0.1 Conclusion and Future Work

0.1.1 Summary

The goal of this dissertation was to design, fabricate and develop state-of-the-art, high-performance dual-polarized antenna arrays which possess low cross-polarization and high input isolation for MPAR application. Different feeding techniques have been discussed and implemented to design several high-performance antenna arrays. First, a brief overview of the evolution of microstrip patch antennas and some of the topologies for realizing dual-polarized microstrip patch antennas are presented in Chapter 2.

In chapter 2, different high-performance microstrip patch antennas for MPAR application have been proposed. In the first design, two none-overlapping, T-shaped transmission lines have been implemented to excited two H-shaped slots. In the second design, a hybrid patch antenna has been designed to improve the geometrical and radiation symmetry of the antenna. The vertical polarization is excited by a pair of 180° out-of-phase currents to attain a low cross-polarization level along beam axis, and horizontal polarization is excite through H-shaped slot in the middle of the ground plane. In the second hybrid feed design to decrease the antenna fabrication complexity and improve the mechanical stability, the balanced prob-feeding technique in the second design has been replaced with balanced aperture coupling method.

In chapter 3, the issues and changes associated with implementing an image feed method in the large antenna array are discussed. It is shown that decomposing the antenna radiation pattern to its even and odd components, for calculating the configured arrays radiation pattern has some fundamental shortcoming. In this chapter, a proper procedure has been proposed for predicting array sidelobe level and reducing its minimum possible level.

In chapter 4, the proposed high-performance single elements for MPAR application in chapter 2 are characterized in the array configuration while the elements are arranged according to the image configuration. Based on the measured results, an input isolation of better than 51 dB and cross-polarization level of better than -45 dB in the main beam area while scanning up to 45 degrees are achieved.

Finally, in chapter 5, conformal array antennas radiation characteristics have been discussed. In this chapter, a 19-element dual-polarized frequency scanning aperture coupled microstrip patch antenna is designed, fabricated, and the simulation and measurement results are presented. The horizontal and vertical beam pointing mismatch issue has been resolved by length optimization of the feed lines. The horizontal and vertical polarization radiation pattern of a single column and three column measurement are presented. Measured results show that the beam pointing angle mismatch for single column measurement is below 0.2° in the entire frequency band and for three-column measurement is below 0.2° from 2.75 to 2.87 GHz.

0.1.2 Contributions

1. Improvement and fabrication of a 19-element dual polarized frequency scanning aperture coupled microstrip patch antenna with less than 0.2° beam pointing angle mismatch from 2.75 to 2.87 GHz and input isolation of better than 40 dB for CPPAR demonstrator.

2. Design and fabrication of a planar array of dual polarized none-overlapping aperture coupled patch antenna with a very high

input isolation and low cross-polarization radiation pattern.

3. Design and fabrication of a high-performance hybrid dual-polarized antenna array excited by aperture coupling and differential probe-fed methods.

4. Design and fabrication a low-fabrication complexity, dual-polarized hybrid-fed microstrip patch antenna excited by balanced aperture coupling and single symmetric aperture coupling methods.

5. Characterization of the issues and changes of using image configuration for cross-polarization suppression in the large phased array antennas and proposing an accurate procedure for predicting and mitigating the sidelobes.

0.1.3 Future Work

The works presented in this dissertation can be expanded in the area of the array final geometry. Multifaceted CPPAR can be an alternative approach for future multifunction phased array radar. In the multifaceted radar approach, the final array geometry will be a polygon. Compared to the four-faced planar array, there are more than four facets that cover 360°. A multifaceted phased array radar has the advantage of low-cost fabrication, similar to planar arrays, and its electromagnetic characteristics are similar to cylindrical polarimetric phased array radar. The future research plans should determine the minimum number of facets, and a maximum number of columns per facet, so the multifaceted radar can satisfy the MPAR requirements. Multifaceted phased array radar approach antenna is a trade-off between performance and fabrication cost. The output of this research will be the optimized geometry for the performance and fabrication cost of future MPAR.