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Using Convex Optimization to Compensate for Radome Effects in Monopulse Arrays

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The quality of array antennas in airborne monopulse systems can be significantly reduced by the radome. A method for determining the radome-induced pointing error is presented in [1]. In addition to causing pointing-error, the radome also increases the side-lobe level. In this paper, we present a method to suppress the side-lobe level by compensating for the radome. A convex optimization method is presented to determine optimal excitation coefficients with respect to the radome. The method is based on [2], which has been modified for monopulse arrays with common excitation coefficients. This optimization method enables the optimal trade-off to be determined for simultaneously small side-lobes in both sum and difference patterns. The radome compensation is achieved by using installed element patterns instead of the array factor in the optimization. Simulation results for a BoR array with 48 elements and an extended hemispherical radome are presented. It is demonstrated that introducing the radome increases the side-lobe level from -20.0 dB to -17.5 dB. By taking the radome effects into account in the optimization, it is demonstrated that a side-lobe level of -20.1 dB can be achieved. This demonstrates that it is possible to compensate for the negative effects caused by radomes by modifying the array excitation. Using this optimization method, we can determine the best possible performance for any given radome design. This approach also results in an increased gain, particularly at large scan angles. Furthermore, the presented approach allows the monopulse slope to be indirectly specified as a design parameter. It is shown that the trade-off between the monopulse slope coefficient and the side-lobe level is approximately linear. Finally, we discuss the applicability of this method for ultra-wideband monopulse arrays, as used for airborne electronic support measures (ESM).

References

[1] H. Frid and B. L. G. Jonsson, “Determining installation errors for doa estimation with four-quadrant monopulse arrays by using installed element patterns,” in *2nd URSI Atlantic Radio Science Meeting (AT-RASC)*, 2018.

[2] H. Lebret and S. Boyd, “Antenna array pattern synthesis via convex optimization,” *IEEE transactions on signal processing*, vol. 45, no. 3, pp. 526–532, 1997.