Analysis of Antenna and Scattering Problems Using a Spectrum of Two-Dimensional Solutions: a Review

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Analysis of nearly cylindrical antennas and scattering problems using a spectrum of two-dimensional solutions (P-S. Kildal, S.R. Rengarajan and A. Moldsvor, IEEE Trans. Antennas Propagat., 44, 1183-1192, 1996) is reviewed in this presentation. Long structures with uniform cross section in geometry and material properties are called nearly cylindrical. When excited by a finite sized (3D) source, if the illumination at the edges is not significant, such a structure may be approximated to a cylindrical structure of infinite length. Fourier transform of source fields as well as the equivalent electric and magnetic currents in the cylindrical structure with respect to the longitudinal or z-direction yields fields in k_z spectral domain, with x and y dependence. It is then possible to determine the equivalent electric and magnetic currents produced in the cylindrical structure due to the source for each k_z spectrum by solving a two-dimensional (2D) problem. In applications requiring the evaluation of the source fields by considering the interaction between the source and the cylindrical structure one needs to evaluate the spatial domain field by performing an inverse Fourier transform of the spectral domain fields. We then solve the 2D problem for discrete values of k_z up to a certain limit. The contribution of the spectral domain fields beyond that limit is evaluated by an asymptote extraction technique. The spectrum of two dimensional solutions (S2DS) has been found to be more efficient with lower computer storage requirement compared to the solution of the original three dimensional problem.

The S2DS technique has been applied to a number of problems in the literature such as the determination of the radiation characteristics and the circuit model of an isolated slot or mutual coupling between slots cut in a rectangular waveguide and radiating between baffles. The slots may be longitudinal or transverse to the broad wall depending on the polarization of interest. Some other structures analyzed by the S2DS technique are slots or patches on circular cylinders of finite length, antennas covered by long cylindrical radome, waveguides with side wall slots, and sources in presence of finite cylinders of composite objects. In the presentation the S2DS technique and some applications in the literature will be reviewed.