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HIGH ISOLATION MICROSTRIP MIMO ANTENNAS FOR WLAN SYSTEMS

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ABSTRACT

This paper introduces a novel design of aperture coupled microstrip antenna for MIMO array applications. The proposed antenna uses 2x4 patches excited from two ports via rectangular slots. HFSS (High Frequency Structure Simulator) and CST (Computer Simulation Technology)softwares are used to simulate the antennas performance. The results are given in term of S-parameters, radiation patterns and gain. In addition a parametric study is done to evaluate the effect of certain antenna parameters on the antenna performances. Form the simulated result, it is concluded that the proposed concept provides a good isolation between the two antenna ports (with low mutual coupling, $S_{12/21}$ *< -28 dB) and high gain. In addition, the obtained results are in good agreement.*

Keywords: Aperture coupled microstrip antenna (ACMA), Mutual coupling, MIMO systems.

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Contribution/ Originality

This study presents a new multi-input multi-output antenna array with a reduced coupling between the two antenna ports.

1. INTRODUCTION

The Multiple Input Multiple Output (MIMO) has become popular research topic among researchers for development of a new wireless communications technology. The concept of MIMO technology was first studied by the pioneer Foschini (1998) [1].The principle is the use of multiple antennas at both the transmitter and receiver to improve communication performance [2]. A new MIMO array configuration of equal antenna elements is chosen to increase the gain. The use of multi-element antenna arrays at both the transmitter and the receiver in a MIMO system can offer great benefits over traditional wireless communication systems [3].

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Multi -input, multi-output (MIMO) system offers significant increase in data throughput and link range without additional bandwidth or increased transmit power [4]. With these advantages, the MIMO technology has been adopted in many wireless standards, such as LTE/LTE-A, WiMAX, wireless local area networks (WLAN) etc., and has been considered for future mobile communication systems [5, 6].

In these applications, where spacing is a strong limitation, in order to achieve high isolation between the two ports, various design techniques such as aperture coupled, hybrid feed, feeds on two different layers and gap feed have been used [7].

The aperture coupled microstrip antenna (ACMSA) offers many advantages over the conventional direct feed antennas such as the ability to use separate substrates for the feeding network, high bandwidth and shielding of antenna from spurious feed radiation [8]. Normally, coupled feed structure can also be used in many applications of MIMO technology like reduction of mutual coupling between two antenna ports.

In this work, we design and analyze a MIMO antenna for wireless communications by using rectangular aperture coupled microstrip patches. Comparing to the MIMO antenna array published in Chouti, et al. [9] the proposed structure with the aperture coupled excitation mechanism provides an improved isolation between the two antenna ports. The concept of the proposed antenna is initially simulated using HFSS simulator. Also, the results are checked by CST software. The numerical results are given in term reflection coefficients and mutual coupling, radiation patterns and gains. This paper is organized as follows; the geometry for single aperture coupled patch antenna and MIMO aperture coupled microstrip antenna array are described in the second section. Results and discussions of 2x4 MIMO antenna array is included in section three. Finally, a conclusion of this work is provided in the last section.

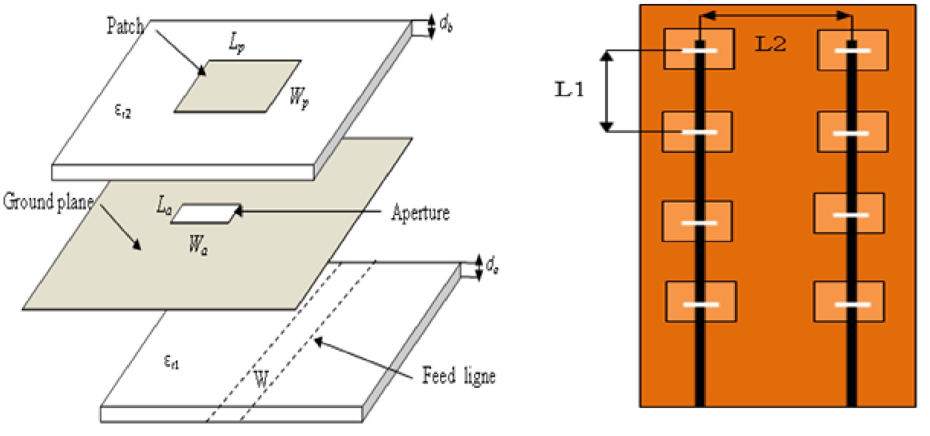
2. ANTENNA DESIGN

The design of the proposed antenna is presented in two parts. The first part is the configuration of the single aperture coupled microstrip antenna shown in Figure 1.a. The rectangular patch has dimension of 14x13mm^2, printed on the upper substrate (Rogers/RT duroid 5880). The lower substrate (with thickness of 0.76mm and relative permittivity of 3.48) is separated from the upper substrate with the ground plane. The excitation is ensured by the transmission feed line with width of 1.6mm, through a slot etched in the ground plane with a width of 2.5mm and length of 10mm .

