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EDITORIAL

Fast solvers for simulation, inversion, and control of wave propagation problems

From 26 to 28 of September 2011, a European Science Foundation (ESF) workshop 'Fast solvers for simulation, inversion, and control of wave propagation problems', *OPTPDE 2011*, was organized, in Würzburg, Germany, with approximately 50 participants from many different countries.

The workshop aimed at fostering development and application of fast computational techniques to direct and inverse wave problems, which are of primal importance in strategic engineering areas. Regarding applications, there were several researchers dealing with propagating and standing wave phenomena, and also inverse problems concerning design, control, and parameter estimation were often discussed. Within this general framework, the following topics were addressed: modeling, data assimilation, fast computational strategies for direct and inverse wave problems, Helmholtz problems, model order reduction, uncertainty quantification, and related applications.

This special issue in *Numerical Linear Algebra with Applications* gives an overview of some of the highly interesting achievements that were presented during the workshop in Würzburg.

In the contribution [1], 'Convergence Analysis for Hyperbolic Evolution Problems in Mixed Norm', D. Boffi, A. Buffa, and L. Gastaldi present a convergence analysis for the space discretization of hyperbolic evolution problems in mixed form. In particular, this paper discusses the relation between the approximation of an underlying eigenvalue problem and the space discretization of the evolution problem.

In the paper [2], 'A Block Krylov Subspace Time-Exact Solution Method for Linear ODE Systems' by M.A. Botchev, a residual-based block Krylov subspace method that solves certain classes of linear systems of ordinary differential equations is discussed. This method consists of two steps that involve an accurate piecewise polynomial approximation of the source term, constructed with the help of the truncated singular value decomposition.

In the contribution [3], 'Local Fourier Analysis of the Complex Shifted Laplacian Preconditioner for Helmholtz Problems', S. Cools and W. Vanroose solve the Helmholtz equation with multigrid preconditioned Krylov subspace methods. A shift parameter appearing in the shifted Laplacian preconditioner is chosen to be a wavenumber-dependent minimal complex shift parameter, which is predicted by a rigorous k-grid local Fourier analysis of the multigrid scheme.

In the paper [4], 'On the Fourier Cosine Series Expansion (COS) Method for Stochastic Control Problems' by M. Ruijter, C. Oosterlee, and R. Aalbers, an efficient numerical technique for solving stochastic control problems under one-dimensional Lévy processes is developed. The method is based on the dynamic programming principle and a Fourier cosine expansion method.

In the contribution [5], 'Multigrid Methods for Cell-Centered Discretizations on Triangular Meshes', P. Salinas, C. Rodrigo, F. Gaspar, and F. Lisbona discuss the design of efficient multigrid methods for cell-centered finite-volume schemes on semi-structured triangular grids. In this paper, novel smoothers are proposed for this type of discretizations.

In the paper [6], 'On the Convergence of Shifted Laplace Preconditioner Combined with Multigrid Deflation' by A. Sheikh, K. Vuik, and D. Lahaye, a Helmholtz solver that combines the shifted Laplace preconditioner with multigrid deflation is investigated by a rigorous two-grid Fourier analysis. Numerical results are presented that confirm the theoretical findings.

In the contribution [7], 'An Improved Two-Grid Preconditioner for the Solution of Three-Dimensional Helmholtz Problems in Heterogeneous Media' by X. Vasseur, H. Calandra, S. Gratton, and X. Pinel, the solution of three-dimensional heterogeneous Helmholtz problems discretized with finite differences with application in geophysics is addressed. In this setting, an iterative two-grid method acting on the Helmholtz operator where the coarse-grid problem is solved inaccurately is proposed and analyzed. A single cycle of this scheme is then used as a variable preconditioner of a Krylov subspace method.

In the paper [8], 'An Inverse Scattering Problem for the Time-Dependent Maxwell Equations: Nonlinear Optimization and Model-Order Reduction' by S. Volkwein and R. Mancini, an optimal control problem governed by time-dependent Maxwell equations is formulated. For the numerical solution of the optimality system, a gradient-based algorithm is applied and successfully tested for some numerical examples.

We wish to express our gratitude to the ESF for their support in realizing and ensuring the success of this initiative. We would also like to thank Mrs. Petra Markert-Autsch of the Chair of Scientific Computing of Würzburg and Mrs. Catherine Werner of the ESF Administrative Coordination Office for their invaluable efforts in organizing this workshop.

We wish you very enjoyable reading.

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