HIGHER ORDER ELECTROMAGNETICS WAVE SIMULATION WITH PML

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Abstract

Accurate prediction of Radar Cross Section (RCS) of large electrical sizes using time domain Electro-Magnetics (EM) requires very fine meshes and long simulation time. This increases the cost of simulations in terms of memory and CPU requirement. Therefore, higher order spatial and temporal accurate methods are used to reduce the mesh requirement and simulation time. The mesh requirement can be reduced further by truncating the computational domain, which increases the wave reflection from the outer boundary. Generally, Perfectly Match Layer (PML) method is used to absorb the outgoing waves without any reflections. Conventional higher order accurate finite volume (FV) schemes require higher-order polynomial data reconstructions. The average reconstruction stencil size is about 120 for a fourth order FV scheme. It is very difficult to maintain such large reconstruction stencils in a thin PML. Here, an EM wave simulation with PML using higher order accurate Spectral Volume (SV) method is proposed. The SV method is amenable for extending higher order accurate approximations at all cells including PML. The stencil weights are universal and the reconstruction of field variables are carried out analytically in the SV method. This avoids a separate treatment for PML and reduces the computational complexity. Hence, the memory and CPU requirements are less compared to the conventional FV schemes.

In the present work, fourth order spatial accurate SV method along with third order temporal accurate R-K method is used in unstructured grid framework. Standard test case of pulse propagation is simulated to validate the pulse absorption by PML. The maximum reflection from the PML boundary is plotted in Fig. 1 and it can be observed that the error induced in the electric field due to reflection at boundary is about 10^{-6}. Further, the method is applied to simulate the EM scattering from two-dimensional perfect conducting NACA-0012 airfoil, which is illuminated on the broadside by a continuous harmonic incident TM wave. The predicted bistatic RCS for an electric size (ka=8□) compares well with the literature data as shown Fig. 2. The proposed higher order accurate SV method along with PML is a good candidate for accurate and efficient EM wave simulations.

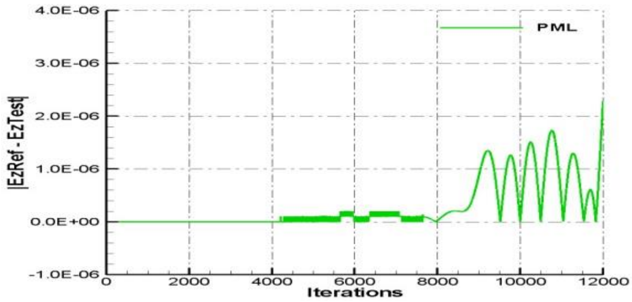

FIGURE 1: ERROR IN Ez AT PROBE POINT

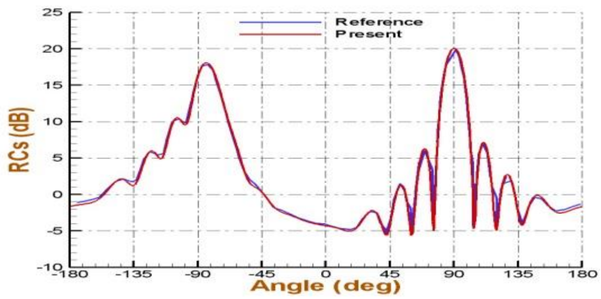

FIGURE 2: COMPARISON OF RCS

Keywords: Spectral volume method, High order, PML, airfoil, RCS.

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