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Review of Microstrip Patch Antenna for its use in Multi Input Multi Output Antenna System

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Abstract: The rapid growth of wireless communication has created a strong demand for high data rates and antenna miniaturization. Multi input multi output systems play a very important role towards this aspect. It is possible to achieve high data rates, enhanced bandwidth and increased capacity using MIMO system. Use of diversity in MIMO systems is effective in reducing multipath fading. The crucial problem in design of MIMO systems is selecting the antenna as performance enhancement depends on the antenna used. In MIMO system as multiple antennas are used at the transmitter and receiver side, studying the properties of various antenna array configurations is required. In this paper a review concerning the properties and advantages of Microstrip patch antenna and its use for design of MIMO system is discussed.

Keywords: MIMO, microstrip patch antenna, wireless communication.

I. INTRODUCTION

The concept of MIMO technology was first studied by the pioneer Gerard J Foschini (1998). The principle is based on multiple antennas at both transmitter and receiver. Owing to its high capacity and high-speed wireless communication concentration, many researchers have focused attention on the multiple-input-multiple-output (MIMO) antenna. The data rates that can be achieved depend strongly on design parameters of the antennas that are taken at the transmitter and receiver side.

The most preferred antennas for a MIMO system are microstrip or patch antennas, due to their low cost and ease of fabrication. The role of microstrip antennas in the current wireless scenario and types of microstrip patch antennas that are used in the design of MIMO systems are presented.

One of the important parameters that describe the performance of an antenna is bandwidth as it signifies the range of frequencies where the antenna radiates more efficiently. In the present paper, a rectangular microstrip patch antenna is proposed. The proposed antenna is analysed for using in a 2×2 MIMO system. This paper investigates the benefits of Microstrip patch antenna for improvement in overall system performance by studying the test results from review papers.

1.1 Multi Input Multi Output Systems

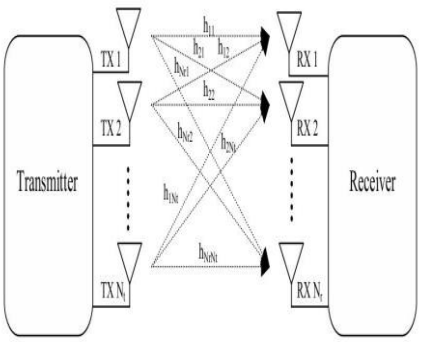

Figure 1: Basic MIMO System

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A MIMO system with N number of transmitting and receiving antennas is shown in figure 1. The basic idea of this system is to transmit various data streams using different antennas at the same carrier frequency and without additional power. When a data stream is transmitted from p^{th} antenna, it is received at the q^{th} antenna after travelling in different paths as shown in the figure. This method of propagation is known as multipath propagation, which occurs due to the reflections of signal from different objects in the path. The importance of antenna selection in these systems is focussed by many pioneers , like A.S.Hiwale, N.B.Chopade, A.A. Ghatol , P.M.Gulhane in "Performance Analysis of Space-time Block Coded MIMO system with Antenna Selection", Ssorin V, Artemenko A, Sevastyanovn A, Maslennikov R, in "Compact bandwidth-optimized two element MIMO antenna system for 2.5 – 2.7 GHz band" to name the few.

II. MICROSTRIP PATCH ANTENNAS

The Microstrip antennas are the most preferred one for use in MIMO system. A microstrip antenna basically consists of a radiating patch placed on a dielectric substrate attached to a ground plane as shown in figure 2.

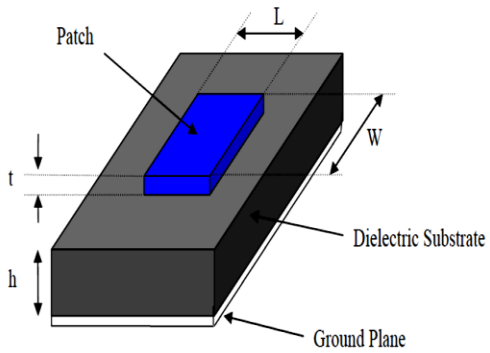

Figure.2: Basic Microstrip Antenna Structure

The microstrip antenna has numerous advantages like lightweight, small volume and a low-profile planar configuration. They can be made conformal to the host surface. Their ease of mass production using printed circuit technology leads to a low fabrication cost. They are easier to integrate with other MICs on the same substrate. But it also has few disadvantages.

