DIRECT SPACE-TIME FINITE ELEMENT SOLVERS FOR THE WAVE EQUATION

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ABSTRACT

For the discretisation of time-dependent partial differential equations, the standard approaches are explicit or implicit time stepping schemes together with finite element methods in space. An alternative approach is the usage of space-time methods, where the space-time domain is discretised and the resulting global linear system is solved at once. In this talk, the scalar wave equation in second-order formulation serves as a model problem. First, a space-time variational setting is introduced, where a modified Hilbert transform is used such that ansatz and test spaces are equal. A conforming discretisation of this space-time variational formulation yields a space-time Galerkin finite element method, which is unconditionally stable, i.e., no CFL condition is required. However, this space-time Galerkin finite element discretisation leads to a large global linear system of algebraic equations. The main part of this talk investigates new efficient direct solvers for this system. In particular, a tensor-product approach with piecewise polynomial, globally continuous ansatz and test functions is used. The developed solvers are based on the Bartels–Stewart method and on the Fast Diagonalization method, which result in solving a sequence of spatial subproblems. The solver based on the Fast Diagonalization method allows solving these spatial subproblems in parallel, leading to a full parallelization in time. In the last part of the talk, numerical examples are shown and discussed.

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