Design and Analysis of MIMO Antenna for Radar Applications

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ABSTRACT

This research works on Two elements Multiple Input Multiple Output (MIMO) antenna is closely placed with each other at edge-to-edge separation 7 mm. Isolation improvement of 9 dB is achieved by keeping the metamaterial structure in between the MIMO elements. With the proposed structure, the isolation is achieved around −52.5 dB. Due to low ECC, high gain, low channel capacity loss and very low mutual coupling between elements, the proposed antenna is a good candidate for the MIMO applications. The proposed antenna is fabricated and tested. A reasonable agreement between simulatedand measured results is observed.

Keyword: *MIMO antenna, S-parameters,mutual coupling, ETC..*

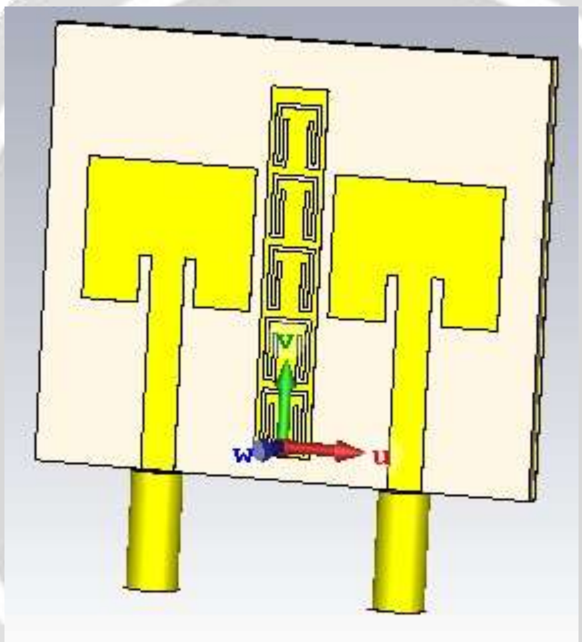
1. INTRODUCTION

In the next generation technologies MIMO antenna play an important role for wireless communication. In this research article discuss on a MIMO antenna with defected ground structure (DGS) structure for different wireless ranges. The scientific community and researchers have started their efforts in the analysis MIMO problems conditions during the various antenna and geomagnetic shapes. Studies of the MIMO antenna parameters during the past two decades have revealed a voltagestanding wave ratio and return loss fields MIMO is first discussed on back to 1971s in research article in terms of multi-channel digital communication systems and crosstalk involvingpair in a cable. MIMO antenna is a key player to design smart antennas, that is use smart signal processing and use in LTE and next generation communication system. Wi-Max communication system is also depended on MIMO antenna. This problem may arise when antennas are placed nearby. MIMO antenna contains at least two spaced radiating elementsin the aim of achieving good isolation between them. However, the available space is unsuitable for practical portable devices. In this respect, many techniques have been adopted to lower themutual coupling between MIMO elements. In, by introducing F-shaped stubs in between the two radiators, the mutual coupling between the MIMO elements was decreased. Very reduced mutual coupling between the MIMO antennas is accomplished by utilizing neutralization line. Other approacheshave been proposed in the literature to augment isolation between the radiators. Among the adopted approaches we can state the introduction of a meandered line resonator in betweenthe radiating elements of the MIMO antenna, the use of different elements for polarization diversity, the use of electromagnetic bandgap structures u-shaped characteristic radiator, defective ground structure.

MIMO antenna suffer from major problem that is mutual coupling, due to mutual coupling generate cross talk. To prevented this problem in the last decade many researchers work on MIMO antenna with parasitic element to decrease the problem of mutual coupling. In the year 2012 Yang, Xin Mi, et.al presented mutual coupling minimization in closely packed patch antennas exploitation wave guide, the band-gap of the wave guide meta-materials (WG-MTM) is worked to de-couple the strongly filled antenna patches. By inserting the wave guide meta- materials between two H-plane together in patch antenna, the coupling of these radiation elements is compact by a least of half-dozen dB among the 10-dB system of measuring. Compared to varied decoupling techniques.

2. ANTENNA CHARATERIZATION

The antenna model geometry is shown in Figure 1. The proposed antenna is printed on a low-cost FR-4 substrate having aloss tangent and relative permittivity of 0.02 and 4.4, respectively.The proposed design has two patches excited using a 3 mm widermicrostrip lines with a 50 W characteristic impedance. Edge to edge separation between the radiating elements of the MIMO antenna is kept as 7 mm.



The proposed antenna’s associated parameters are providedin Table 1.

Table 1. Different Parameters and values of the antenna.

Parameters	Dimension (mm)	Parameters	Dimension (mm)	Parameters	Dimension (mm)
L	37	W	44	Ws	3
a	4	b	1.1	Lsr	30
Wp	15	c	5.3	d	4
Lp	13	Wsr	5	•	•

3. STEPS FOR THE DESIGN OF MIMO ANTENNA

The iterative design process of the proposed MIMO antenna that includes three steps is presented in Firstly, a single radiating element patch antenna with microstrip feed is designed and optimized to operate efficiently. Width and length of the optimized antenna were chosen as 15 mm and 13 mm respectively. Secondly, another patch antenna is designed near to the first one as shown in Figure 2 (step 2). The unit cell of the proposed metamaterialstructure is shown in Figure 3b is used as decoupling structure. The unit cells are used between the antennas for a good isolation between the two antenna elements (step 3).

