Fast spectral PDE solvers for general structures

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Abstract

We present fast spectral solvers for Partial Differential Equations that address some of the main difficulties associated with simulation of realistic engineering systems in the frequency- and time-domains. Based on a novel Fourier-Continuation (FC) method for the resolution of the Gibbs phenomenon and fast high-order methods for evaluation of integral operators, these methodologies give rise to efficient frequency- and time-domain solvers for PDEs for general engineering problems and structures. Our integral algorithms can solve, with high-order accuracy, problems of electromagnetic and acoustic scattering for complex three-dimensional geometries; our FC-based differential solvers for time-dependent PDEs, in turn, give rise to spectral time evolution, essentially free of pollution or dispersion errors, for general PDEs in the time domain. A variety of applications to linear and nonlinear PDE problems, including the Maxwell equations, the Navier-Stokes equations, the elastic wave equation, Laplace eigenvalue problems, etc., demonstrate the significant improvements the new algorithms can provide over the accuracy and speed resulting from other approaches.