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Study on Miniaturized Dual Polarized MIMO Antenna

Prakhar D. Vyas
M.Tech Communication Engineering
VIT University
Chennai,India
prakhardvyas@gmail.com

Abhijit G. Raut
M.Tech Communication Engineering
VIT University
Chennai,India
abhijitraut93@gmail.com

Dr.Usha Kiran Kommuri
Assistant Professor Sr.
VIT University
Chennai,India
usha.kiran@vit.ac.in

Govindu vinod kumar
M.Tech communication Engineering
VIT University
Chennai, India
g.vinodkumar987@gmail.com

***Abstract*—** MIMO (Multiple input multiple output) used multiple transmit and receive antennas to utilize multipath propagation. This method is for multiplying the capacity of a radio link. In wireless communication standards MIMO has an essential element. "MIMO" refers to a practical technique used for sending and receiving more than one data signal via multipath propagation on the same radio channel at the same time. The demand of wireless communication increases due to miniaturized Antenna and dual polarization. Compactness in system is increased by miniaturization. Data propagation rate increased due to dual polarization by differentiating propagation polarization. In this work attempt will be to conduct elaborate Study, Design and Analysis of some of the Miniaturization techniques along with bandwidth enhancement and also on Dual polarization techniques. In future the techniques will be combined and study for Miniaturized Dual Polarized MIMO Antenna will be done.

Keywords- *miniaturization, dual polarization.*

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I. INTRODUCTION

Wireless communication and networking technologies have viewed tremendous growth, resulting in requirements for higher channel capacity and link reliability. To meet these requirements, diversity techniques, such as space and polarization diversity would be helpful. With the miniaturization of communication systems and devices, polarization diversity has become attractive, as it achieves diversity using various polarized antennas, requiring less space. Among all Dual linearly polarized antenna is found to be best suited for wireless communication over dipole antenna. Dual-polarized antennas are used in cellular base stations for polarization diversity. It was observed that antennas with dual orthogonal ports provide lower output correlation and higher diversity gain compared to traditionally used slanted dipole antennas for cellular base stations.

Polarization diversity is best suited for urban environments with dominant multipath fading. A Dual-polarized antenna configuration for MIMO system provides improved channel capacity compared to a single polarized antenna configuration. Dual-by simultaneously obtaining information in the horizontal and vertical planes. Micro-strip antennas are an attractive option for the design of dual-polarized antennas due to their advantages, such as a low profile, low cost, being easy to fabricate, and their ability to be integrated on PCB.
However, achieving broad bandwidth and high isolation between two orthogonal ports for micro-strip antennas has been a challenging task. Thus Miniaturization can be done to increase the compactness of the system thereby Enhancing the Bandwidth.

II. PROPOSED WORK

Different Miniaturization and Dual Polarization Techniques will be Studied and best of it will be be implemented. Miniaturization may be done by using any of the following techniques:

i) Use of slots in the patch
ii) Use of high permittivity dielectric materials
iii) Use of magneto-dielectrics
iv) Use of novel geometries like fractals.

In our Work we will be using **Fractal technique** which displays self similar patterns, meaning "the same from near as from far". It has the ability to reduce the surface area which will be helpful in different applications. Dual polarization contains both Horizontal and vertical polarization. There are various design techniques of dual polarized micro strip antennas with high isolation between two orthogonal ports such as dual linearly polarized antennas with coaxial feeds and direct coupled micro strip lines, dual linearly polarized Gap-fed antennas, dual linearly polarized Probe-fed antennas, dual linearly polarized Aperture-Coupled antenna. Both of the above techniques would be Combined for a MIMO system thereby Increasing both Bandwidth and also increasing the Data Transfer rate

In entire antenna design, we used 50,70,100 ohm transmission lines.

