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DESIGN OF DUAL FREQUENCY COMPACT TRIANGULARPATCH ARRAYFORMIMO APPLICATIONS

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Abstract: **In this paper, the design and characterization of microstrip triangular antenna array is presented. The proposed antennas are giving dual bands at 6-6.5 Ghz& 7-7.5 Ghz to support C-band applications. The proposed dual band antennas show omnidirectional radiation pattern with the gain values of 11.06dBi at 6.7 GHz & 8.470dBi at 7.36 Ghz. The patch array has two input ports for the orthogonal polarizations MIMO applications. The radiation pattern, result loss & gain of proposed antenna are presented. In this paper, an antenna diversity gain is evaluated for MIMO system by measuring the envelope correlation coefficient. The proposed antenna array is analyzed for the capacity it can offer in an ideal environment it is observed that antenna indicates quite perfect behavior & offers a good performance for utilization in a MIMO system for C band applications**.

Keywords – **Triangular microstrip patch, Antenna arrays, Omnidirectional, Envelope correlation coefficient**

I. INTRODUCTION

Multiple Input Multiple Output (MIMO) systems are receiving a great attention because architecture uses more than one antenna elements in transmitter and receiver ends to overcome the limit of channel capacity in a rich multipath environment [1]. The theoretical capacity of the system increases linearly with the increasing number of elements in MIMO antenna systems.

However, practical considerations indicate about the corresponding capacity of the system that it can be reduced if the received signals in any of the different antenna elements are correlated [2]. This effect explains that to obtain diversity gain in the antenna system, the value of "ρ" is less than 0.5 [3]. It is obvious that MIMO performance is affected by correlation and it represents a crucial parameter for modern wireless applications. The envelope correlation between antenna elements is one of most important because it is related with the spectral efficiency and degrades the performance for wireless applications.Antenna correlation calculation method is given by appropriate method of analysis. The method is suitable for experimental measurements and requires the knowledge of scattering parameters obtained on the antenna elements. This method is the adopted throughout this paper. The procedure for the calculation of correlation be-tween antennas in a two antenna system using the scattering parameters is given in [10].

II. SYSTEM MODEL

The system model for implementation of a MIMO system for C band applications with single antenna at the transmitter and two antennas at the receiver is as shown in the figure 1 below.

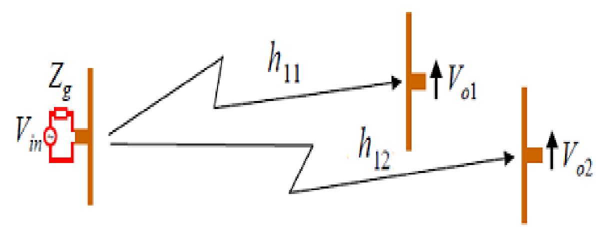

Figure1. System Model

The H that represents the H matrix for this system with one Tx and two RX and is given as

$H = [\,h11\;\; h12]$For a narrow band MIMO channel the capacity is given by [4] as

C =E [log 2 (det {IN, +pHH+IN))] (1)

Here p is the average signal to noise ratio at each receiver and H is the Nr x Nt channel matrix. N=min (Nt, Nr). Nt and Nr are the number of transmitting and receiving antennas respectively. Also each element of H is taken as complex Gaussian distributed random variable which signifies that each

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pair of transmit and receive antennas experiences independent fading.In order to propose an antenna array for the given system model, a triangular patch antenna array with two antenna elements is proposed and is mentioned in the next section .

III. ANTENNA DESIGN

The alignment of the proposed dual band antenna at 6.7 and 7.36 GHz is shown in Figure 2. It consists of two triangular patches which are placed on the same substrate layer with εr = 4.4, thickness of t =1.57mm, tangent loss of tanδ = 0.0009 and copper thickness of 0.035mm.

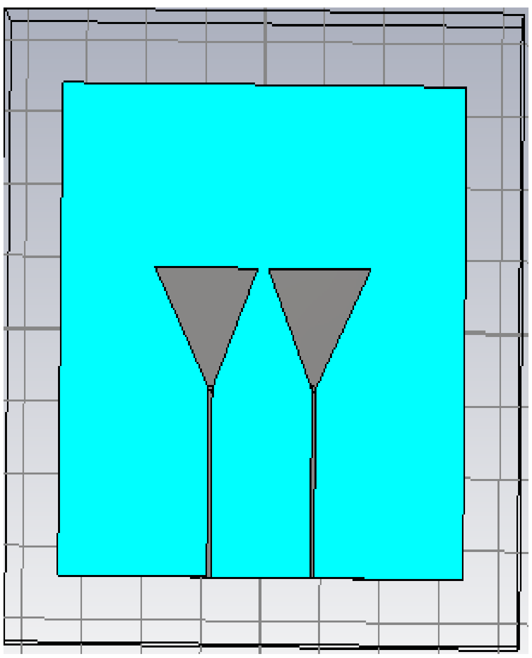

Fig 2. Triangular Patch Antenna

To obtain the results of the return loss of the antenna, CST Microwave Studio was used. The physical dimensions of the antenna are calculated using transmission line model.

