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Design of MIMO Antenna for 5G Application with Defected Ground

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Abstract: *Modern medical systems are working by the concept of monitoring human health conditions by implanting certain devices into the body. These body devices have to be compact and small in size with good efficiencies. Driven by the concept of wireless communication, many projects have been started to combine antennas and medical devices in a way that the wearer does not notice the working of the systems. The antenna designed for these purposes are called Implantable Antennas and should be compact, flexible, lightweight and strong. Implantable medical devices (IMDs) are capable of communicating with an external monitoring device wirelessly. These IMDs have a huge recognition in the field of biomedicine for obtaining real time and stored data in biomedical field. This project presents an implantable antenna design for biomedical applications. The parameters such as SAR, frequency, bandwidth is compared and analyzed. The problem is identified causing changes to the results and in order to get better results a system is proposed. The parameters are modified to obtain a change in the design. Ansys High Frequency Structure Stimulator (HFSS) is the software used for designing and simulating the proposed antenna. The human safety is taken as an important parameter. To preserve patient safety, Implantable devices must be biocompatible.*

Keywords: HFSS software, UWB, 5G MIMO antenna

I. INTRODUCTION

A Multiple-Input-Multiple-Output (MIMO) Microstrip Patch Antenna 2 ports has been Input- designed and implemented. The proposed antenna consists of two ports and a two Array of Microstrip Patch Antenna ground plane extruded on the substrate. The antenna is fabricated on an inexpensive FR4 a dielectric constant ofεr = 4.4. MIMO system characteristic evaluation of a four port MIMO antenna operating at 5 GHz is performed. a new MIMO patch antenna is proposed, the proposed antenna consist of patch with certain dimensions in the top layer of FR-4 dielectric substrate, and ground plane in the bottom of it, this antenna is feeding by microstrip feed line with 50- ohm characteristic impedance. A MIMO antenna operates at 5 GHz has been proposed in this project. This first chapter discusses the background of the project providing the project overview, problem statement, objective, scope of the study and the methodology taken to achieve the objectives. Over the years, wireless system have increased rapidly.Antenna is the most important part of wireless communication system for transmitting and receiving information in the form of Electromagnetic EMWaves. Advancements in communication technology have led to increased usage of wireless devices. Moreover there is always an increase in demand for miniaturization, higher data rate as well as operating speed of these wireless device.

II. LITERATURE REVIEW

The intense research is going on in UWB antenna design since it is widely acceptable in various applications. The various design is introduced with modifications in recent Microstrip Antenna Structures with modifications like different shapes, use of neutralized structure, defected ground structures. Some of the papers related to UWB antenna design is discussed in this section.

Ajay Kumar Dwivedi, Anand Sharma, Akhilesh Kumar Pandey, *Vivek Singh*:The presented 2-port MIMO antenna has two T shaped radiating elements placed in front of each other and energized by the 50 Ω SMA connectors. Rectangular ring shape ground plane and T shaped radiators are designed on the top side of the FR- 4 substrate having attributes (εr = 4.4, tanδ = 0.019, and thickness of 0.8 mm). Modeling, simulation, and optimization of the proposed antenna are carried out by Ansys HFSS 18 electromagnetic sover. In order to achieve the proposed design firstly, we take a simple rectangular patch antenna with a grounded substrate represented as antenna 1. In the second step, the ground plane of rectangular shape has converted into a rectangular ring and shifted on the top side of the substrate where the patch antenna is already printed, which origi- nates antenna 2. Parametric variation is executed on the width of the patch in antenna 2 to enhance the bandwidth and for the attainment of circular polarization. This para- metric variation changes the width of the antenna from 10 to 2 mm results in antenna Proposed antenna 4 is obtained from antenna 3 by incorporating a rectangular slot of 3 mm on the rectangular ring shape ground plane in the appropriate position. Based on mini- mum return loss, maximum IBW, and maximum 3-dB ARBW findings the antenna 4 is considered as an optimum antenna for MIMO design.

