Isogeometric approximation of the scalar wave equation

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In recent years several there has been an increasing attention to high order simulations of acoustic and elastic wave propagation. While our previous works focused on approximations based on spectral and spectral elements methods, we then extended our study to Isogeometric (IGA) methods that allow not only the standard p- and hp- refinement of hp-finite elements and spectral elements, where p is the polynomial degree of the C^0 piecewise polynomial basis functions, but also a novel k- refinement where the global regularity k of the IGA basis functions is increased proportionally to the degree p, up to the maximal IGA regularity $k = p - 1$ [1].
In this presentation we consider the numerical approximations of the acoustic wave equation with absorbing boundary conditions, that are introduced in order to simulate wave propagation in infinite domains, by truncating the original unbounded region into a finite one. The spatial discretization is based on IGA Galerkin [2] and Collocation [3] in cartesian and curvilinear 2D regions, while the time discretization is based on explicit or implicit Newmark schemes. We illustrate a detailed experimental study of the two IGA methods with regard to spectral properties of the IGA mass and stiffness matrices [5], stability, accuracy and convergence of the IGA schemes [2, 3, 4] with respect to all the discretization parameters, namely the local polynomial degree p, regularity k, mesh size h, and the time step size Δt of the Newmark schemes. Finally we show some preliminar numerical results on the application of an additive overlapping Schwarz preconditioner to both IGA Galerkin and Collocation approximations, testing its performance with GMRES or preconditioned conjugate gradients iterative methods.

References

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