PHASELESS PLANAR NEAR-FIELD ANTENNA MEASUREMENTS: RECENT PROGRESS AND DEVLOPMENTS

Yahya Rahmat-Samii
Department of Electrical Engineering
University of California, Los Angeles
Los Angeles, CA 90095-1594, U.S.A.
Tel: 310 206 3847, Fax: 310 206 8495, e-mail: rahmat@ee.ucla.edu

Why Using Phaseless Near Field Measurements: The application of phase retrieval techniques for phaseless near-field antenna measurements has enjoyed much progress in recent years. These techniques have, in fact, sufficiently matured so that accurate antenna measurements can be performed when the phase information is either unavailable or inaccurate. The excessive cost of vector measurement equipment, high frequency measurements, and "in-the-field" measurements are examples of applications in which phase retrieval methods may be attractive. This presentation provides a comparative evaluation of conventional (amplitude and phase) and phaseless (amplitude only) planar near-field measurements for non-ideal measuring probe locations. It will be demonstrated that the presented phase retrieval algorithm can more accurately reproduce the true pattern of the antenna under test (AUT) because of the diminished sensitivity of the amplitude of the near-field, as compared to the phase, with respect to the measuring probe locations. Although methods for correcting probe position errors exist for conventional planar near-field measurements, they are best suited for small errors and, more importantly, require knowledge of the precise locations at which the measurements were obtained. A phase retrieval approach, on the other hand, requires no knowledge of the actual measurement locations other than the nominal location of the *two* required measurement planes, obviating the need for expensive feedback equipment and should be suitable for even rather large probe position errors, obviating the need for specialized mechanical systems at high frequencies.

Two-Plane Phase Retrieval Algorithm: The phase retrieval algorithm employed in this presentation is based on an iterative Fourier method adapted for use with UCLA's bi-polar planar near-field measurement system (See the figure). The procedural steps required for executing this algorithm are summarized next. The algorithm requires near-field amplitude measurements on *two* planes which are separated by just a few wavelengths. A geometric description of the AUT's aperture plane, commonly referred to as the object or aperture constraint, is also utilized in the reconstruction process. The amplitude data on each measurement plane and the AUT aperture constraint comprise the inputs to the Fourier iteration used for the phase retrieval. The product of the Fourier iteration is the complex near-field distribution on the AUT aperture plane and each of the two measurement planes. The Fourier iteration ensures, assuming successful retrieval of the phase, that the complex field distribution on these three planes are related by the Fourier transform. The computed error metrics on the two measurement planes, at this point, are examined to determine whether iterations should continue. Appropriate stopping criteria include both an absolute error limit and an error convergence limit. If a stopping criterion is met then the retrieved amplitude and phase on the AUT aperture plane and the two measured planes are stored and the iterations terminate. If a stopping criterion is not met then the process is repeated until a stopping criterion is met. This relationship allows the far-field pattern of the AUT to be computed from the complex field distribution on any one of these three planes, using standard planar near-field techniques.

Case Studies: Both simulation and measurement results will be presented to demonstrate the utility of the phaseless measurement technique. As representative examples, an array antenna and a Luneburg lens antenna will be used to perform measurements. Comparison will be made between the antenna patterns generated using the phaseless measurements and the ones obtained applying both the amplitude and phase measurements. Future research directions in applying phaseless measurements will be highlighted.