M. Paranthaman, S.Palanivel Rajan: This rectangular antenna is made of FR4 substrate with a relative permittivity of 4.4 and thickness of 1.6mm. The radiator is made of copper. The use of FR4 is because of the good strength to weight ratios and very negligible water absorption. This is also very biocompatible and goes hand in hand with our application requirements. The main reason of going for FR4 is that it has no radiation. The design of this rectangular antenna comprises of various rectangles of various dimensions. The outer rectangle measures 900mm^2 (30*30) in area. The inner rectangles are of dimensions 94.09mm^2 (9.7*9.7). Here the excitation is done through the port which is a lumped port. Antenna design requirements: This antenna does not operate in free space but operate in the human body. In order to do so, there are certain requirements which are patient safety, good communication,biocompatibility, low power consumption and long life.Patient safety: The ISM band frequency that is recommended for patient safety is 2.4 to 2.5GHz and MICS recommends 401 to 406MHz.SAR values should be considered. Communication: The implantable antenna that fit inside the body is the transmitting antenna and the off- body devices are the receiving end.

Derin Arda Şahin, Adnan Kaya: In this article a dual-band microstrip antenna resonating at 2.4 GHz and 5 GHz frequencies is designed for use in Wi-Fi applications. The overall dimensions of the antenna are 29 x 26 x 1.6 mm^3. For the antenna to operate at two different frequencies, the antenna is printed on the substrate of FR4 with two C-shaped strips and a microstrip feed line on the front side. L-shaped slot in ground plane.While the bandwidth of antenna at 2.45 GHz resonance frequency is 140 MHz (2.38-2.52 GHz), the bandwidth obtained at 5 GHz resonance frequency is 552 MHz (4.78-5.34 GHz).

Ankit kumar Patel,Akhilesh Kumar Pandey, Shekhar Yadav, Komal Jaiswal , Rajeev Singh: This paper presents a compact multiband micro strip patch antenna with defected ground structure (DGS).The patch and ground are made on top and back side of the FR-4 substrate. The designed antenna has multiple resonating bands because of a loaded slot on ground plane. Designed antenna operates in the frequency bands of 16.9–21.1 GHz, 23.4-25.1 GHz and 28.65-37.56 GHz with centre frequencies of 20, 24, and 32 GHz respectively. The fractional bandwidth of designed antenna is 21%, 7%, and 27.8% at centre frequencies orderly. These resonating bands are applicable in surface movement radars (SARs) and satellite communications. The group delay of the proposed antenna is in the range of -0.5 n-sec to 0.5 n-sec for all bands. It is shown that the designed antenna has appropriate gain and good radiation efficiency over operating bands. The frequency ratio of antenna for proposed dimension is above 1.2 and VSWR is below 2 for all bands. Keywords: DGS, multiband antenna, SAR antenna, HFSS.

III. PROBLEM STATEMENT

In order to Increase the capacity of a wireless communication channel a single antenna element is not enough, this issue could be solve using MIMO.

By having multiple antennas in a closely packed system, the problem of mutual coupling is a very challenging issue.

In order to improve the mutual coupling, normally the antenna elements are spaced farther apart to reduce their effect on each other. However, this results in increasing the size of the structure.

Designing a MIMO antenna for point-to-point communication, which requires antenna withhigh gain, precise directivity and high efficiency, is also challenging work

