Comparison of Multi-Objective Optimization Methods for Large-N Antenna Arrays

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Modern optimization techniques are well suited for finding solutions based on one criterion; however, many design problems require the optimization of multiple parameters. Often, a composite fitness function is created for use in the optimization by simply setting the fitness function's value equal to a weighted sum of several parameters. However, the weighted sum is a very crude way of finding optimal results, limiting results to a very narrow portion of the solution space. Ideally, when faced with optimization problems of more than one parameter, engineers would like to compare the solutions which lie upon the Pareto front (i.e. the set of all non-dominated solutions). To find the Pareto front, a class of multi-objective optimization methods have been developed which determine a global fitness based on their dominance over or proximity to other members of the population.

It has been shown that there are advantages to using antenna array layouts that possess both fractal and random properties (Y. Kim and D.L. Jaggard, *Proc IEEE.*, **74** (9), 1278-1280, 1986). One class of such arrays, called polyfractal arrays (J.S. Petko and D.H. Werner, *IEEE Trans. Antennas and Propagation*, **53** (11), 3604-3615, 2005), have been shown to be well adept for use in genetic algorithm optimizations. Polyfractal arrays possess a compact chromosome structure and recursive beamforming properties, making them also ideal for large scale optimizations. In this paper we evaluate the effectiveness of several multi-objective optimization algorithms (N. Srinivas and K. Deb, *Evolutionary Computation*, **2** (3), 221-248; E. Zitzler and L. Thiele, *IEEE Trans. on Evolutionary Computation*, **3** (4), 257-271, 1999) when they are applied to polyfractal array design problems. Polyfractal arrays are used in two distinct types of multi-objective optimizations: planar array beamforming and linear array bandwidth optimization. This paper shows that one can find optimal large-N array layouts by combining multi-objective optimizations with polyfractal array geometries.