

Analysis of Electrical Large Targets with Adaptive Basis Functions

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There has been significant progress made recently in the integral-equation analysis of scattering from complex targets. For example, the multi-level fast multipole algorithm (MLFMA) has been developed to significantly reduce the memory and computation time required of method-of-moments-like solvers. In particular, for N unknowns the MLFMA requires order $N \log N$ memory and CPU. In most problems general basis functions are applied, such as the well-known Rao-Wilton-Glisson (RWG) triangular-patch basis functions. While these basis functions are very general for electrically large targets they often result in a large number of basis functions (and unknowns N). For large targets there are often extended regions of relatively smooth shape, and simpler extended basis functions may be applied. For example, there has been previous work on developing high-frequency localized basis functions, such accounting for physical-optics as well as diffraction-induced currents. Unfortunately these previous studies have required significant a priori knowledge of the properties of these extended basis functions, and therefore this technique has only been applied to simple targets.

We here use the MLFMA with RWG basis functions to compute the currents induced on large targets. We use the RWG up to the highest frequency possible with available computer memory. A signal processing technique, termed matching pursuits, is then used to adaptively and autonomously represent the RWG-defined currents into simpler and extended constituents, characteristic of general diffractive scattering. These simpler basis functions result in far fewer unknowns, thereby reducing memory requirements. These new basis functions are now used in the scattering analysis, to carry the computations to higher frequencies.

The MLFMA is extended for the case of such physically and geometry motivated basis functions. In addition, iterative techniques are developed to address the effects of poor conditioning.