The final structure consists of two port antennas array based on the basic form of the aperture coupled rectangular patch, as shown in Figure 1.b, the distances between each radiating element 'L1' and 'L2' were 34.2 mm and 39.2 mm, respectively.

3. NUMERICAL RESULTS AND DISCUSSION

The antenna configuration of Figure 1.b, were simulated using full wave HFSS software and checked using the CST Microwave Studio software.



(a) (b)

Figure-1. Design of the proposed structure: (a) Basic form, (b) MIMO antenna array

A. S-Parameters

Figure 2 illustrates the simulated reflection coefficients ($S_{11/22}$) curves using both HFSS and CST. Both S_{11} and S_{22} are found to be similar, due to the symmetry of the structure. From the simulation results, it can be seen that the proposed design operates around 6 GHz and provides bandwidth 90 MHz with good agreement between the two numerical results.

The simulated results of the transmission coefficients ($S_{12/21}$) of the MIMO aperture coupled microstrip antenna array are depicted in Figure 3 with the HFSS simulator and CST microwave studio. The mutual couplings between the two antenna ports are -28.42 dB and -29.42 dB corresponding to the HFSS and CST simulators, respectively.

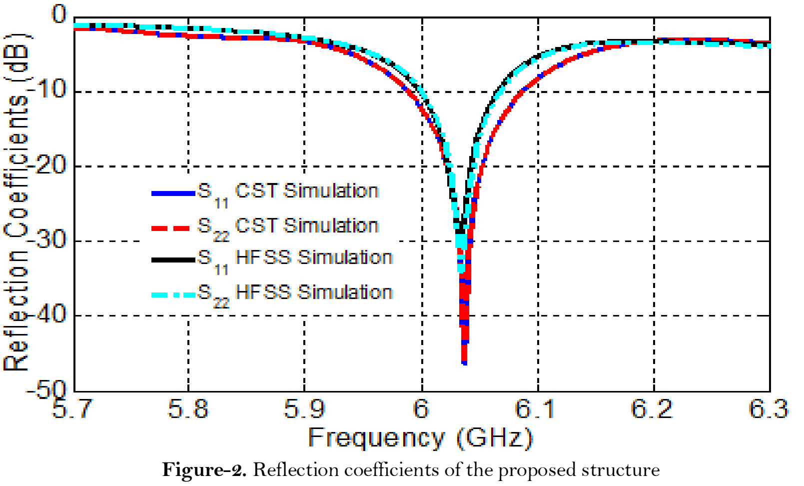


Figure-2. Reflection coefficients of the proposed structure

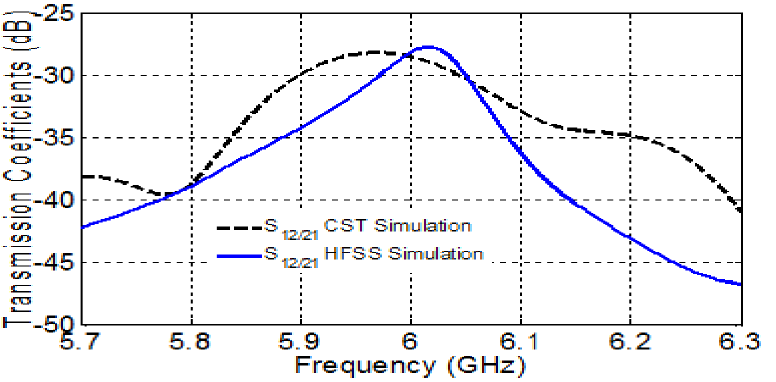


Figure-3. Transmission coefficients of the MIMO antenna.

The results in term mutual coupling are compared in Table 1, among the proposed antenna and reference antennas [8]. From this table, it is found that the proposed antenna design gives a mutual coupling less than - 28 dB, which presents an improvement of 13 dB in the isolation compared to the proposed antenna in reference [8]. The reduction is due to the effect of using aperture in the finite ground plane. This isolation is achieved without using any additional decoupling elements and the developed antenna system is adequate to the requirements of wireless MIMO systems.