To calculate length and width of the transmission line we used below formulae:

$$\ell = \frac{270^\circ(\pi/180^\circ)}{\sqrt{\epsilon_e}k_0} \quad (1)$$

$$\frac{W}{d} = \begin{cases} \dfrac{8e^A}{e^{2A}-2} & \text{for } W/d < 2 \\ \dfrac{2}{\pi}\left[B-1-\ln(2B-1)+\dfrac{\epsilon_r-1}{2\epsilon_r}\left\{\ln(B-1)+0.39-\dfrac{0.61}{\epsilon_r}\right\}\right] & \text{for } W/d > 2 \end{cases} \quad (2)$$

To find effective dielectric constant:

$$\epsilon_e = \frac{\epsilon_r+1}{2} + \frac{\epsilon_r-1}{2}\frac{1}{\sqrt{1+12d/W}}. \quad (3)$$

To find characteristic impedance:

$$Z_0 = \begin{cases} \dfrac{60}{\sqrt{\epsilon_e}}\ln\left(\dfrac{8d}{W}+\dfrac{W}{4d}\right) & \text{for } W/d \le 1 \\ \dfrac{120\pi}{\sqrt{\epsilon_e}[W/d+1.393+0.667\ln(W/d+1.444)]} & \text{for } W/d \ge 1. \end{cases} \quad (4)$$

III. WORK DONE

Study has been done on the micro strip patch antenna by designing a micro strip patch antenna in HFSS 13.0. By giving 50 ohm feed line at the width of the patch on the operating frequency of 2.4 GHz. So that we are getting vertical polarization in the output at a frequency response of 2.3 GHz and the gain of 3 dB. After that using Power Divider Circuit we gave excitation along length of the micro strip antenna.

By this power divider we obtained horizontal polarization. This power divider helps to split the given power to two sides equally. so we have to obtain 3 dB power at both sides.

Thus we designed a micro strip patch antenna which operates at dual frequencies 1.88 and 2.4 GHz simultaneously which can be used for wide band applications.

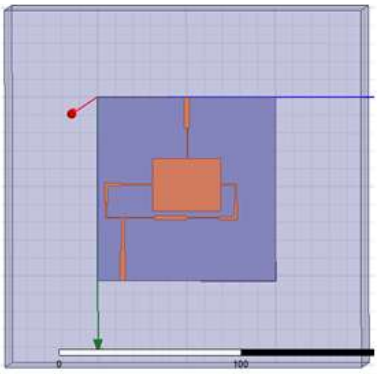

Figure 1.Patch antenna with power divider

We have obtained double frequencies by designing this dual polarized antenna. At port (1,1) it resonates at 2.3 GHz frequency and at port (2,2) it resonates at 1.88 GHz frequency. Frequency responses are given below:

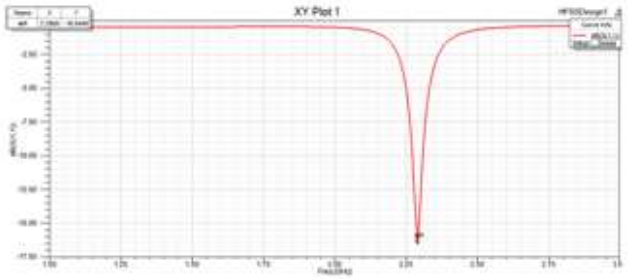

Figure 2.Frequency response of Patch Antenna with
Figure 2.Frequency response of Patch Antenna with power divider at 2.4 GHz

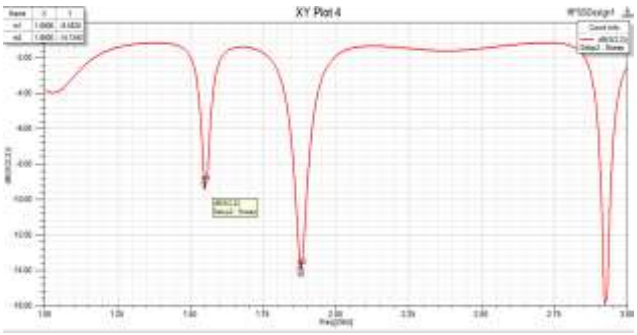

Figure 3.Frequency Response at 1.88 GHz

Also we have obtained Radiation Patterns.So that we can measure Gain obtained at certain frequencies which we have calculated .

