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Next Generation Communication System using MIMO Antenna for Mutual Coupling Reduction

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ABSTRACT – In this research paper discuss anotched band with a low profile This article discusses the design of a G-shaped ultra wideband (UWB) MIMO antenna for mobile terminals. Both of these systems are based on UWB MIMO antennas. Square components make up the first, and G-shaped elements make up the second one. MIMO antennas with two 8x8 mm2 square components, each operating between 2.2 and 13.3 GHz, were initially developed for UWB use. Transmission lines with a 50 ohm impedance were used to feed the square elements (MTL). The end of MTL was constructed with a thin strip line in order to match the impedance. An additional T-shaped strip (TSS) was used on the ground to enhance low-frequency separation despite adequate inter-element separation for optimal MIMO deployment. After that, a G-shaped structure was formed on the square element, which truncated the critical WLAN standard frequency range of 4.4–6.2 GHz even more. Studies were conducted to demonstrate that the G-shaped element may be tweaked by altering its dimensions and to evaluate the impact of changing the system's dimensions on its reflection performance. Based on antenna characteristics and MIMO parameters, the G-shaped antenna system was evaluated. In addition to its low-profile parts, the G-shaped MIMO antenna has almost omnidirectional patterns, steady gain, and high diversity performance in addition to its low profile parts..

***Keywords*—Envelope Correlation Coefficient (ECC), Multiple-Input Multiple-Output (MIMO), Ultra Wideband (UWB), Defective Ground Structure (DGS), Voltage Standing Wave Ratio (VSWR), Wireless Local Area Network (WLAN).**

I. INTRODUCTION

Antennas for wireless communication systems are increasingly becoming multi-purpose radiators, especially as customer demand for faster speeds rises. A lot of people have looked into antennas with a wide range. This is because the reasons for this are detailed above. The ease of manufacture, low power consumption, high transmission rate, and cheap cost of these antennas are only a few of their benefits. Those in the telecommunications business are always on the lookout for a design that can accommodate several concurrent applications, all of which improve rapidly. With a variety of uses in mind, wireless communication companies are developing hybrid and smart antennas.

Different applications need a wide range of bandwidth, high data rates, and a high level of dependability in wireless communication. Multiple input and multiple output (MIMO) expertise results in the best results in non-line of sight communications. Because of the high density of devices, the effect of having several antennas on a single substrate is obvious. Using the polarisation diversity approach, it is possible to broadcast and receive signals in both horizontal and vertical directions. For the precise stimulating challenges and requirements of current MIMO antennas, four radiating components on a single substrate must be correctly isolated. When compared to other antennas, the micro strip patch antenna with circular polarisation and an asymmetric 3D printed substrate achieves a wide axial ratio beam width (ARBW) of 3dB with a wide 3db beam width, which is called a wide beam width.

Always on the increase is the need for faster data speeds to accommodate HD video and online gaming. As one of the solutions, MIMO (multiple input, multiple output) technology may surpass the data throughput limit of traditional wireless communication systems. As an example, Wi-Fi 6 may handle up to 12 x 12 multi-user (MU) MIMO, resulting in quicker and more stable connections. Although designing

MIMO antenna systems is not an easy undertaking, it does require rigorous design approaches. Antenna gain, antenna balance, isolation between or among antennas, and radio desensitisation all impact throughput in a MIMO system. 1. Antenna gain and radiation pattern isolation, as well as common-mode (CM) current rejection, must be carefully researched in order to achieve the MIMO performance criteria. Using numerous antennas, the MIMO system provides more spatial variety. If the radiation patterns of the antennas are diverse, then the system will have a variety of patterns. An antenna's gain pattern is directly connected to the antenna's spatial coverage surrounding the object on which it is placed. An omnidirectional pattern with high gain is often desired for Wi-Fi routers. In this scenario, a balanced antenna with a combined omnidirectional gain pattern would be an excellent option for the system. Using the envelope correlation coefficient (ECC), we may determine how isolated or coupled the communication channels are. 1–10 Getting improved isolation between or among antennas might help lower the ECC.Finally, a high rate of throughput necessitates the use of an EMC design. Receiver desensitisation may be caused by CM current flowing from the coaxial feed cable to the ground plane. It is a major difficulty for wireless device designers to overcome the issue of radio frequency desensitisation. The MIMO system's throughput may be significantly reduced if the user is not paying attention. There are now three frequency bands in use by modern high-performance Wi-Fi systems (2.4G, 5.2G, and 5.8G).

