CHAPTER 5

CONCLUSION

This thesis is the result of the desire to achieve compactness, and enhance the performance of a microstrip antenna array, with Electromagnetic BandGap structures and the Frequency Selective Surface. The research extends to improve the bandwidth and directivity. The overall size of the microstrip antenna array has been attained through the placement of EBG structures near the feedline of the single antenna and the microstrip antenna array, compared to the conventional placing of the EBG structures. Additionally, the placing of the FSS in an aperture coupled microstrip antenna array has improved the performance. With this singular goal in focus, the author of this work has designed a microstrip antenna array with two different feed methods, ie., the inset feed and aperture coupled. Both the proposed microstrip antenna arrays have been designed with a single element, two elements and four elements. A set of geometries of the EBG structures (mushroom-like, fork-like, dual band compact and slotted meander line structure) has been investigated for the performance of the antenna designs. The impedance bandwidth has been investigated for several different microstrip antenna arrays. The simulated results of the antenna array with EBG structures show good agreement with the measured results. The proposed antenna array has been designed to operate at single and dual band of frequencies, of 4.8 GHz, 3.12 GHz and 4.8 GHz for the wireless local area network. The improved performance of the microstrip antenna array with EBG structures is obtained for the return loss, directivity, VSWR, bandwidth
and radiation pattern. From the results obtained, it is clear that the EBGs structure has the ability to suppress surface waves and broadside radiation power. To validate the proposed concept, the measured results are presented and the following conclusions are arrived at.

i) The fractional bandwidth and directivity of the single microstrip antenna designed to operate at the single frequency of 4.8 GHz, is observed to be 3.32 % and 5.3 dBi.

ii) The fractional bandwidth of the two element microstrip antenna array designed to operate at a frequency of 4.8 GHz, is observed to be 4.57 % and 13.11 dBi.

iii) The VSWR of the inset fed-microstrip antenna of single and two elements are observed to be 1.8 and 1.3.

iv) The reduction in the antenna area for the single, two and four element microstrip antenna with mushroom-like EBG structure is 18 %, 32 % and 44 %.

v) The mutual coupling between the elements of the microstrip antenna array with mushroom-like EBG structures at the feedline is observed to be 33.5 dB with a size reduction of 38 %.

vi) The mutual coupling and the inter element spacing in the microstrip antenna array, with the slotted meander line structure in between the antenna elements are observed to be -35 dB and 0.1 λ0.
vii) The fractional bandwidth of the dual band-polarised two element microstrip antenna array, designed to operate at 3.12 GHz and 4.8 GHz, is observed to be 5.81 % and 3.85 %.

viii) The VSWR and directivity of the dual band-polarized microstrip antenna array are observed to be 1.3 and 11.2 dBi.

ix) The VSWR and directivity of the dual band-dual polarized, microstrip antenna array are observed to be 1.1 and 12.5 dBi.

x) The fractional band width of the aperture coupled single element microstrip antenna, designed to operate at 3.12 GHz and 4.8 GHz, is observed to be 5.6 % and 5 %.

xi) The fractional band width of the aperture coupled two element microstrip antenna is designed to operate at 3.12 GHz and 4.8 GHz, is observed to be 4.1 % and 3 %.

xii) The fractional band width of aperture coupled four element microstrip antenna designed to operate at 3.12 GHz and 4.8 GHz is observed to be 5.3 % and 3.4 %.

xiii) The directivity values of the aperture coupled single, two and four element microstrip antenna designs, are 8 dBi, 11.2 dBi and 15.1 dBi.

xiv) The VSWR of the aperture coupled microstrip antenna with single, two and four elements is observed to be 1.4, 1.2 and 1.3.

xv) The reduction in the mutual coupling between the radiating elements with the FSS, is observed to be 19.6 dBi.
The analytical investigations carried out, reveal the following.

i) The reflection characteristics of the EBG are not sufficient to evaluate the EBG performance, when it is used as an antenna ground plane. Hence, the dispersion equation for the mushroom-like EBG is obtained using the TLM based code.

ii) The dispersion equation and dispersion diagram for the mushroom-like and fork-like EBG structures are obtained theoretically, using the Multiconductor Transmission Line (MTL) theory, which is illustrated through extensive simulation and measurement results. From the diagram, the passbands and stopbands are obtained.

iii) The mutual coupling effects between the radiating patches are theoretically verified, using the equivalent circuit model of the microstrip antenna array. The investigation of the mutual coupling between antenna array elements is done, using EBG structures and the FSS layer. The capacitance effects are considered for the calculation of the mutual coupling investigation, which is illustrated through the simulation and measurement results.

More stable results are obtained, when EBG structures with the microstrip antenna and antenna array are used. Thus, we demonstrate that EBG structures are a better solution for the design of inset fed microstrip antenna arrays, characterised by a low profile, wide band and highly directive. Also FSSs are incorporated as a superstrate layer for the design of the aperture coupled microstrip antenna array, characterised by a simple, wide band and high directive. The present thesis is the outcome of the experimental, simulated and theoretical investigations carried out on a
compact and performance enhanced microstrip antenna array, using electromagnetic bandgap structures and a frequency selective surface.

5.1 SCOPE FOR FUTURE WORK

As a future work, it would be interesting to investigate the other examples of EBG structures and their applications. The analytical formulation introduced here can be extended for the case of the microstrip antenna array, embedded in a multilayered artificial dielectric structure. For further performance enhancement, waveguide feed networks could be utilized, to substantially lower the feed loss and improve the efficiency of large arrays. Stacking more patches could also be employed, to further widen the operating bandwidth. Human errors during the fabrication process are the major cause of the discrepancies between simulated and measured results. Hence, some developments have to be carried out to make the fabrication process easier to handle. Besides that, a few prototypes should be fabricated in order to obtain good results in measurement. Therefore, wide knowledge and experience are required.