Microstrip antenna suffer from narrow bandwidth due to the high Quality factor (Q).The value of this Quality factor Q can be minimized by increasing the thickness of the dielectric substrate. But, increase in the thickness of the substrate results in the formation of surface waves. These surface waves result in mutual coupling in the MIMO systems, weakening the overall system performance. Hence mostly thickness of dielectric is taken 4.4 to enhance the bandwidth and reduce mutual coupling. Many researchers like Adil Hameed Ahmad and Basim Khalaf in "Design and Simulation of Broadband Rectangular Microstrip Antenna, Ogunlade Michael Adegoke,Ismael Saad Eltoum in "Analysis and Design of Rectangular Microstrip Patch Antenna at 2.4Ghz WLAN Applications", Rachmansyah, Antonius Irianto, and A. Benny Mutiara in "Designing and Manufacturing Microstrip Antenna for Wireless Communication at 2.4 GHz," have paid attention on performance of microstrip patch antenna.

III.METHODOLOGY FOR SIMULATION

In order to achieve the goal of best performance of microstrip patch antenna designer uses simulation tools during different steps of the designing process.Simulations of various samples of Microstrip patch antennas can be done using simulation software's like HFSS, IE3D, CAD FEKO, EM.CUBE, CST, AWR microwave office etc .

High Frequency Structure Simulator (HFSS), introduced by Ansoft is the EM simulation to develop and implement technologies for design of different type of antennas. HFSS is preferred for simulation of Microstrip patch antenna. Figure 3 shows the design simulation steps of microstrip antenna. It is clear from fig. that the designer has to give microstrip patch, width of dielectric, dimensions of patch, slot dimensions, frequency, medium, input voltage etc. to HFSS and observe various microstrip antenna parameters. Figure 4 shows the simulated antenna studied in review papers.

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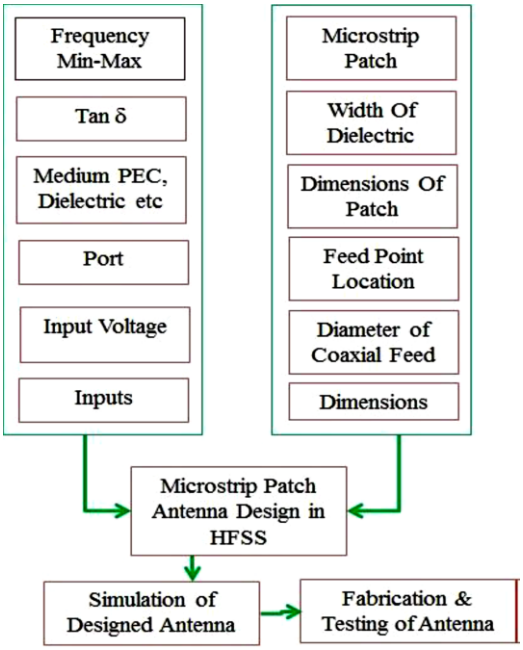

Figure.3 Design Steps of Antenna Simulation

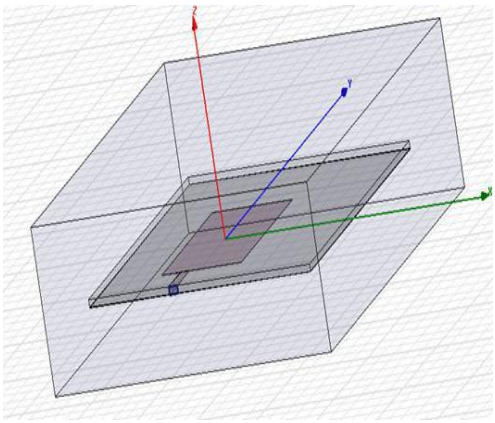

Figure: 4 Microstrip Patch Antenna simulated using HFSS.

IV. RESULTS

The results of the antenna under study from the review paper for the return loss , VSWR and radiation pattern is as given below. From the results obtained, we can observe that the antenna under study is having a band frequency operation of 2.4GHz with -29.69dB return loss. The voltage VSWR standing wave ratio is 1.2.Figure 5 and 6 shows the return loss and VSWR.

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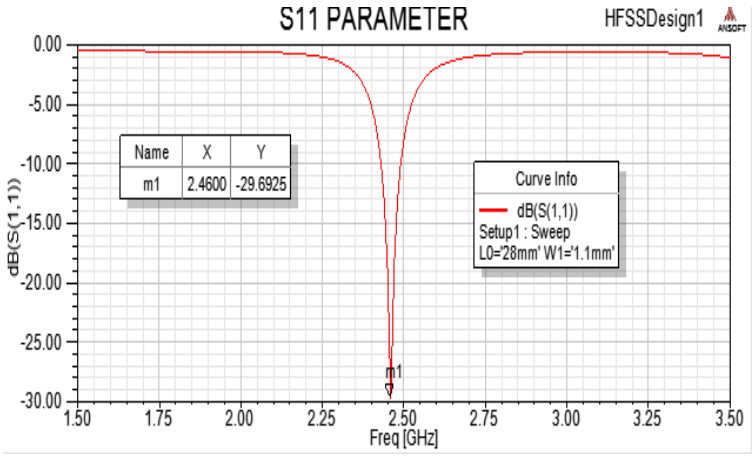

