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Preface

The special issue "Computational Methods for Hyperbolic Problems" highlights papers selected from the presentations given during the mini-symposium of the same title at the International Conference on Applied Mathematics, Modeling and Computational Science (AMMCS 2011), which was held in Waterloo, Ontario, Canada from July 25 to July 29, 2011. This mini-symposium was organized by Allen M. Tesdall and Jae-Hun Jung, at the invitation of the conference organizers, Ilias Kotsireas and Roderick Melnik.

The goal of the mini-symposium was to bring together researchers at all levels, including students, junior researchers, and senior researchers from areas of both theory and application, and to provide them the opportunity to discuss recent progress in computational methods for hyperbolic problems and related open problems. In total, 19 presentations were given, including the one-hour semi-plenary talk by Mark Carpenter from NASA Langley Research Center. The number of authors and coauthors represented in all of the presentations in this mini-symposium was more than 35, including researchers from a variety of levels ranging from undergraduate students to internationally renowned researchers. For example, one undergraduate research team composed of four undergraduate students from SUNY at Buffalo gave a presentation on the efficient computational method for vascular flows, entitled "A hybrid radial basis function method for numerical solutions of vascular flow," and Barbara Keyfitz of The Ohio State University presented an insightful address entitled "A new look at singular shocks."

The broad spectrum of presented subjects included both theoretical and computational aspects of hyperbolic problems. The presentations regarding theoretical aspects covered uncertainty analysis of volcanic mass flows, the hyperbolic moment closure method for the Navier–Stokes equations, Riemann problems, and solution structures of singular, weak, and diffraction shocks; the presentations focusing on computational methods dealt with recent progress in various methods including the discontinuous Galerkin method (dGM), weighted essentially non-oscillatory (WENO) and essentially non-oscillatory (ENO) methods, spectral methods, radial basis function methods, stability preserving time-stepping methods, and generalized polynomial chaos methods. A variety of hyperbolic PDEs were considered, including the magneto-hydrodynamics (MHD) equations, nonlinear optics equations, vascular flow equations, Buckley–Leverett equations, Korteweg–de Vries equations, the unsteady transonic small disturbance (UTSD) equations, the compressible Navier–Stokes equations, and equations governing lake hydrodynamics and lava flows (further details about the mini-symposium can be found under http://www.ammcs2011.wlu.ca/).

Hyperbolic conservation laws describe a wide range of wave propagation and fluid flow phenomena, including shock waves in nonlinear situations. During the last several decades, important advances have been made in the numerical computation of accurate and stable solutions to these problems. Due to the breadth of the field, it is impossible to cover extensively such a variety of work in a single mini-symposium, or in a special issue. This special issue presents 11 refereed papers, and the scope of the issue instead focuses on some frontier and timely research topics and noteworthy new developments in applications for future research.

In particular, Wang and Kao extend classical central schemes for hyperbolic conservation laws to the modified Buckley–Leverett equation, and Kim and Lee apply Lax–Liu positive schemes to solve two-dimensional Riemann problems for the nonlinear wave system (a simplification of the isentropic Euler equations). Tesdall and Hunter apply finite difference schemes for the self-similar UTSD equations to investigate problems for weak shock diffraction, while Lorin and Chalmers propose strategies for the design of numerical methods for one-dimensional nonconservative hyperbolic systems. Pitman and his co-workers, and Jung and Chakraborty, present uncertainty analyses of hyperbolic problems for glacier lake flows and for the nonlinear optics equations, respectively. Yakovlev and his coauthors present a new dGM for the MHD equations that locally enforces the exact divergence free constraint on the magnetic field, and Krivodonova and Qin present an efficient mesh algorithm for solution of the Euler equations on non-uniform Cartesian meshes. Jung and his co-workers propose a new idea for fast computation of vascular flows based on the library and interpolation concept. Berzins investigates strategies for limiting the ENO reconstruction function so that the ENO polynomial is data bounded. In addition, Steinmoeller and his co-workers apply spectral methods for lake flow problems.

The guest editors express the hope that this special issue will provide readers with a glimpse into recent innovative research on various topics in computational methods for hyperbolic problems.

Finally, the organizers of the mini-symposium and the guest editors of this special issue express their gratitude to all the participants in the mini-symposium and to their coauthors, particularly those who are publishing their valuable papers in this special issue. They also wish to thank the reviewers of the papers submitted to this special issue for all their efforts, and the editorial members of the Journal of Computational Science, in particular Editor-in-Chief Peter Sloot and journal manager Uma Devi Mahalingam, for their time and help, which made it possible to finalize this special issue.

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