Multi-Objective Optimization of Slot Array Antennas Using Full Wave Moment Method Analysis

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Waveguide-fed slot array antennas have been employed in numerous ground and space based systems. Design and analysis techniques developed for such antennas are applicable to slot arrays in substrate integrated waveguides which are finding applications at millimeter wave frequencies and beyond. Slot array designs are generally based on Elliott's equations and variations thereof. Elliott's design procedure enforces the specified aperture distribution of the array elements and an impedance match at the input port at a single design frequency, generally at the center of the frequency band. Elliott's equations are not suitable for design optimizations or multi-objective designs. Previously we have used the moment method solution to the aperture electric field of all slots in a planar array in not only assessing the performance of the array but also for improving its design.

Recently we reported the results of an investigation involving genetic algorithm optimization of a planar slot array using the moment method analysis (S. R. Rengarajan, RF and Microwave Computer Aided Engineering, 2013). The directivity and return loss were optimized over 5% frequency band. In this paper we demonstrate multi-objective optimization of a slot array using the genetic algorithm. In particular, for a planar array consisting of four quadrants, the sum pattern, and the azimuth and elevation difference pattern are all optimized. This is a challenging problem since the mutual coupling environment for each of the three patterns is different. A previous work employed an averaging technique to design such an array, thereby making a significant compromise on the performance (J. H. Schaffner, D. Kim, and R. S. Elliott, Alta Frequenza, pp. 312-319, Nov. 1981). A novel technique to reduce the computation time used only one entire domain basis function for each slot aperture in the moment method. Subsequently an accurate equivalent solution corresponding to many basis functions was obtained. Numerical solutions validating our theory as well as optimum designs will be presented in the symposium.