In order to decrease the number of antennas, it would be ideal if a single antenna could cover all of these frequencies. It is difficult to create tri-band monopole antennas outside of router boxes, which are often used in Wi-Fi systems. It is thus necessary to employ numerous monopole antennas to cover all essential bands in multi-port MIMO Wi-Fi 5 and Wi-Fi 6 systems. Many Wi-Fi router designs, sizes, and specific applications may be restricted by these external monopole antennae. A single tri-band embedded antenna with tiny structures has been tested for Wi-Fi applications. A hybrid fractal-shaped planar monopole antenna is used in Reference 2 to implement MIMO for portable mobile devices. All ECC values in the operational ranges were less than 0.04. Isolation between two closely spaced broadband MIMO differential filtering slot line antennas was explored in Reference 4, and the observed ECC between the antennas was decreased to less than 0.01. The frequency range of 4.4 to 5.8 gigahertz is limited, though. In an intriguing paper, an inverted F-shape MIMO antenna with an ECC value of 0.015.5 was also suggested. Diversity in radiation patterns, CM current rejection, and receiver desensitisation have not been addressed in any of this research.

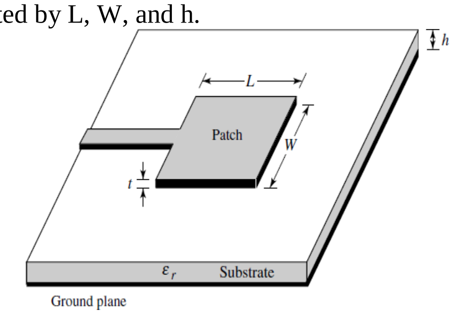
Due to its small size, this research presents a two-element tri band MIMO antenna for Wi-Fi applications. The suggested antenna's higher performance is dependent on the use of a wide-bandwidth, high-efficiency electromagnetic structure (WHEMS). WHEMS antennas have previously been demonstrated to be a suitable contender for efficient wide bandwidth and multiband antennas with small sizes. 11-16 The two components are positioned at a 90-degree angle to one another. Consequently, they have strong isolation between them and good omnidirectional radiation patterns when they are used together. Because it has two open-ended slot lines on the antenna, this CM choke is very important. It prevents wireless receivers from becoming desensitised to the CM current that flows on the antenna's outside surface.

II. ANTENNA PARAMETERS AND CHARACTERISTICS

Electromagnetic waves travelling in an unguided medium may be transformed into electrical power signals by an antenna. An antenna is a metallic device used for radiating (transmitting) and receiving radio waves, according to Webster's Dictionary. In between guided medium and free space, there is an antenna. Coaxial wires and hollow tubes are used as the guiding media. Antennas are required for all forms of communication. There is an antenna on every electronic device in the current communication system, such as a cell phone, a TV, or a computer. Those that transmit electromagnetic waves are known as transmitter antennas, while those that receive them are termed receiver antennas. Transceivers, on the other hand, are antennas that can perform the dual function of both sending and receiving electromagnetic waves. Resonating metallic devices that work in certain frequency ranges are known as antennas. For effective communication, both the sending and receiving antennas must be properly matched. Communication can't take place if the antennas aren't correctly aligned. As has been seen, every metal item may behave as an antenna, resonating in a certain frequency range.

A. Microstrip Antennas

There are three parts to an MPA the dielectric substrate, the ground, and the radiating patch. The MPA is the fundamental radio signal transmission and reception unit. Planar microstrip antennas (MPAs) are another name for MPAs. In 1970, MPAs were first put into practise. They may be used in a variety of fields, including space, military, GPS, and civic applications. Ground patches are printed on one side of a non-metallic substrate with regular or irregular simple patches. MPAs may be designed in a variety of forms, the most popular of which are rectangular, round, square, triangular, and elliptical. The MPA's key advantages are its low profile, light weight, cheap cost, ease of manufacture, and ability to adapt to additional circuits that are printed. Figure 2.1 depicts the shape of MPA. The length of the patch, the width of the patch, and the thickness of the substrate are all indicated by L, W, and h.



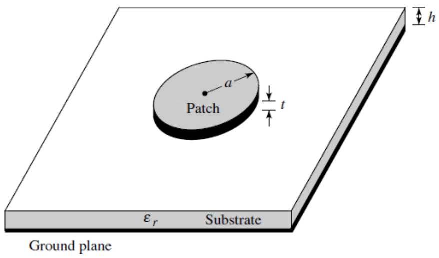


Figure 1: Microstrip Patch antenna (a) Rectangular (b) Circular

B.Feeding Techniques

When it comes to microstrip antennas, stimulation is a simple process.The following is a breakdown of the many sorts of feeding strategies.

