A Novel Method of Singularity Removal in Self-Term Computations of the Three-Dimensional Green's Function

John Michael Hall[1]
(1) ECPI University, 5555 Greenwich Road, Virginia Beach, VA USA

The three-dimensional Green's Function in computational electromagnetics calculations involves a 1/R spatial decay. When integrating over the self-interaction term, great care must be taken to handle the 1/R integration as R approaches zero (i.e., the "self-interaction") to prevent the computational case of division by zero, which produces an infinite (and therefore computationally intractable) result. In these cases, approaches have been taken in the past such as integrating over a circular patch of equivalent area as the element in question (Harrington), or much more complicated methods of singularity removal by dividing the Green's Function into two mathematical parts, one containing the 1/R singularity, and another with the 1/R singular part removed (Rao). While the advantage of this approach is that the part with the singularity removed is a well-behaved function as R approaches zero, the disadvantage is that the 1/R singular part still cannot be evaluated directly.

In this presentation, a formulation is developed for transforming the three-dimensional Green's Function into a mathematical form which enables explicit and direct evaluation of the Green's Function at 1/R singularities without the need to appeal to circular patch approximations which alter target body geometry, or mathematically complex and computationally expensive methods of integrating around the singularity which are resource-intensive, and still fail to explicitly integrate the 1/R singular part. In addition to direct, fast, accurate evaluation of the three dimensional Green's Function in cases where R approaches zero, the new formulation also allows for replacement of the classical three-dimensional Green's Function in non-singular computations as well, if desired. The formulation, resulting equations, and supporting data will be all be presented in detail.