OPTIMIZATION OF WIRELESS ARRAYS WITH ARBITRARILY LOCATED ELEMENTS

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We are investigating the potential of using arbitrarily placed wireless transceivers to increase the probability of maintaining a communication link in an electrically harsh environment. Specifically, we examine the performance of a well-known matrix-based array optimization technique applied to the case when the antenna elements exist in a complex environment and the observation point is not in the far-field of the array. Study of array performance in a non-ideal setting represents an important step in determining the feasibility of using this optimization technique for *ad hoc* wireless arrays within a building.

Array directivity or gain optimization techniques based on the general eigenvalue equation and Hermitian matrices are well covered in past literature, (e.g., É. I. Krupitskii, *Sov. Phys. Dokl.*, **7**, 257-259, 1962; R. F. Harrington, *IEEE Trans. Ant. Prop.*, **13**, 896-903, 1965; and D. K. Cheng, et al., *IEEE Trans. Ant. Prop.*, **13**, 973-974, 1965), as well as in a more recent publication (T. S. Angell et al., *Optimization Methods in Electromagnetic Radiation*, Springer, 2004). However, we apply the optimization technique differently from the typical approach in three key ways. First, the observation point, or the desired point of optimum radiation is now located within the volume of the array (which requires the use of a slightly modified expression for "gain" or "directivity" as a performance index). Second, we examine the statistical behavior of the optimized performance, e.g., average gain, by optimizing 200 sets of random element and observation point locations. Third, the effects of some simple boundary surfaces are included through the use of Green's functions and first order impedance boundary conditions. This last item relates to work on arrays in arbitrary environments (S. P. Morgan, *Bell Syst. Tech. J.*, **44**, 23-47, 1965).

Simulation results for the directivity or gain of the array in the presence of several boundary configurations will be presented. These boundary scenarios include both perfect electric conductor (PEC) and approximated building surfaces for horizontal and vertical ground planes to model array performance in the presence of a building floor or wall. Array performance with a corner reflector boundary created from the intersection of horizontal and vertical surfaces is also simulated to examine corner impacts. Finally, we present results for an array between two parallel PECs to study the impacts of resonance on the optimized directivity. Our directivity results for arrays in free space are comparable to previously published results on arrays optimized for far-field radiation. In addition, our results indicate on average that the optimized directivity or gain with simple boundaries is within 3dB of that for the optimized configuration in free space.