Sparse point representation techniques with time step control

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ABSTRACT

We consider a high order space-time adaptive finite difference scheme for electromagnetic wave simulations. Adaptivity in space is defined in the context of the Sparse Point Representation (SPR) method [1], which is based in multiresolution techniques of interpolating wavelets. A threasholding procedure of the wavelet coefficients, which are used as indicators of the local smoothness of the fields, leads to grids that are sparse and non-uniformly spread: coarser in smooth regions and finer close to irregularities. For the discretization of spatial partial derivatives, a central fourth order finite difference scheme is applied with step size proportional to each point local scale. To improve the performance of the SPR method, our purpose is to evaluate the effect of using higher order Kunge-Kutta (R-K) schemes for time integration. Furthermore, we apply a controlled time stepping procedure to make integration more safe and efficient. A usual practice in the ODE community is to allow variable time steps, depending on the magnitude of local truncation errors, which are estimated by the application of two embedded R-K solvers of different orders. In the spirit of the methodology used in [2], we shall present SPR simulation results for the bidimentional TE_z mode Maxwell's equations, where the time step is authomatically adjusted during the time evolution using RK 2(3) scheme. Stable simulations are produced, even with a CFL input outside the constant CFL stability limit of the RK 2(3) scheme, and good agreement is obtained, when compared with the solution produced by the reference scheme in uniform grid.

References

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