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Periodic Structures for Mutual Coupling Reduction in Antenna Arrays

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Abstract—Abstract - Mutual coupling between antenna elements is a serious problem when multiple antenna elements are mounted in an array. In a microstrip array, a periodic structure is used to prevent mutual coupling between machineries. In this paper, the Jerusalem cross periodic structure is projected as an efficient interpretation for reducing mutual coupling in a two-element microstrip array antenna. It is simulated and fabricated to apply the desired periodic structure on the substrate between the patches. The outcomes of simulations are similar to the results of experiments. The outcome of mutual coupling is compact as a outcome of this method, according to the results

Keywords: Microstrip array antenna, EBG Mutual coupling, Jerusalem Cross periodic Structure

I. INTRODUCTION

Mutual coupling occurs when antenna elements in an antenna array communicate electromagnetically. Mutual coupling manifests itself in various ways in transmitting and receiving antenna arrays by accident and thus must be handled accordingly. If the element spacing is minimal, the effect of mutual coupling is serious. It will have a significant impact on the antenna array in the following ways 1. Adjust the radiation pattern of array 2. Modify the collection in a manifold (the received element voltages) 3. Alter the antenna elements' identical characteristics (change the input impedances) [1].

In the design of microstrip arrays, mutual coupling among elements is an important consideration.. Mutual coupling between elements has been shown in a number of studies to reduce array performance, resulting in impedance disparity, side-lobe near rises, perusing sightlessness, and loss. [1] Space and surface waves also trigger mutual coupling between microstrip components. A surface wave has a significant effect on mutual coupling when the microstrip substrate width is larger than 0.30/ (2p/p1r), where o is the effective wavelength in free space and r is the relative permittivity of the substrate. Many methods for reducing mutual coupling between antenna elements caused by surface waves have been established over the years in the design of microstrip arrays. To prevent surface wave mode excitation, shorted patches were suggested. [3–4]. In [5–6], Mutual coupling was suppressed using electromagnetic bandgap (EBG) structures. To suppress surface-wave propagation, an EBG structure produces an electromagnetic crystal, which reduces unnecessary mutual coupling between components. Defected ground structures (DGS), which are created by engraving designs on the ground plane, have gotten a lot of press recently. The DGS has a small footprint as a resonator. As a significance of this benefit, Microwave filters and corresponding circuits, as well as removing harmonic and cross divergence in microstrip antennas, are only a few of the applications. [7–8] However, only a few papers have been written on the subject of suppressing mutual coupling among antenna array components. [9]

Several approaches to reducing mutual coupling between antennas have been suggested by researchers. They discovered that disorienting the antennas is an efficient way to improve isolation. [10]. Lossy materials have also been used to minimize the radar cross-section of structures like airplanes and antennas by suppressing surface currents generated on conducting bodies. [11], Patches on a high dielectric substrate, on the other hand, have a very small bandwidth. To minimize mutual coupling between antennas, parasitic elements such as metallic walls have been used. [12].

II. PERIODIC STRUCTURE GEOMETRY OF THE JERUSALEM CROSS PROPOSED

In this work, to reduce the mutual coupling of microstrip antenna arrays, a Jerusalem cross periodic structure is projected. In the substrate and between the patches, the suggested periodic structure was used. The presented simulation results were obtained using the AnsoftHFSS, which is based on finite elements (HFSS). In the X and Y directions, the parametric analysis is presented on the length, width, and Jerusalem cross spacing. The simulation and investigational results of the projected antenna and the position antenna indicate that the Jerusalem cross has strong application potential for reducing mutual coupling. .

III. JERUSALEM CROSS PERIODIC STRUCTURE

The Jerusalem cross periodic structure is used in this article, which is shown as a unit cell in Fig. 1 and the array antenna loading by three rows of Jerusalem cross periodic structure in Fig. 2. Cross periodic structure

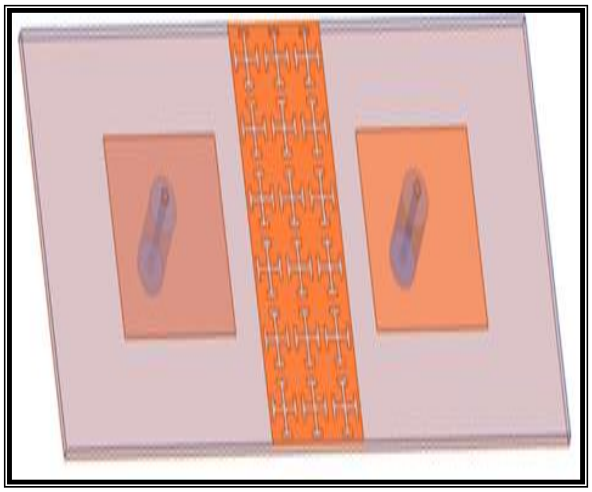

Figure 2. Antenna array for three rows of the Jerusalem

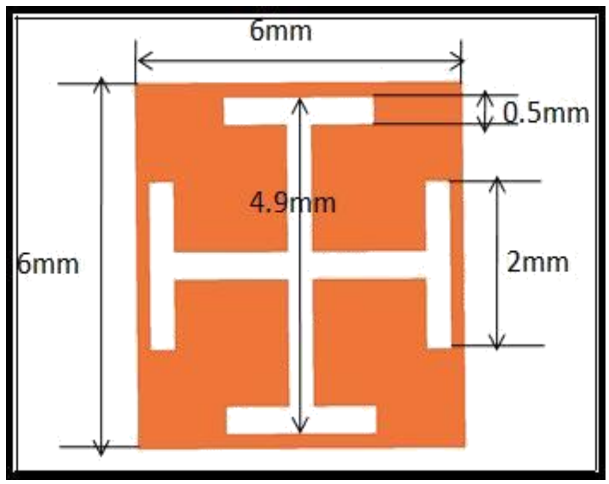

Figure 1. A Jerusalem Cross periodic structure unit cell

IV. GEOMETRY OF THE ARRAY ANTENNA

A microstrip array antenna is made up of an r substrate and two patch components with a 28mm spacing between them.. The substrate's dimensions and relative permittivity, r, are 100mm36mm and 100mm36mm, respectively.. Fig. 3. illustrates In the simulation, the array antenna structure was used. The patches in this paper are L=22mm and W=17.2mm in length and width, and the antenna resonates at 5GHz.

