OPTIMIZATION OF THE PERFORMANCE OF MICROSTRIP PATCH ANTENNAS AND ARRAYS BY USING GENETIC ALGORITHMS

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Ph.D. Thesis

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Peradeniya, Sri Lanka 2014

This thesis has been submitted to the University of Peradeniya as a partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Abstract

Microstrip patch antennas (MPAs) are increasingly being used in the areas of cellular radio systems and short range radio links such as Bluetooth and wireless local area network (WLAN). These antennas can be mounted easily on hot-spots, lap-tops, mobile phones etc. due to their low volume, light weight, simple planar configuration and integrability with other electronic components. With the rapid development in the wireless communication systems, demand for broadband/multiband and high-directivity MPAs are on the increase to provide more services for multiple users. However, conventional MPAs have some disadvantages such as narrow bandwidth, low efficiency and low gain. Hence, performance improvement of MPAs has been an interesting challenge for the antenna research community. Numerous techniques such as stacking patches, suspending patch on air, shorting the patch to ground, inserting slots and slits in the patch and/ or ground plane and optimization have been used separately or in combinations by researchers to overcome the limitations of MPAs.

This thesis presents the use of genetic algorithm (GA) optimization with some of the aforementioned techniques (modified patch, air gaps and shorting) for performance improvement of MPAs. The patch geometry, shorting and feed positions, substrate material and thickness have been optimized for achieving the broadband/multiband properties, high directivities and compactness. The full potential of combined use of GA with performance enhancing techniques for MPA design has been exploited in the thesis while providing an analysis of the effects of patch geometry, substrate thickness, its permittivity, air gaps and shorting pins on the overall performance. Numerous novel broadband, multiband, miniature and high-directivity MPAs for various wireless communication applications have been designed. The proposed single element high-directivity MPAs exhibit comparable directivities with square element patch arrays of the same physical area.

Simulations have been carried out in the HFSS environment integrating a home-made Visual Basic (VB) code to perform GA operations. This home-made code has been developed within the frame of the present thesis. Performance of fabricated samples has been assessed by measuring the resonant behaviour, radiation characteristics and efficiency to validate the results. Further, a novel method of using overlapping cells for coding the patch geometry in the GA optimization procedure has been introduced.