Antenna Array Fault Identification Using an "Exact" Discrete Inverse Method

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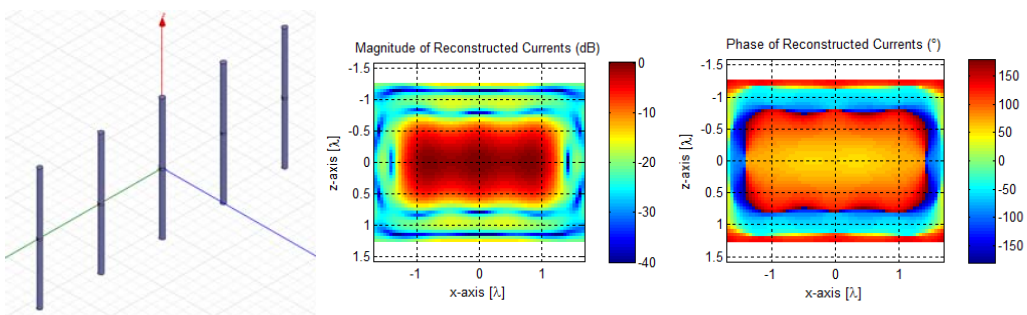
Applications of inverse source reconstruction can be found in many areas, such as electromagnetics, medical imaging, and remote sensing. Here, the "Exact" Discrete Inverse Method (EDIM) initially proposed by W. R. Stone and recently presented at the North American Radio Science Meeting in Ottawa, Canada, will be applied to antenna arrays and reflectors in order to obtain the equivalent current distribution and to possibly identify faulty array elements or reflector-surface imperfections. The effects of data noise on the current reconstruction will also be presented.

Measurements and the commercial software package *HFSS* are used to produce radiation-pattern data for a given antenna system. The complex radiated electric field is sampled over a sphere surrounding the radiator for both the phi and theta components of the field. Using this data, equivalent currents are reconstructed through matrix inversion using the Conjugate Gradient on Normal Equations (CGNR) algorithm. The results are presented as the magnitude and phase over a two-dimensional aperture. In the case of a reflector system, a discrete equivalent-source holographic image is formed. The use of this method to identify reflector-surface imperfections is demonstrated. This method could potentially be used as a diagnostic method in anechoic chambers. In this case, one knows what excitation (i.e. magnitude and phase) over the array is needed, and this is compared to what is actually produced. The performance of this method is evaluated under different signal-to-noise conditions. Also, measured data for a simple array is presented.

Figure 1 shows an example in which the radiation-pattern data for five half-wavelength dipoles, separated a half-wavelength apart, was obtained using *HFSS*. The complex electric field data was sampled every two degrees around a 30-foot radius sphere surrounding the radiators. This noiseless data was subsequently fed to the EDIM algorithm, from which both the magnitude and phase where recovered.



(a) (b) (c)

Fig. 1: Problem Geometry (a). Recovered Current Magnitude (b) and Phase (c).