Figure. 5. The return Loss

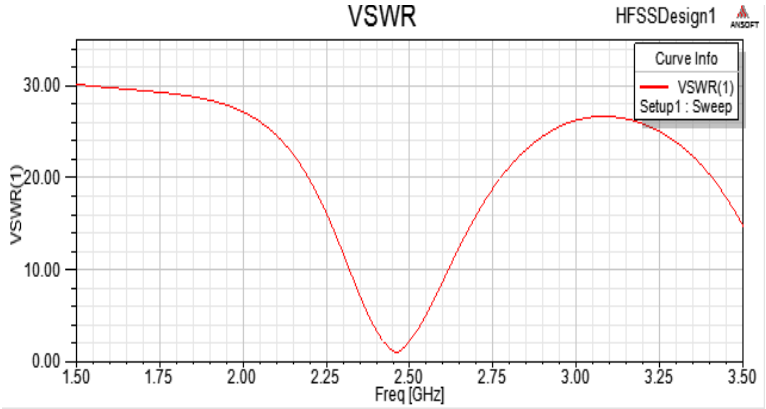

Figure.6. VSWR of studied antenna.

Figure 8, 9 shows the simulated E- and H- field radiation patterns of the proposed antenna at a frequency of 2.4GHz. Radiation pattern refers to the direction of the electromagnetic waves radiates away from the antenna. It is a graphical representation of radiation properties of the rectangular microstrip patch antenna as the function of space coordinate. There are two types of fields namely, far and near field but, in this antenna design we are only focusing on the far fields. By setting the EH Plane, the far field radiation sphere setup values of Phi start from 0 and stop at 90, with step size of 90.Similarly, the values of theta start from -180 and stop at 180 with a step size of 1. The values of phi and theta are good from the simulation results as shown in the radiation pattern 1 below. In actual fact, a microstrip patch antenna radiates normally to its patch surface. The radiation pattern of the antenna is omnidirectional and with this, this antenna can be used for MIMO systems.

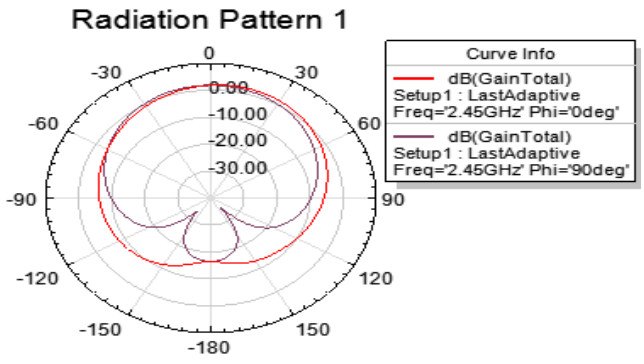

Figure8. Radiation Pattern

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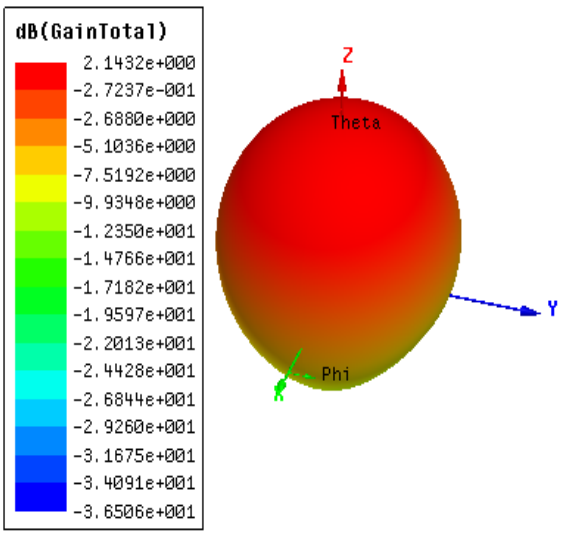

Figure 9.3D-Gain Total

V. CONCLUSION AND FUTURE SCOPE

In this paper we have studied, reviewed and analysed the performance of Rectangular microstrip patch antenna and its possible use in designing of MIMO systems. The studied antenna is having return loss of-29.6925 dB at 2.4GHz .This designed antenna was simulated on HFSS software. For this antenna, a sufficient band-width was achieved, the desired frequency of 2.4GHz is achieved, likewise the VSWR value of 1.2 is achievable. The values obtained for microstrip antenna makes it a promising solution to be used in proposed 2x2 MIMO system.

It can be concluded that a lot of research is required to be done in antenna design for the better performance of MIMO systems, which form a main part for the future wireless communication.

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