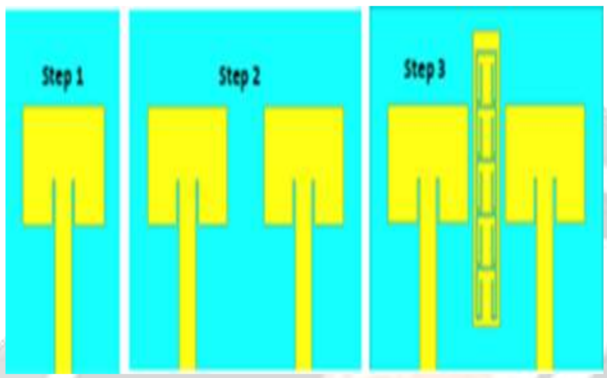


Figure 2. Steps for the design of proposed MIMO antenna.

4. S-PARAMETERS

Figure 3 presents the simulated reflection coefficient (*S*11) and the transmission coefficient (*S*21) of the proposed MIMO antenna with and without using meta material. It is clear from the Figure 3a that *S*11 of the MIMO antenna with and without metamaterial is almost same. The resonant frequency of MIMO antenna without metamaterial is observed at 5.82GHz while the resonant frequency of the proposed MIMO antenna using metamaterial is observed at 5.89 GHz.It is worth highlighting that very low mutual coupling is constantly preferable for efficient MIMO antennas. Figure 3a shows that antenna without having metamaterial has poor isolation in the whole operating band. A very highisolation is achieved by employing metamaterial between theradiating elements.

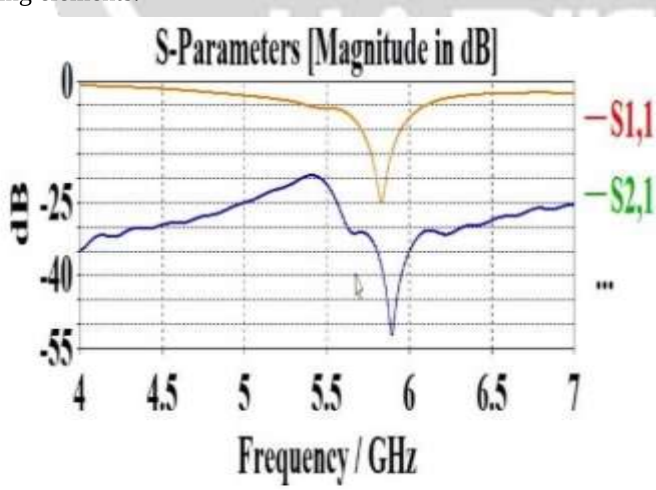


Figure 3. Simulated S-parameter

5. SURFACE CURRENT

The isolation behavior can also be explained through the analysis of the antenna's surface current distribution at the frequency of interest. The current distribution at 5.8 GHz in both cases is presented in Figure 4. Upon excitation of port 1 of two port antenna, a high mutual coupling is obtained between the monopoles, because the current is strongly coupled to another radiator. It is obvious from the Figure 4 that mutual coupling is diminished by the insertion of metamaterial unit cells between the two radiating elements. Thus, a very low mutual coupling is achieved.