A microstrip line is used as a direct RF power supply to the radiating patch, which is categorised as contacting.

When RF power is sent by electromagnetic field coupling to a radiation patch, it doesn't touch anyone.

C.Microstrip Line Feed

Transmission of RF power from conducting strip to microstrip patch occurs in microstrip line feed. Impedance matching is compatible with the design and fabrication on the same substrate. A microstrip line feed is shown in Figure 2. For thicker substrates, the principal disadvantage is an increase in surface waves and spurious radiation.

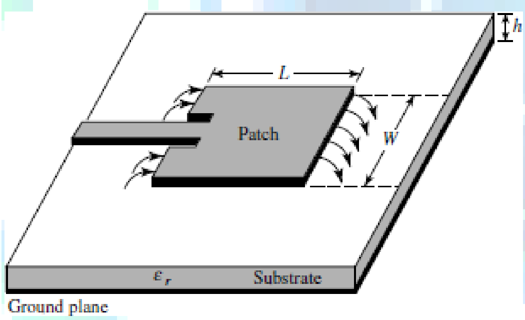


Figure .2: Microstrip feeding

Coaxial probe feed

This feeding approach makes use of an inner pin and an outer layer conductor as both conductors. Small holes in the outer layer conductor link the inner conductor to the radiating element. This is seen in Figure 3. The design and fabrication of this feeding method are straightforward. It has a low level of spurious radiation below ground level. The antenna's impedance is adjusted such that the probe's location is near 50 ohms. The benefit of using a coaxial feed or probe feed is that the feed may be positioned within the patch at any desired location and be matched to its input impedance. This method's spurious radiation is very low, its bandwidth is limited, and its production on thin substrates is simple. For thick substrates, the modelling is much more complex.

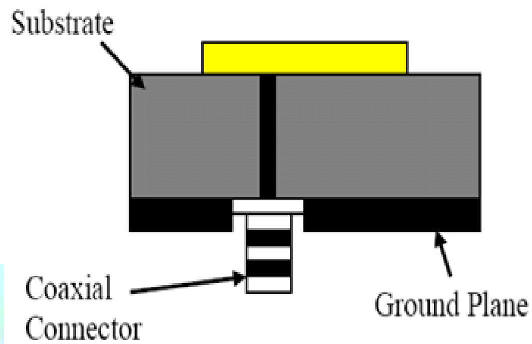


Figure 3: Coaxial probe feed

III. PROPOSED METHOD

In this presented work shows the multi-antenna arrays they've recently attracted a lot of attention because of their low cost, light weight, reduced production complexity, simple integration, and conformity. It is possible to increase the antenna's bandwidth (B.W.) as well as its gain (G). MIMO patch antennas have become increasingly common because of their ease of fabrication and application. This antenna's frequency response is optimised for usage in the giga hertz (GHz) range, which encompasses wireless local communication, wireless fidelity, and multi-band MIMO. It's designed to work between 3.929 and 6.5175 GHz. Flexible patch antennas are becoming more significant in Wireless Local Area Network (WLAN) applications (WLAN). S11, VSWR, Gain, Radiation Pattern, Envelope Correlation Coefficient (ECC) and Mutual Coupling (MC) are all simulated findings that are provided. In this chapter, the antenna designs and simulated outcomes are discussed in depth. This thesis describes new microstrip antennas.

In the research work present a smartphone and tablet MIMO microstrip patch antenna Wireless Local Area Network (WLAN) and Wi-MAX Antennas are essential standards in this development because of their well-known desirable features, such as their compact size, ease of fabrication, and ease of usage. G-shape MIMO antennas are in high demand owing to their favourable qualities, such as their ease of fabrication, their adaptability to a wide range of communication devices, and their versatility in applications requiring low mutual coupling technology.

The proposed design completed in the three stages,

I. In the first stage discuss the G shape patch antenna,

II. In the second design discuss the multi input multi output G shape patch antenna.

III. In the third stage discuss the MIMO antenna with reduced mutual coupling antenna

Stage-I G Shape Patch Antenna -

In the proposed G shape MIMO antenna, first design G shape patch antenna. front end of G shape patch antenna, the ground structure of design, in the ground section apply defected ground structure (DGS) of bandwidth improvement resultant of design shown in the next chapter that is simulation and result. a, b, and c shows the design specification of the proposed design. The proposed design contain three different layer or parts. There are ground, substrate and patch. the geometry of proposed design. In the proposed design first desirable the basic geometry of patch antenna, after that describe the MIMO antenna and that describe final design that G shape MIMO with parasitic element.

