Computing electromagnetic scattering by means of an *hp*-adaptive FE method in the frequency domain

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Abstract

Accurate calculations of the electromagnetic scattering from objects is of great importance in the design of low observable, so-called, stealth vehicles. External scattering from electrically large convex objects is usually estimated by means of approximate high frequency methods, such as physical optics (PO). So called numerically exact methods, such as the method of moments (MoM), the finite difference method (FDM) and/or the finite element method (FEM) are preferable whenever it is possible. In the special case of scattering from resonant cavities with non-smooth geometries possibly coated with radar absorbing materials, such as an engine inlet of an aircraft, a PO-based method is not applicable and the MoM is not the preferred choice here either.

Here an *hp*-adaptive finite element method has clear advantages. The *hp*-adaptive approach is perhaps the most powerful approach present for the resolution of the steep gradients in the electromagnetic fields in case of domains with non-smooth geometries and/or in the presence of material interfaces. Use of higher order approximations reduces the otherwise significant dispersion error present in low order standard *h*-type finite element and finite difference methods.

Here, the Silver-Müller radiation condition in the far field is satisfied, in the weak sense, by using infinite elements (IE). The approach is verified and validated against analytical solutions and other high quality numerical solutions.

The electromagnetic scattering is determined using a RCS-based goal oriented error estimator. The singularities in the solution are thus resolved to an appropriate level of accuracy by using a *hp*-adaptive approximation refinement strategy. The effect of geometric irregularities on the RCS will be shown using the scattering on a thin disc.

FEM, MoM and PO results for the scattering on an open pipe will be compared. Comparisons of our computational results with *in situ* measurements performed on the open pipe are available (for US citizens) from the Electromagnetic Code Consortium (EMCC) [1]. The open pipe problem demonstrates important physical phenomena such as edge diffraction, length scale differences and cavity resonances.

References

[1] The Electromagnetic Code Consortium
URL: `http://www.arl.hpc.mil/PET/cta/cea/emcc/emcc.html`

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