On the Back Hemisphere Far Fields of an Aperture Antenna

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In assessing the radiation fields of an aperture antenna one often makes use of data sampled over a near-field plane in front of the aperture. The samples are represented as a spectrum of plane waves which is asymptotically evaluated in the far zone. This provides an accurate assessment of the radiation field over an interval of polar angle about the normal to the aperture the extent of which is determined by the proximity of the scan plane to the aperture and its extent. As the extent of the scan plane approaches infinity the range of polar angles for which accurate far fields are obtained approaches the entire front hemisphere, i.e., -90 to +90 degrees. Of course, infinite scan planes are not practically attainable so the angular range of validity is typically significantly less than the full hemisphere. Previous efforts to mitigate this limitation have employed an extrapolation of the fields using the Gerchberg-Papoulis algorithm and these have yielded quite reasonable accuracy over the front hemisphere. [Martini, et al., IEEE Trans. AP-56, 11, 3485-3493, 2008]

In this work, the continuity of free space fields is exploited to extrapolate the fields far beyond the front hemisphere. The finite size of the scan plane is taken into account to obtain accurate front hemisphere far zone fields in and near the aperture plane. Further, the aperture plane fields are used to estimate the fields radiated into the back hemisphere. In this approximation, the currents induced on the back structure of the antenna are neglected. One consequence of this is neglect of the blockage of interfering rays that produce nulls in the back hemisphere pattern. One thus obtains deeper nulls than will actually occur and the field values near the aperture plane in the back hemisphere are less accurate. Nevertheless, with some attention to these details, the overall structure of the back hemisphere pattern can be understood phenomenologically. The characteristics of the results attainable using this approximation are illustrated via comparison of far zone full sphere patterns with corresponding ones obtained via spherical near field measurement.