An h-adaptive asynchronous spacetime discontinuous Galerkin method for TD analysis of complex electromagnetic media

Reza Abedi, University of Tennessee

An asynchronous spacetime discontinuous Galerkin (aSDG) method is presented for electromagnetics that directly discretizes space and time by unstructured grids satisfying a specific causality constraint. This enables a local and asynchronous solution procedure. The method is shown to be dissipative. The energy stability, convergence rate, and dispersion error of the method are discussed. Numerical methods are presented that demonstrate the use of mesh adaptive operations in spacetime and two error indicators for controlling the energy dissipation and the errors in satisfying Gauss divergence laws. The choices of average and Riemann numerical fluxes are discussed in the performance of the method. Next, the method is applied to computing scattering coefficients of certain unit cells. By Fourier analysis and inversion of the obtained transmission and reflection coefficients in the frequency domain, the equivalent impedance, wave speed, permittivity, and permeability of the unit cell are obtained for frequencies of interest. The linear solution cost of the SDG method, its powerful adaptive operations, and derivation of the entire spectrum with one time domain simulation are attractive attributes of the proposed characterization method.