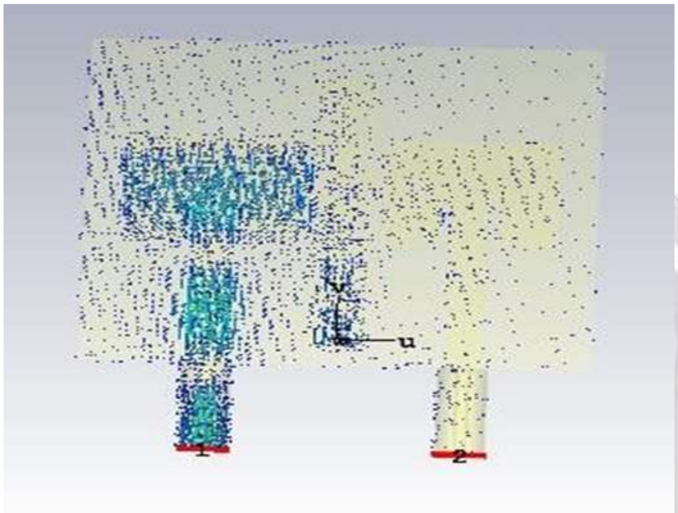


Figure 4(a): surface current distribution of MIMO antenna at port 1

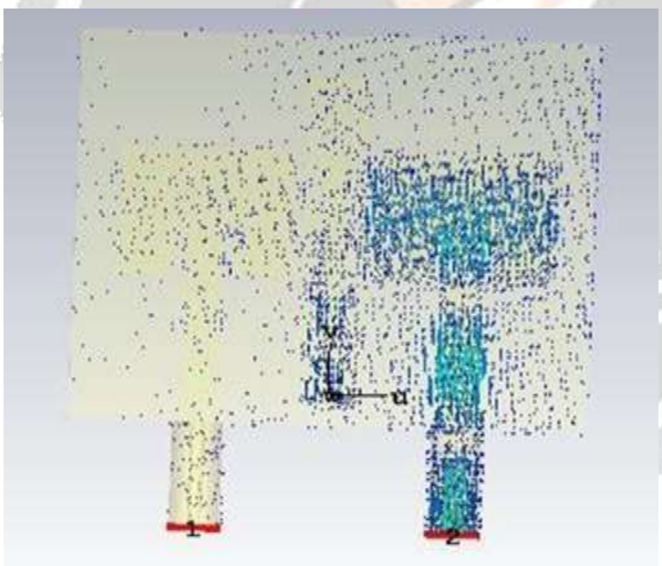
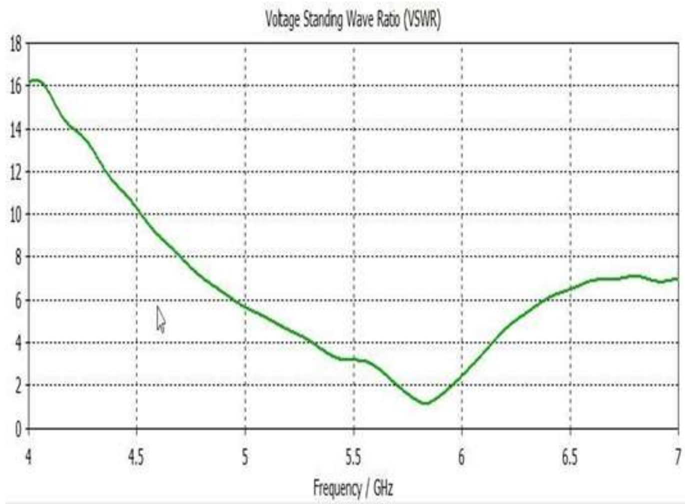


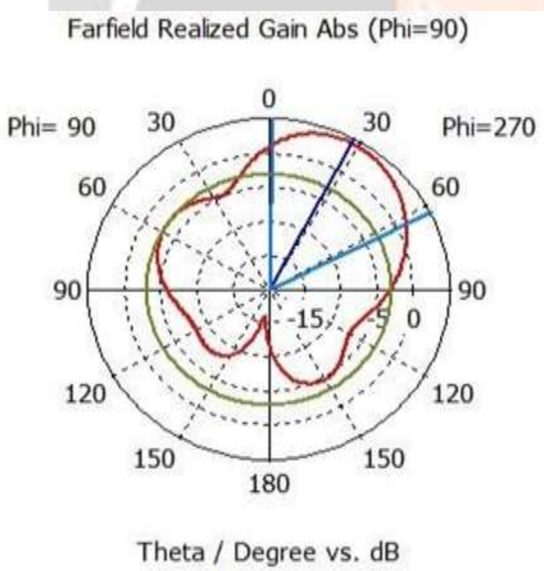
Figure 4(b): surface current distribution of MIMOantenna at port 2.

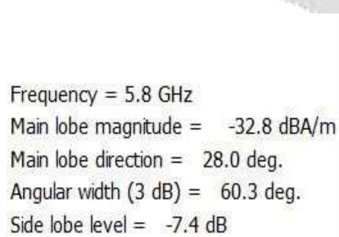
6. VSWR

Voltage standing wave ratio (VSWR) is defined as the ratio between transmitted and reflected voltage standing waves in a radio frequency (RF) electrical transmission system. It is a measure of how efficiently RF power is transmitted from the power source, through transmission line, and into the load. A common example is a power amplifier connected to an antenna through a transmission line. SWR is, thus, the ratio between transmitted and reflected waves. A high SWR indicates poor transmission-line efficiency and reflected energy, which can damage the transmitter and decrease transmitter efficiency. Since SWR commonly refers to the voltage ratio, it is usually known as voltage standing wave ratio (VSWR)



7. SIMULATED RADIATION PATTERN





8. RESULT DISCUSSION

S-parameters values are shown in Figure 7 for a comparison with the simulated results. Comparing the simulated and the measured results, we can notice that there is a slight frequency shift. This may be due to several factors which include the SMAconnector loss, cable loss, limitation of milling machine as well as radiating boundaries during the measurement process. The measured frequency band of the proposed MIMO antenna is within the range of 5–5.9 GHz with $S11/S22 < -10$ dB and $S21/S12 < -25$ dB.

9. CONCULSION

Throughout the scope of the presented paper, the design, prototyping, and measurement relating to a MIMO antenna, useful for MIMO applications, have been thoroughly depicted. The proposed antenna, operating at 5.8 GHz, has a simple structure with a size of 44 × 37 mm2. By incorporating metamaterial structure between the radiating patches of the MIMO antenna, a high isolation between the MIMO elements is achieved.

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