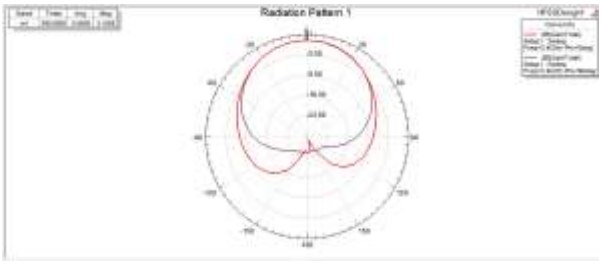

Figure 4.Radiation pattern for 2.4 GHz

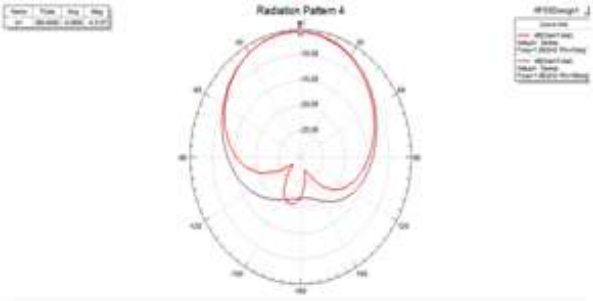

Figure 5.Radiation pattern for 1.88 GHz

Fractals are novel Geometries that are used for Miniaturization to obtain effective Bandwidth. Hausdroff-Besicovitch Dimension is used to calculate the Fractal area.

For our study we have designed a Koch fractal loop antenna as shown in Figure 6 using CST STUDIO SUITE 2010.

The Frequency response and the Radiation pattern of the designed antenna is shown in Figure 7 and Figure 8 respectively.

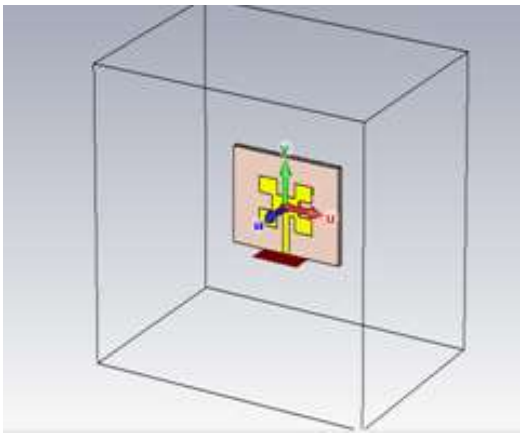

Figure 6 .First iteration of Koch Fractal loop antenna

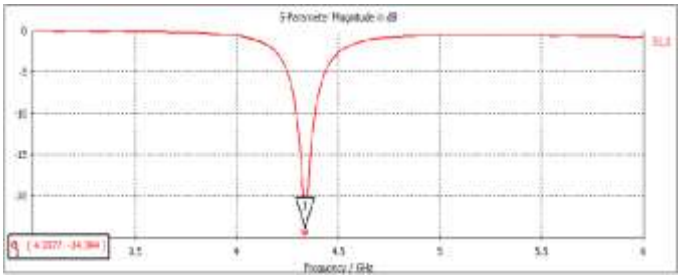

Figure 7. Frequency response for Koch fractal loop *Figure*

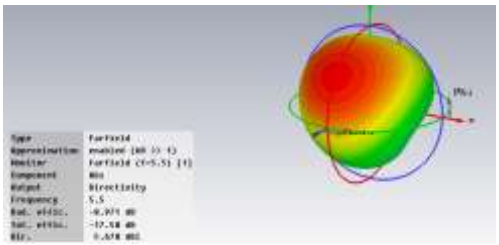

Figure 8.Radiation pattern for Koch fractal loop

The Koch Fractal loop antenna as shown in Figure 6 can be introduced within the Antenna shown in Figure .1 to increase the bandwidth. In order to Increase the Bandwidth further more a slot may be introduced behind the Antenna so that the antenna resonates at one frequency ant the Slot resonates at other frequency thereby increasing the Bandwidth and study can be made .

IV. Future Work

Different fractal geometries with different iterations will be studied and compared. The Geometry with better results would be used to Optimize the work done.

V.CONCLUSION

The proposed works aims at increasing the Bandwidth and the data transfer rate of a MIMO system . The vertical polarisation is obtained by using a 50 ohm line mictrostrip patch antenna whereas by giving a excitation along the length of the antenna using a power divider circuit Horizontal polarisation is obtained. The Increase in Bandwidth can be obtained by using Novel Geometries like “FRACTALS”

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