A MATLAB-based planar array design assistant package with applications to meteor radar systems

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Interferometric techniques are commonly used in all-sky meteor radar systems for meteor location determination. Essentially, interferometric techniques use the phase information recorded from different receiving antennas to estimate the elevation and azimuth of the meteors. Prior efforts have been made to determine an antenna geometry that improves the performance of meteor radar systems. For example, Hocking and Thayaparan (1997) used four antennas typically spaced by 1.5 to 3 wavelengths to locate the meteors. Jones (1992) and Hocking (1997) presented an antenna geometry using a 5 element array with minimum antenna spacing of 2 wavelengths to estimate the direction of arrival (DOA) of the meteors. By spacing the antennas more than 2 wavelength apart, these array geometries were successful in reducing the electromagnetic coupling effect between the antennas, which can introduce errors in the estimation of meteor locations. Without a clear metric for performance it is difficult to compare geometries. In this work, a MATLAB planar antenna array package mainly designed for visualization of the direction of arrival (DOA) estimation performance of arbitrary user designed antenna array is presented. Performance comparisons of nominal array geometries are also provided. Several metrics are available in this package in an effort to provide the user with a comprehensive examination of an array's performance. The metrics are the Cramer-Rao bound (CRB), which is the minimum variance that can be obtained for any unbiased estimator; the co-array, the autocorrelation of the antenna array's aperture function; elevation angle resolution, which is determined by the aperture of the co-array, this parameter is especially interested by the researches who use a meteor radar to observe the horizontal wind field of the upper atmosphere; and beam pattern, which is important when unbiased DOA estimation results are the main concern in designing an array. This software can provide a plot of two-dimensional and three-dimensional beam patterns given user located isotropic radiators. Results will be presented for nominal meteor radar geometries including the cross, T, L and circle geometries.