A Self Calibration Technique for a DOA Array with Near Zone Scatterers

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This paper will present an iterative self calibration technique for a Direction of Arrival (DOA) array to automatically remove the effects of mutual coupling and near-zone resonant size scatterers whose locations are known, but whose geometries are unknowns. The array geometry, and thus its method of moments (MM) [Z] matrix, are assumed to be known. The method is applicable to the case where there may be several incident waves of unknown amplitude and DOA, and several near zone scatterers. The method requires the array to determine the coefficients in a spherical harmonic expansion of the scattered fields as well as the DOAs. Harmonic expansions are known to be efficient in representing the fields of resonant size scatterers, and have the advantage that the scatterer geometry need not be known.

The key concept is to use some of the degrees of the freedom of the array to determine and remove the effects of the scatterers, and others to determine the DOAs. Approximately $(\beta R+1)^2$ spherical harmonics are required to represent a scatterer which will fit into a sphere of radius R at a frequency with wavenumber β. Thus, a single $R = \lambda$ scatterer would require more than 64 degrees of freedom, i.e., array elements. Two avoid the necessity for this impractically large number of array elements, we have developed an iterative procedure in which the spherical harmonic coefficients are found two at a time.

For simplicity, previous DOA calibration techniques have often assumed that the shape of the current is identical on all array elements. Typically, this shape is evaluated as the current on an isolated element illuminated by a broadside wave. However, the true shape of the current will be different on each array element, and will be dependent upon mutual coupling, the unknown size, shape and location of the near zone scatterers, and the unknown magnitudes and DOAs of the incident plane waves. Here, in the iterative solution to find the spherical harmonic coefficients and the DOAs, we employ the MM to determine the true shape of the array currents.

Numerical results will be presented for a uniform linear array of dipoles, and will illustrate the ability of the method to determine the array DOAs starting from the assumed known (i.e., measured) terminal voltages or currents.