TABLE I : Patch Antenna Specifications

Substrate Material	FR4
Dielectric Constant	4.4
Loss Tangent	0.009
Substrate Height	1.57 mm

TABLE II: Calculated Parameters

Dimensions of Triangle	34.5mm
Microstrip feed Width	1.25mm
Bandwidth	168.3 Mhz

IV. RESULTS AND DISCUSSION

All the simulations related to Triangular Patch Microstrip antenna array design for MIMO applications (Fig .2) were carried out using CST MWS'10. The result of impedance bandwidth is presented in this section. The antenna resonates at 6.7 and 7.3 GHz. Following are the simulated results:

4.1 Return Loss

Reflection coefficient (S11) is the ratio of the amplitude of a wave reflected from a surface to the amplitude of the incident wave. The return loss graph of an antenna represents its impedance bandwidth with respect to a return loss of less than -10dB. Figure 3 represents the return loss for a patch antenna.An impedance bandwidth of 165.3 MHz around 6.7 GHz with a peak return loss less than -25dB and 100 Mhz around 7.37Ghz with a peak return loss less than -20 dB is covered by the patch antenna .

The Em waves transmitted by the two antennas do not interfere with each other's output and that can be verified from the figure 4 .A correlation coefficient of 0.1 and 0.25 can be seen at the two resonant bands of 6.7 and 7.3 GHz respectively

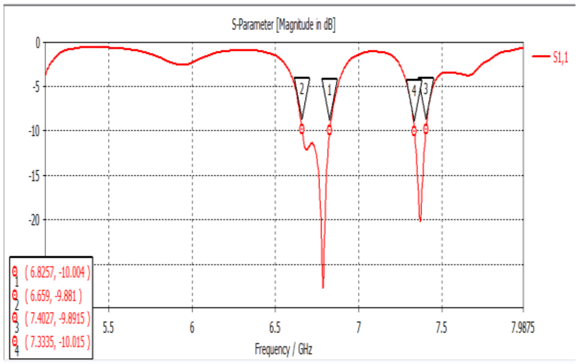

Fig 3. Return loss [S11] of triangular patch antenna

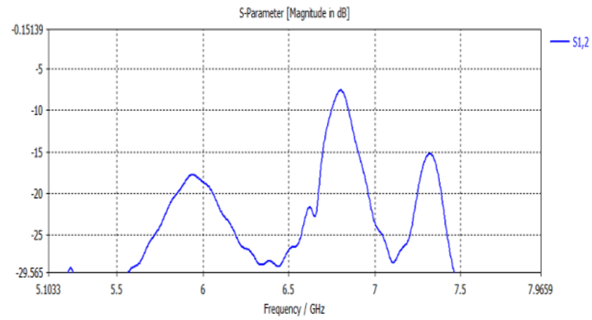

Fig 4: Return loss [S12] of triangular patch antenna

4.2. Radiation Pattern

Figure 5.1 shows the gain plot at frequency of 6.7 Ghz which is 11.06 dBi and Figure 5.2 shows the gain plot at 7.37 Ghz which is 8.470 dBi.