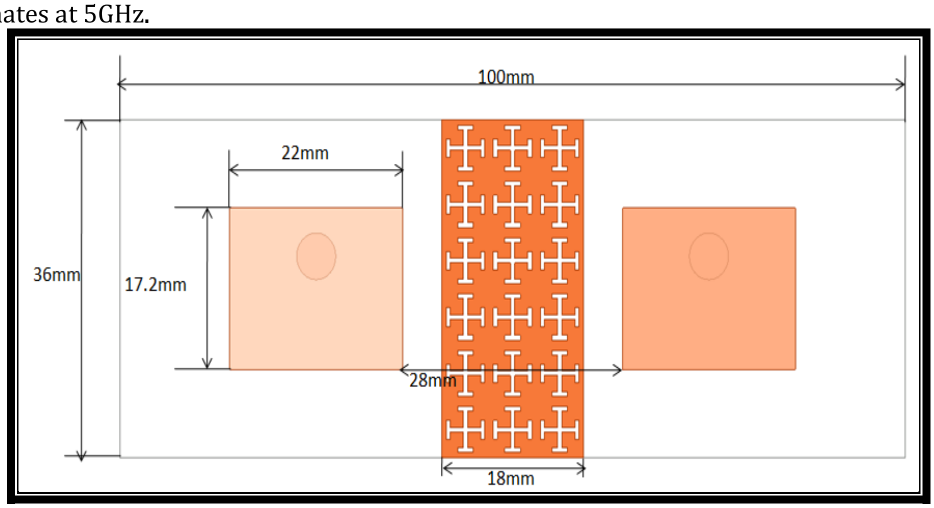

Figure 3: Top view of a microstrip antenna patch with two paired microstrip antennas.

V. RESULTS AND DISCUSSION

The S21 Vs Frequency with and without FSS slot values of -20.1315dB and -29.6077dB are plotted in the graph bellow Figure 4. for S21 Vs Frequency with and without FSS slot... By putting the JCS slot between the two array antenna components, the mutual coupling is reduced.

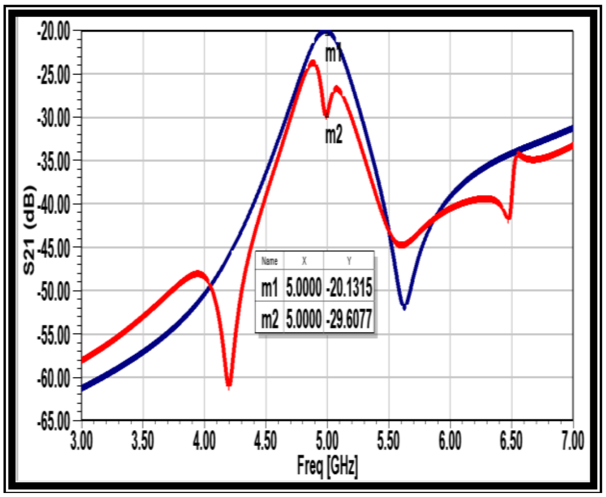

Figure 4: Comparison of S21 Vs frequency with and without FSS

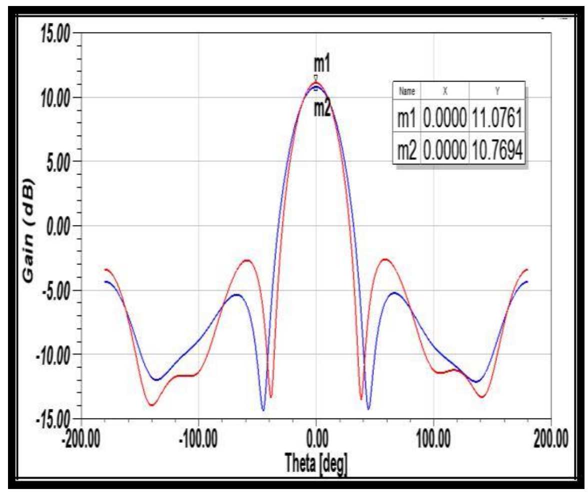

Figure 5: Assessment of Gain Vs theta with and without FSS

The value found without FSS slot 10.7694dB and with FSS slot 11.0761dB is plotted in the graph for Gain Vs Frequency with and without FSS. By 0.3067 decibels, the gain has improved.

Figure 6: Plot of VSWR without FSS

Figure 7: Plot of VSWR with FSS

The common connection among the array's antenna elements decreased from experimental results of -21.898 to -37.931 as shown in figures 6 and 7. This comparison showed that the Jerusalem cross periodic structure's unique capability reduces common connexion among array antenna components.

Table 1: A comparison of the MSPAA optimized for Mutual Coupling's simulated and calculated performance

The outcome of a simulation	Effect that can be measured
-20.1315dB to-29.0677dB	**-21.898dB to -37.913dB**

CONCLUSION

According to replication and measurement results, the outcome of mutual connection in an array is compact using JCPS as considered.

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