Rectangle Brick

Rectangle cut

Feed Line

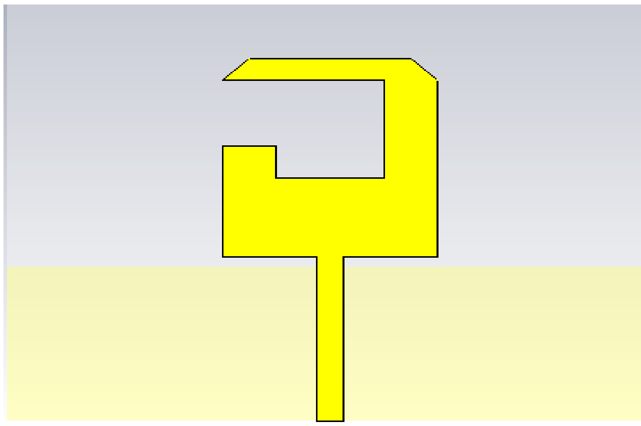


Figure 4 **Shows G Shape patch antenna (First Stage)**

Stage - II Second Design Multi Input Multi Output (MIMO) G Shape Patch Antenna -

In the second design discuss the G shape MIMO antenna The main motive of this research work is to design a MIMO antenna for this use a FR - 4 substrate (εr= 4.4 andtan δ = 0.0027).The length(L), width (W) and height (H) of the proposed design is shown that is $(48 \times 38.32 \times 1.67)m.m3$design. The length ($L$) and width ($W$) are same as the substrate but height (H) is changed. In the figure 5 shows the G shape

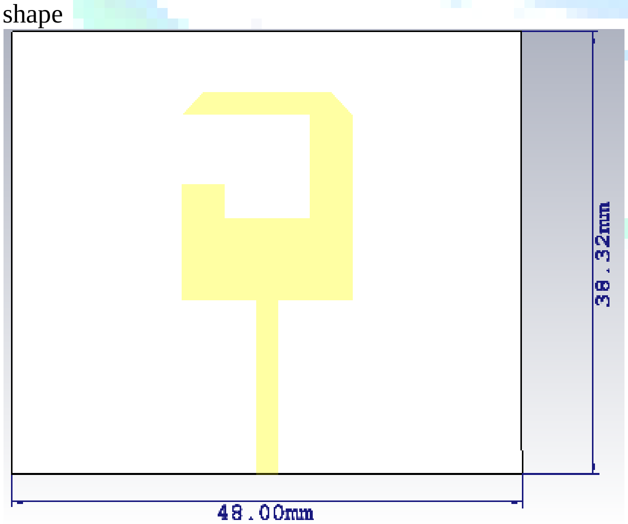


Figure 5 **Shows the dimension of substrate**

MIMO patch antenna. For MIMO structure apply wave guide port that is shown in figureThe dimension of MIMO patch antenna The upper side place G shape MIMO geometry. The dimension of proposed MIMO geometry Dimensions of G Shape MIMO Patch antenna the MIMO antenna design specification the resultant of design contains mutual coupling. for the reduction of the mutual computing apply parasitic element. In the next stage that is step III shows the final design that is G shape MIMO patch antenna with parasitic element.

Stage-III MIMO Antenna With Parasitic Element

The final design, in this final the parasitic element that is introduced between MIMO antenna for the reduction of mutual coupling. Mutual coupling is very serious problem in the MIMO antenna in the last decade many MIMO patch antenna suffer from this problem, that is also effected the ECC and other performance parameters MIMO antenna.

IV.SIMULATION AND RESULT

In this chapter discuss the simulation and result of the proposed antenna. In this proposed antenna different substrate technique as well as multi layer substrate are used for enhance the bandwidth , return loss (S-11) and other properties of antenna. The proposed G shape MIMO patch antenna is design for Giga hertz (GHz) frequency range up to 6.5 GHz.

A. CST Design environment

Below the figure 4.1 shows the basic view of CST software. The proposed design in the CST 2016 version. The system for designing used is core 2 duo 2.3 G processor. The main part of proposed design is substrate (S), patch (P), ground (G) and feeding system (Waveguide feed).