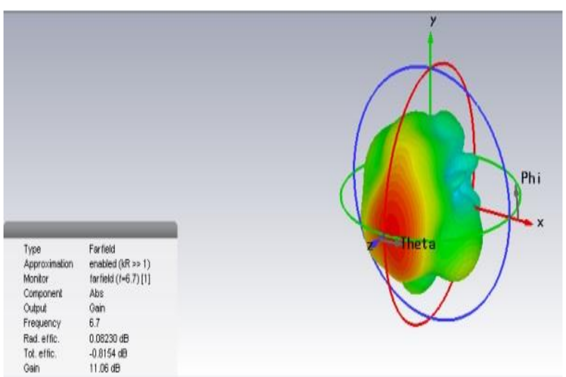

Fig 5.1. Radiation pattern at 6.7 Ghz

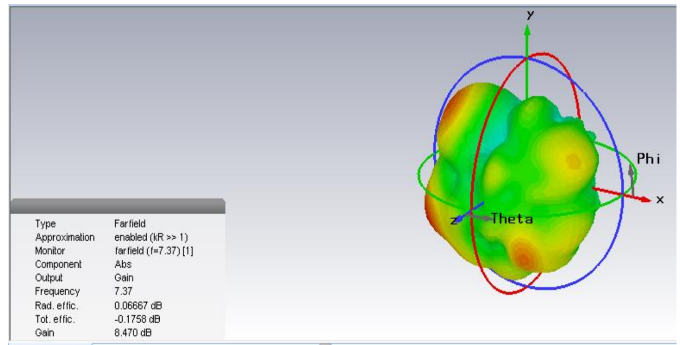

Fig 5.2 : Radiation pattern at 7.37 Ghz

4.3. Correlation Coefficient

In a 2 × 2 MIMO system envelope correlation coefficient "ρ" is affected under the influence of different propagation paths of the RF signals that reach the antenna elements. The approximation of values for this coefficient is based on a simple closed-form equation which varies from 0 to 1. A low correlation between the two outputs obtained from the antenna show that they do not affect each other much.

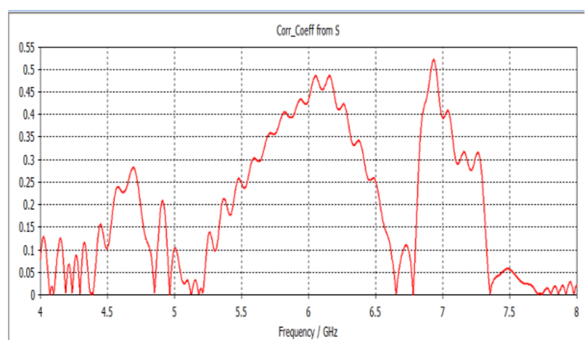

Fig 6: Eenvelope correlation coefficientof triangular antenna

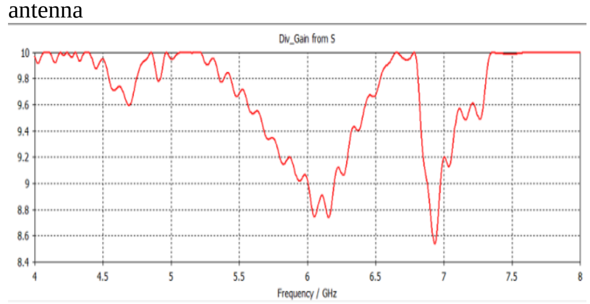

Fig 7: Diversity Gain of triangular patch antenna

4.4. Diversity Gain

Due to some diversity scheme , diversity gain is the increase in signal-to-interference ratio, or gives the estimation for the reduction in transmission power when a diversity scheme is introduced, without a performance loss. Figure 7 shows the diversity gain of 10 and 9.5 at the respective bands of antennas operation.

V. PROPOSED APPLICABILITY OF ANTENNA

In order to analyze the applicability of the antenna array to a given practical scenario, its capacity analysis is important as mentioned below.

5.1Capacity with increasing signal power

Figure 8. was plotted using the equation

$$C = B^{*}.log_2\,(1+\frac{P}{N0*B}) \qquad (2)$$

which shows that Increase in the signal power will mean that spliting the signal level into more number of levels while ensuring low bit error probability.

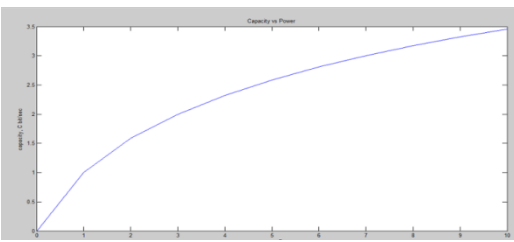

Fig8: Capacity vs Power

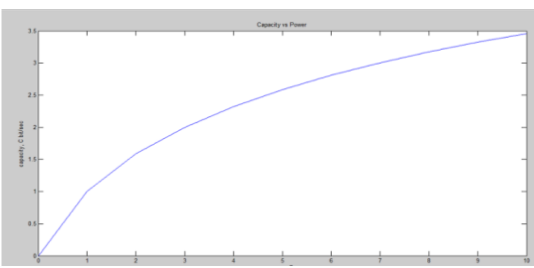

Fig 9: Capacity vs Bandwidth

5.2. Capacity with increasing bandwidth

A more bandwidth supported by this array leads to more data rate supported by the system; this is plotted using equation (2).Figure 9 shows that increasing the bandwidth has effects: More bandwidth tends to higher the capacity as the no. of transmissions per second is also increased.

VI. CONCLUSION

In this paper array of triangular patch was developed. By optimizing the structure parameters two bands can be efficiently obtained for WLAN/WiMAX/ Hyper LAN2/C-band applications, which are verified by simulated results. This dual band antenna gives good radiation characteristics and can be used in wireless communication systems.

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