IV. METHODOLOGY

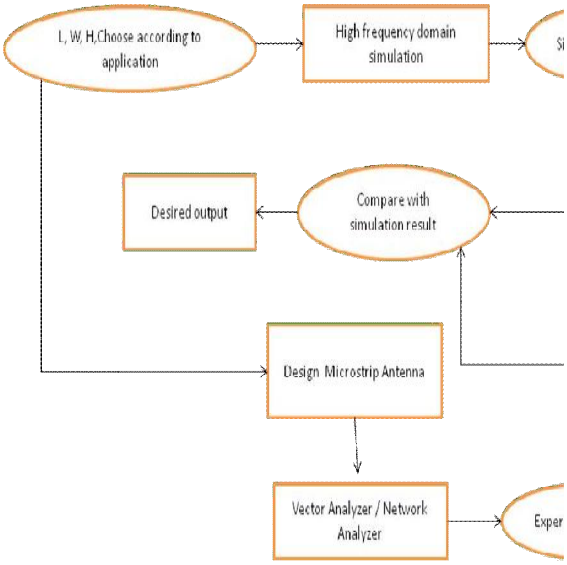

Fig1 Block diagram

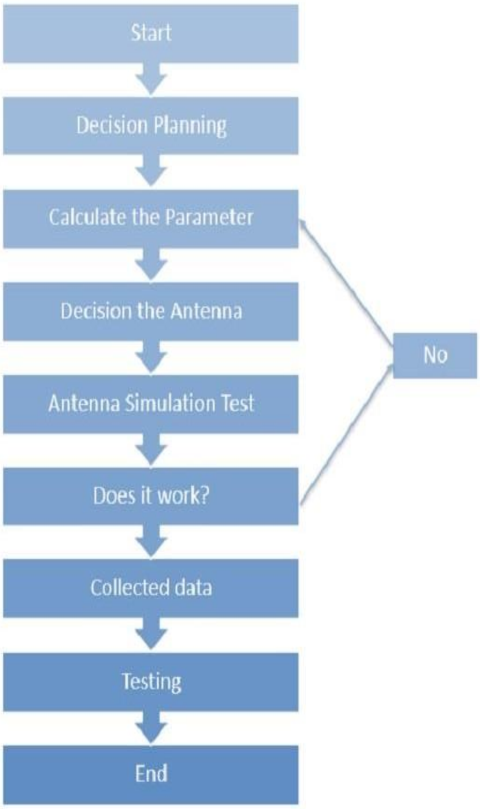

Fig2. Flow Chart

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Figures and Tables

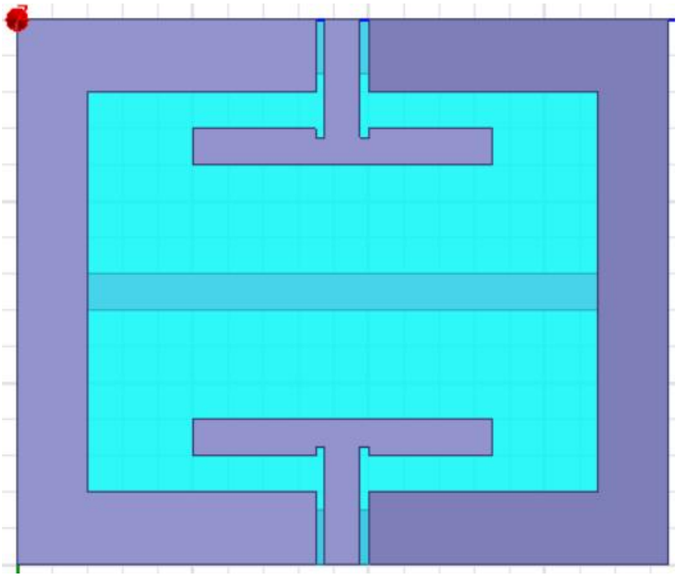

Fig3.Front View Of Antenna

parameter	Length(L)	Width(W)	Height(H)
Patch	2mm	17mm	-
Ground 1	30mm	4mm	-
Ground 2	30mm	-4mm	
Defected Ground	-2mm	-29mm	
Substrate	30mm	37mm	-1.6

Table Antenna Parameter Value

Abbreviations

- MIMO Multiple Input Multiple Output UWB Ultra-Wideband
- HFSS High Frequency Structure Simulator

IV. CONCLUSION

The MIMO antenna is designed using HFSS. The result shows that it has minimum return loss in the frequency range of 5 GHz. Multiple-input multiple- output, or MIMO, is radio communications technology or RF technology that is being mentioned and used in many new technologies these days. Wi-Fi, LTE (3G long term evolution) and many other radio, wireless and RF technologies are using the new MIMO wireless technology to provide increased link capacity and spectral efficiency combined with improved link reliability using what were previously seen as interference paths

V. RESULT

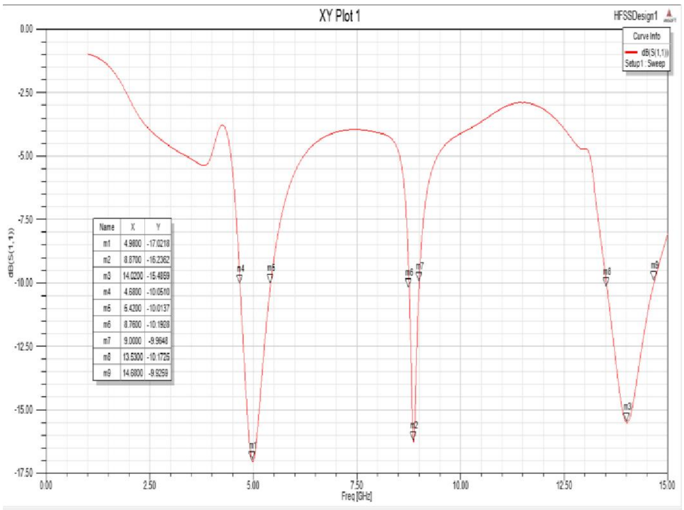

Fig4 Return loss of proposed antenna

Operating Frequency (GHZ)	Return Loss (DB)
4.98	-17.02
8.87	-16.23
14.02	-15.48
4.68	-10.06
5.42	-10.01
8.76	-10.19
9.00	-9.96
13.53	-10.17
14.68	-9.92

