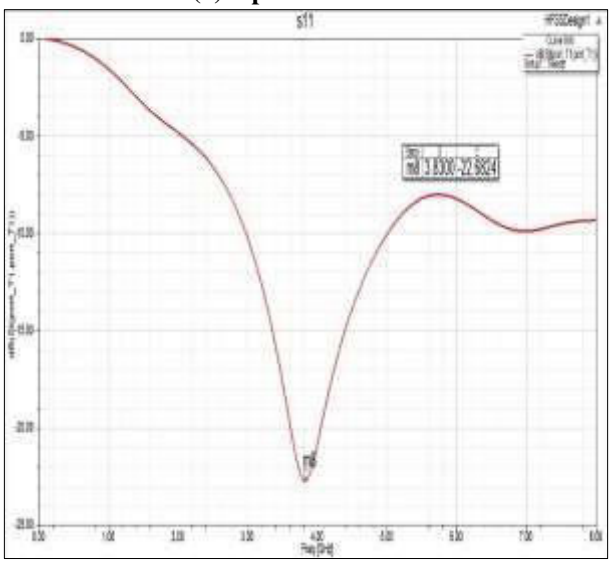
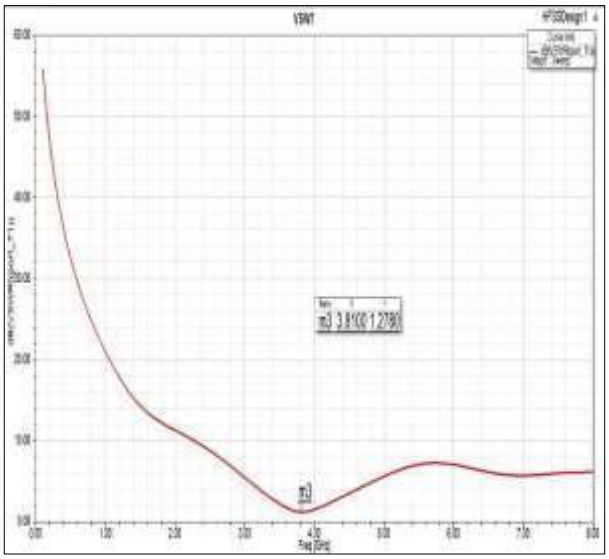
Orthogonal Antenna Results:

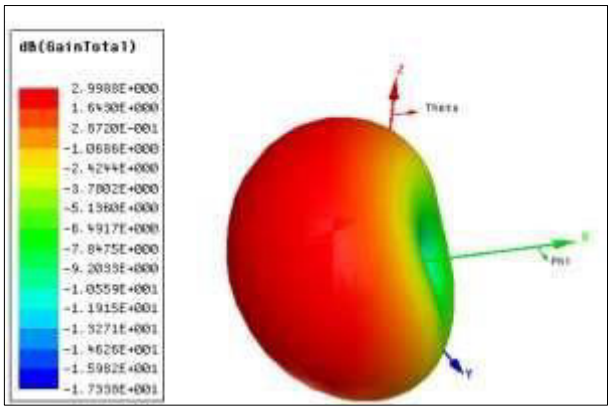
(a) S parameter



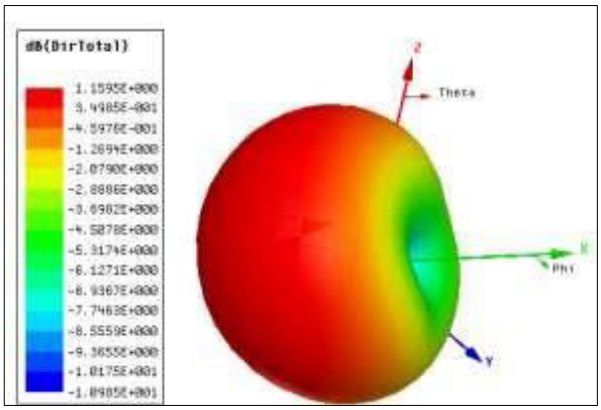
(b) VSWR



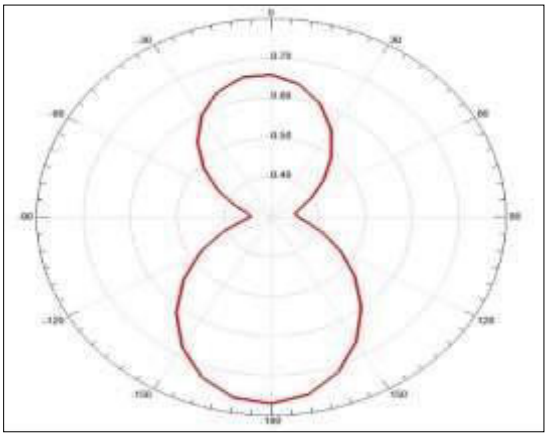
(c)Antenna Gain



(d) Antenna Directivity



(e)Radiation Efficiency



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IV. RESULT

The simulation results showed that the proposed antenna design is achieved through HFSS (High Frequency Structure Simulator). The performance of antenna can be estimated through Gain, S parameter and VSWR. From our understanding of designing single antenna we observed that there is narrow frequency and inefficient radiation. So we proposed double antenna design. From the results we understand that there is increased bandwidth and efficiency. And also for a good radiating element the return loss should be less than -10dB and VSWR should be less than 2. From our design we are capable of producing antenna design with return loss less than -10dB and VSWR less than 2.

V. CONCLUSIONANDFUTURESCOPE

The structure of microstrip patch antenna is Nine shaped. The design and simulation of these antennas are done using HFSS software 17.2 version. From our results we observed the proposed antenna design has its applications in both lower and upper wifi bands, WiMAX. And also as the substrate is FR4 epoxy, it is easy to fabricate because of low cost and wide availability. The proposed antenna is incorporated in many portable devices in various applications, due to its frequency of operation and small area occupied. Nowadays these antennas are been used in machine learning algorithms.In the future work, we try to design different shapes other than Nine shape inorder to improve the parameters for wireless applications.

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