A Revisit of Random Arrays and Some Recent Applications

Hao Ling*
Department of Electrical and Computer Engineering
The University of Texas at Austin
Austin, TX 78712-1084

and

Yuanxun Wang
Electrical Engineering Department
University of California at Los Angeles
Los Angeles, CA 90095

It is well known that to design antenna arrays with uniformly spaced elements, the element spacing must be kept below half a wavelength to avoid the appearance of grating lobes. In his pioneering work nearly four decades ago, "A Mathematical Theory of Antenna Arrays with Randomly Spaced Elements" (*IEEE Trans. Antennas Propagat.*, **15**, 257-268, 1964), Professor Yuen-Tze Lo showed that a highly thinned array with an average spacing much greater than half a wavelength could achieve the same beamwidth performance as that of a uniformly spaced array while overcoming the grating lobe problem. It was also shown explicitly that the price for a large reduction in the number of elements is the sidelobe level of the array.

In this paper, we discuss several recent applications of the concept of random arrays, or more generally, non-uniformly sampled functions, to problems related to antennas, computational electromagnetics and radar imaging. First, the random array idea is applied to ultra-wideband aperture design. It is shown that by using a multi-frequency, random aperture, it is possible to achieve constant beamwidth over a very wide bandwidth. Design studies using quasi-random apertures involving identical random subarrays are also considered.

Second, the non-uniform sampling idea in random arrays is applied to accurately interpolate coarsely computed electromagnetic prediction data in frequency and aspect. In order to overcome the high sidelobes produced by the coarse, random sampling, a CLEAN-based iterative technique is applied to achieve an accurate and sparse parameterization. Results are demonstrated using the computation data from the fast multipole computer code FISC.

Finally, the concept of non-uniform sampling is applied to the problem of radar image formation from measurement data. It is shown that radar data from a maneuvering target resemble the random array problem in the target pose dimension with respect to the radar. By using the iterative CLEAN-based technique, it is shown that two- and three-dimensional images of targets can be successfully constructed.