A fictitious domain method based on a discontinuous finite element time domain formulation

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The fictitious domain method was designed to solve partial differential equations in exterior domains by embedding a given geometry in a regular grid (the grid is artificially extended inside the obstacle and surface currents on the triangulated surface of the conductor have to be taken into account). The method therefore ends up as a local perturbation of a numerical scheme based on a cartesian grid, and it turned out to be really efficient for time dependent problems, in particular for the electromagnetic scattering by a perfect conductor using Yee's FDTD method.

In this particular context, we present in this paper a fictitious domain approach based on a Discontinuous Galerkin Time-Domain (DGTD) method, based on a cartesian grid and parallelepipedic elements. In the general case, the convergence of the method is linked to obtaining an uniform inf-sup condition, leading to a compatibility condition between the boundary mesh and the volumic mesh, i.e. the volumic space step is linked to the smallest triangle of the surfacic mesh. Thus the constraint can be severe for surfacic meshes with small details, in particular for methods which do not cope easily with locally refined grids (like the FDTD method). A DGTD method is perfectly adapted to the use of local subgridding and allows the control of the volumic meshes dimension.

Waiting new numeric results for the conference, we present here a test case which consists in simulating the electromagnetic fields generated by an electric dipole ($f = 1Ghz$) located near a metallic sheet which is first located in the vertical plane corresponding to the volumic mesh, then inclined with an angle $\theta = 45^o$ with the vertical plane. The pictures show field contours computed using the DGTD fictitious domain method for the two orientations of the reflecting plane. The two contour plots match very well, which yields a first validation of the method.

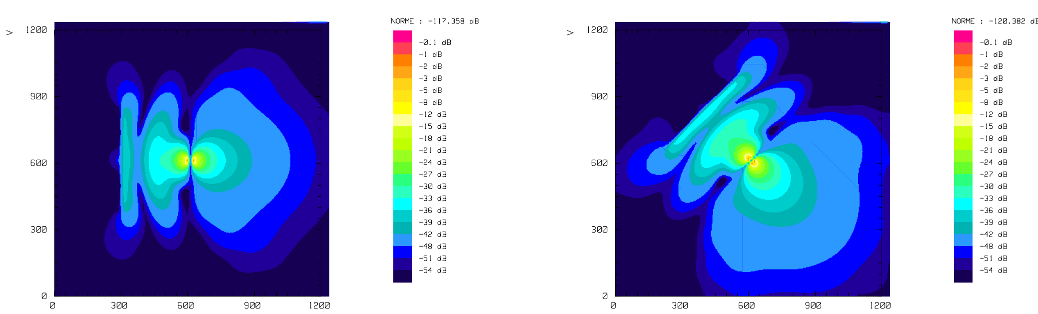

Figure 1: Electric field in the plan Oyz