A Self Calibration Technique for a DOA Array of Unknown Geometry

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This paper will present a self calibration technique for a Direction of Arrival (DOA) array to automatically remove the effects of mutual coupling. For the uniform linear array (ULA), it is assumed that we only know the number of array elements, Q, and the element spacing. We do not know the element geometry, element far zone patterns including polarization, and mutual coupling. It is assumed that we do know the length Q vector of terminal currents, i, when the array is illuminated by an unknown number, J, of incident plane waves of unknown DOAs and complex amplitude and polarization. The problem is to determine the complex amplitude and DOAs of the J incident waves, with the effects of mutual coupling removed. The method is not able to determine the polarization of the incident waves. The approach is to use the degrees of freedom of the array to determine the array method of moments impedance matrix as well as the DOA information.

For simplicity, we assume that the (unknown) *shape* of the current on each array element is identical. This should be a reasonable approximation provided the element spacing is not too small. In this case, in principle we could construct a one mode per element MM solution for the array, i.e., the array terminal current vector is given by the order Q MM matrix equation $[z]i = v$. In a typical MM problem, we know $[z]$ since we know the array geometry, we know v since we know the incident field, and we solve the MM matrix equation for the terminal current vector, i. By contrast, here we have the inverse problem where we are given i, and must solve for $[z]$ and v. Although in general the symmetric $[z]$ matrix will have approximately $Q^2/2$ unknowns, our assumption of identical current shape on the elements, makes $[z]$ Toeplitz, with only Q unknowns. This is further reduced by employing a far zone approximation for the mutual impedance between far spaced elements. Ultimately, we set up a matrix equation to be iteratively solved for $[z]$, as well as the DOA information.

Examples will be presented illustrating the ability of the method to determine the DOAs with the effects of mutual coupling removed. We will also illustrate the ability of the method to determine the Toeplitz [z] matrix and the complex amplitudes of the incident waves, to within a constant.