Table2 Return loss for various operating frequencies

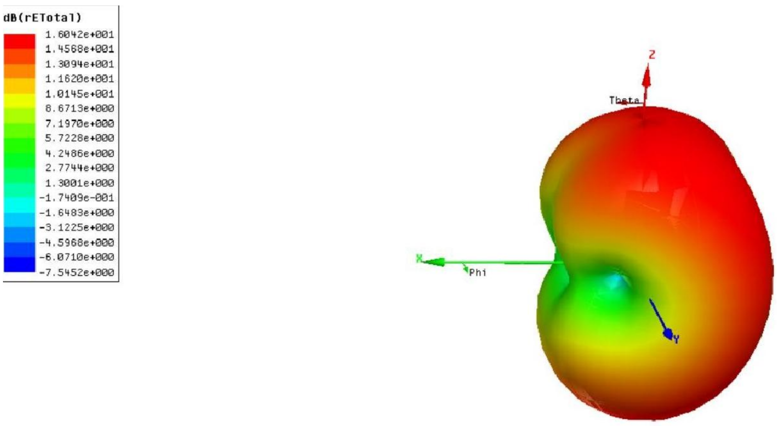

Fig5 Total Electric Field

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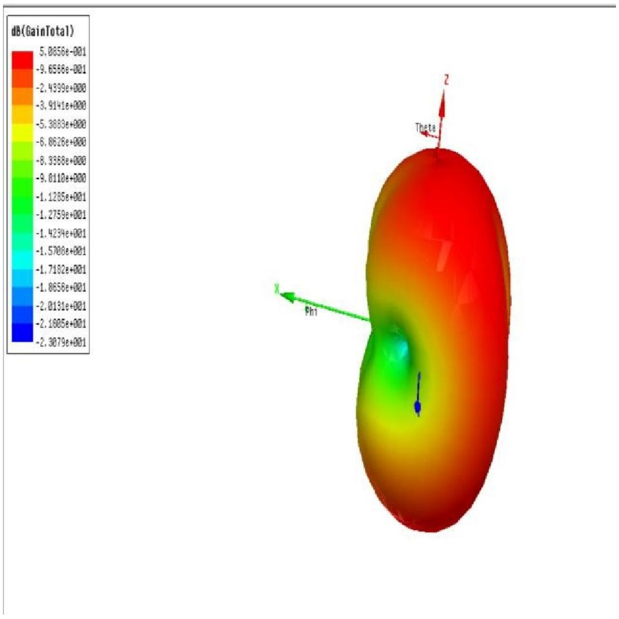

Fig6 Total Gain in dB

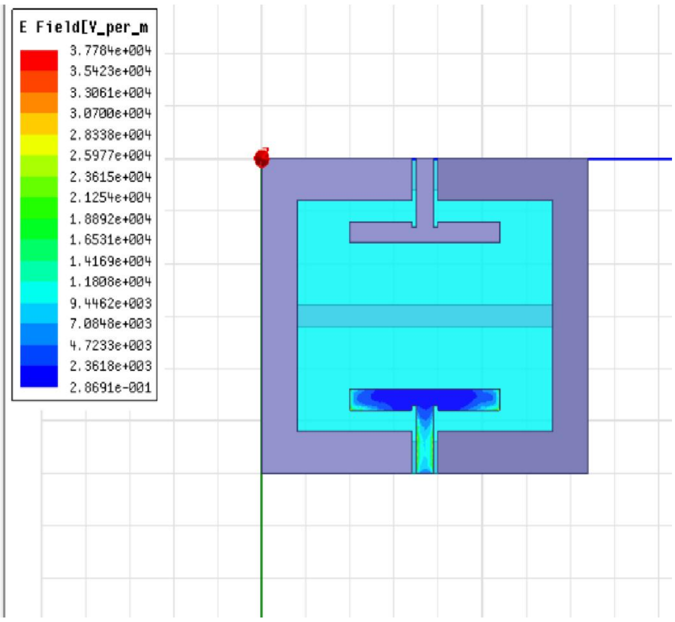

Fig7 Magnitude of e field on patch

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