Table-I. Mutual coupling comparison.

	Mutual coupling between the ports ($S_{12/21}$) <
Reference [8]	-15 dB
The proposed design	-28 dB

B. Radiation Characteristics

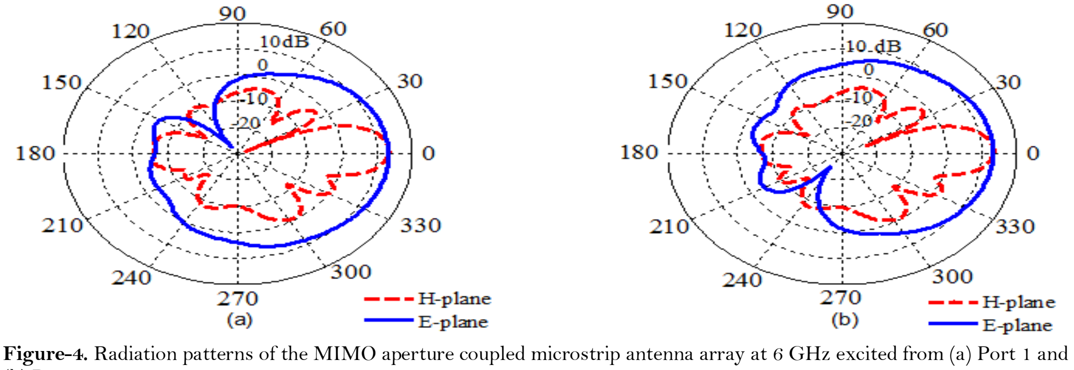


Figure-4. Radiation patterns of the MIMO aperture coupled microstrip antenna array at 6 GHz excited from (a) Port 1 and (b) Port 2.

The E-plane (φ=0°) and H-plane (φ=90°) radiation patterns of the proposed structure antenna excited at 6 GHz from both port 1 and 2, are depicted in Figure 4. From these curves, it can be seen that a symmetrical radiation pattern is achieved for both the ports.

The simulated gains of the MIMO aperture coupled microstrip antenna array are illustrated in Figure 5. It can be observed that the gain at the resonance frequency is 13.36 dB for the port 1 and 13.37 dB for the port 2, which is sufficient for many wireless applications.

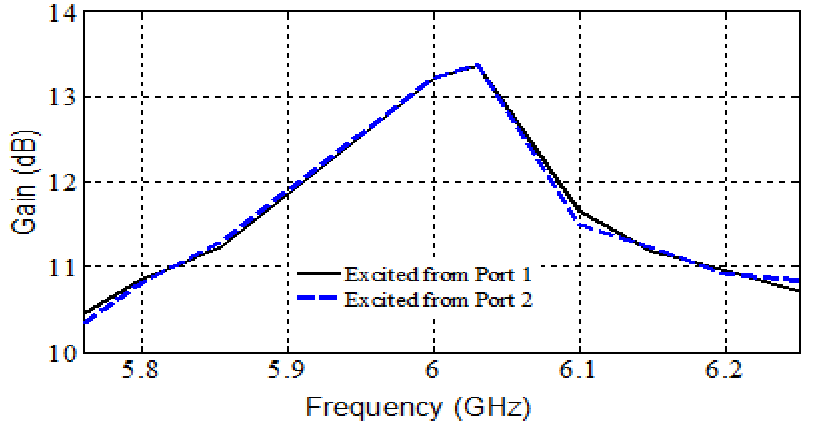


Figure-5. Simulated Gains of MIMO antenna.

4. CONCLUSION

In this paper, we have presented a numerical analysis of a new MIMO antenna array. The antenna design operated around 6GHz was simulated by HFSS simulator and checked using CST software. Good agreement was achieved between the two numerical results. The structure proposed in previous work [8] has a mutual coupling of-15.17dB. While, the present proposed antenna has a lower mutual coupling which is -28.42dB. The proposed antenna with optimal dimensions achieved good matching and good isolation at the resonant frequency. In addition, a high gain of 13.36 dB at the resonance frequency and symmetrical radiation patterns for the two ports is also achieved. With this features the proposed MIMO microstrip antenna array could be used for WLAN communication systems.

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Contributors/Acknowledgement: All authors contributed equally to the conception and design of the study.

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