The Use of Inverse Imaging in Array Design

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The inverse imaging of an array aperture distribution based on the complex computed (or measured) far-field data has proven to be a useful tool for array design, especially when mutual coupling seriously affects the array aperture distribution. This paper describes the use of inverse imaging as a means of feedback in the design of a corporate fed planar 2D array of conformal elements (e.g., patches or slots) for 35 GHz. The presentation will describe the difficulties that lead to the use of inverse imaging, and imaged results allowing the final design to more closely match the target distribution are presented.

Most array designs proceed with little regard for mutual coupling. Coupling between radiating elements (.5 to .7 wavelength spacings) is usually not a problem and coupling between the radiating apertures and the corporate feed circuit is considered negligible. This means that selection of the radiating element type, feed type, and substrate parameters associated with conformal elements (e.g., patches or slots) can usually be made based on previously published results and the design simply verified (and fine tuned) using an available 2-1/2 D simulation. In these same cases, the corporate feed design providing the required amplitude and phase distribution can be done separately using the same simulation package. However, things are not so simple when designing a large, 2D, conformal element array with integrated microstrip corporate feed at 35 GHz (wavelength ~8 mm). Here, problems arise with just about every aspect of the design and the back-of-the-envelope design that usually needs only verification and fine tuning no longer works because the tight "packing factor" for the feed circuit quickly leads to unintended mutual coupling between all parts of the layout. As a result, the intuitive relationship between feed circuit parameters and the array amplitude and phase taper is obscured, if not lost all together. This doesn't mean that an adequate design cannot be found. It just means that the designer must compensate for the mutual coupling. However, since radiating elements are not represented as "ports" of the scattering matrix in most 2-1/2 D simulation software, meaningful output representing the true aperture distribution is not available. Hence, the design process becomes strictly trial and error with the only feed back being the computed far-field radiation pattern.

The inverse imaging approach presented here provides the necessary connection between the adjustable feed network parameters and the true aperture distribution in the presence of disruptive mutual coupling between circuit and radiation components.