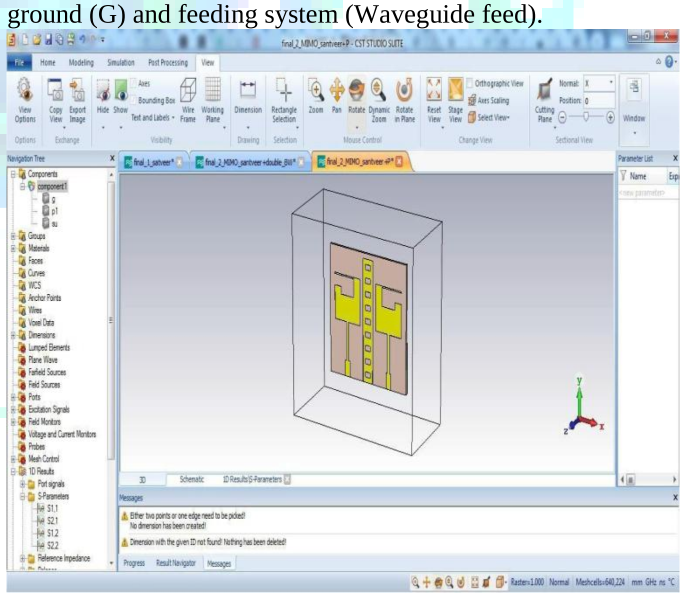


Figure 6 Shows the front view of proposed design

B. Results of Proposed Design

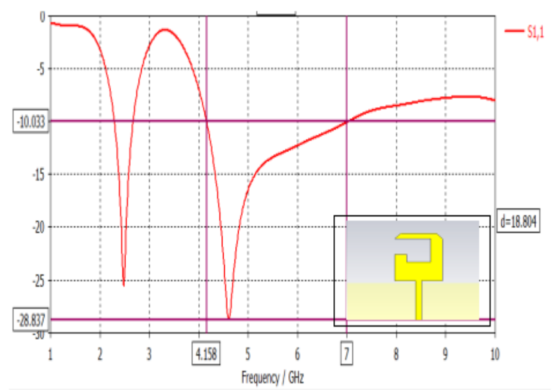
This design G Shape based Patch antenna shows better performance as compare to design 2 that is discussed in the above section 5.4. The dimension and other parameters are already discussed in the previous section. The result of proposed design better in such result parameters, they are bandwidth (B.W.), gain (G), return loss (S-11) and radiation pattern of the antenna.

Design Step 1 G shape Patch Antenna - Return Loss (S -11)

It is the power loss in the signal that is reflected due to discontinuity in the transmission line

S-Parameters [Magnitude In dB] d=2.842

Y Axis shows S-11



X axis the frequency range of the proposed work

Fig. 7 Return loss (S-11) of proposed antenna 2 (Single Wide Band)

VSWR Parameter –

Voltage standing wave ratio (VSWR) (d=2.4016)

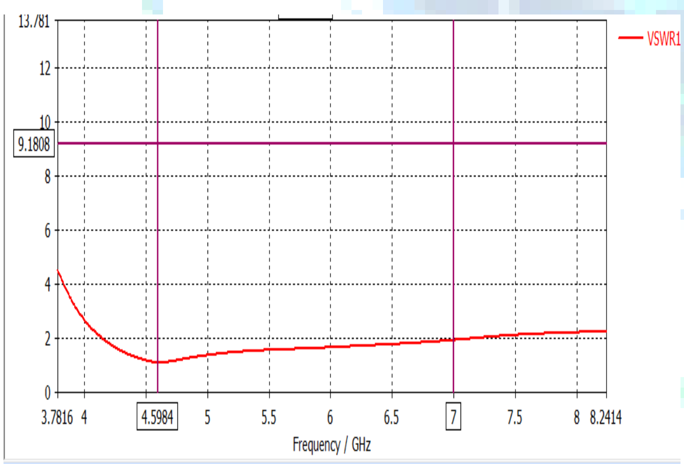


Fig.8 Shows theVSWR ofproposedflexiblebowtieantenna

V. CONCLUSION

In this research paper present the suggested antenna simulation and outcome. The bandwidth, return loss (S-11), and other characteristics of the antenna are improved in this design by using alternative substrate techniques, including a multi-layered substrate. For frequencies up to 6.5 GHz, a G-shape MIMO patch antenna is suggested. Between Wi-Fi and Wi-Max, this planned frequency range encompasses a number of bands ranging from 3.9 GHz to 6.5 GHz in width. WLAN and WiFi systems are becoming more popular with MIMO antennas with G-shaped MIMO patches. The S11 Return Loss, VSWR, and radiation pattern are all included in the findings of the simulation. In this chapter, the findings of antenna design and modelling are detailed. There are new microstrip antennas that have higher gains that are the focus of this research project. It also discusses the conversion of electrostatic capacitance (ECC).

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