Null Synthesis and Implementation of Cylindrical Microstrip Patch Arrays

by

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As the wireless communications networks expand, the number of both unwanted directional interferences and strong nearby sources increase, which degrade system performance. The signal-to-interference ratio (SIR) can be improved by using multiple nulls in the directions of the interferences while maintaining omnidirectional coverage in the direction of the network users. For the communication system considered, the interferences are static and their spatial positions are known. A non-adaptive antenna array is needed to provide spatial filtering in a static wireless environment. Omnidirectional arrays, such as cylindrical arrays, are the most suitable to provide the omnidirectional coverage and are capable of suppressing interferences when nulls are inserted in the radiation pattern.

In this thesis, a cylindrical microstrip patch antenna array is investigated as an antenna to provide an omnidirectional radiation pattern with nulls at specified angular locations to suppress interference from directional sources. Three null synthesis methods are described and used to provide the omnidirectional array pattern with nulls using the radiation characteristics of the cylindrical microstrip patch antenna elements. The orthogonal projection method is extended to incorporate the directive radiation patterns of the cylindrical microstrip patch elements. Using this method, an optimal pattern that minimises the squared pattern error with respect to the ideal pattern is obtained. Instead of only minimising the array pattern error, a multi-objective optimisation approach is also followed. The objective weighting method is applied in null pattern synthesis to improve the amplitude pattern characteristics of the cylindrical patch arrays. As a third null synthesis technique, a constraint optimisation method is applied to obtain a constrained pattern with the desired amplitude pattern characteristics. The influence of the array attributes on the characteristics of the amplitude patterns obtained from the null synthesis methods, is also studied.

In addition, the implementation of the cylindrical microstrip patch array is investigated. The influence of the mutual coupling on the characteristics of the null patterns of the cylindrical patch arrays is investigated utilising simulations and measurements. A mutual coupling compensation technique is used to provide matched and equal driving impedances for all the patch antenna elements given a required set of excitations. Test cases in which this technique is used, are discussed and the consequent improvements in the bandwidth and reflection coefficient of a linear patch arrays are shown. The characteristics of the resulting null pattern for the cylindrical microstrip patch array is also improved using the compensation technique.

Keywords: antenna, microstrip, array, cylindrical, null, synthesis, orthogonal, projection, coupling, compensation.

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