# Efficient Frequency Domain Technique for Electromagnetic Scattering from Arbitrary Objects Using the Random Auxiliary Sources

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Electromagnetic scattering from 3D objects of arbitrary boundary condition is presented implying the use of Random Auxiliary Sources (RAS) method. This technique provides a fast electromagnetic solver for arbitrarily shaped objects in the frequency domain. The technique is based on enforcing the boundary conditions by replacing the object by equivalent random electric and/or magnetic sources that are arbitrarily distributed within a controlled pre-specified domain. The proposed equivalent problems involve the use of few randomly distributed current filament for two dimensional problem (2D) and infinitesimal dipole sources of arbitrary orientations and moments for three dimensional problems, apart from the boundary of the object, which values are determined via least square method. Consequently, no need for singularity extraction is required. An acceptable tolerance bound of the boundary condition satisfaction error is insured using iterative procedure. Nevertheless, an optimum choice of procedure parameters is made via statistical analysis to provide the fastest and yet accurate solution.

The present solutions provided by the proposed technique promise significant reductions in the execution time and memory requirements better than method of moment solutions based on surface integral equations. The technique is verified by comparing current distribution on spheres with Mie's series solution. Also, a significant simulation time reduction is achieved over the commercial integral equation solver of CST-MWS (CST Microwave Studio, Ver. 2012, Framingham, MA, 2012) package using the method of moments (MoM) with direct or iterative solvers.

The potential of the proposed technique can be explored by comparing the execution time and the required number of unknowns with CST-MWS package using only single core processing with double precision. These results are shown the Table below as an example. The technique will be presented with more examples to further illustrate the simplicity and efficiency of the proposed technique.

**Comparison between the proposed technique and the CST-MWS**

| Sphere Radius | $2\ \lambda_0$ | $1\ \lambda_0$ |
|---|---|---|
| Boundary Condition | PEC | Dielectric $\varepsilon_r = 2$ |
| RAS (testing points, # unknowns CPU time) | (5080, 1500, 21.4s) | (2572, 771, 38.96s) |
| CST-MWS (unknowns, CPU) | (9710, 136s) | (9400, 84s) |
| CST Iterative Solver CPU time | 113s | 87s |