11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20–25, 2014, Barcelona, Spain

THE NONLINEAR ERROR TRANSPORT METHOD FOR ARBITRARY LAGRANGIAN-EULERIAN COMPUTATIONS

Jeffrey M. Connors[1], Jeffrey W. Banks[2] and Jeffrey A. Hittinger[2]

[1] University of Connecticut, 1084 Shennecossett Road, Groton, CT 06340,
jeffrey.connors@uconn.edu, www.math.uconn.edu/~connors
[2] Lawrence Livermore National Laboratory, Box 808, L-561, Livermore, CA 94551

Key words: *error estimation, error transport, arbitrary Lagrangian-Eulerian.*

Arbitrary Lagrangian-Eulerian (ALE) schemes are often used to model large-deformation hydrodynamics. In general, numerical errors are not negligible due to insufficient grid resolution imposed by computational resource limitations. It can be useful to employ *a posteriori* error estimates to help to undertand the results of ALE simulations. We discuss the application of the nonlinear error transport (NET) method in order to resolve fields of error directly in both the Lagrangian and remapping steps of ALE schemes.

Previously, the NET method was developed for Eulerian computations and shown to resolve fields of error very well, including for problems with shocks. In this approach, an auxiliary set of equations is derived that governs the evolution of the discretization error fields. It turns out that the solution of the error equations may also be approximated with some modifications to the code used to approximate the primal governing equations. This approach is attractive since (1) it leverages existing code to control the code development requirements and (2) the error may be estimated in any quantities of interest.

The application of NET to ALE schemes is new and poses interesting challenges. First, we discuss the formulation of the error equations within the Lagrangian reference frame, including both the errors in particle positions and in state values. Then we explain the meaning of remapping error in the context of the overall discretization error budget. Subsequently, the methodology is introduced to discretize the error equations for both the Lagrangian and remapping steps, which requires special consideration of the role of errors in particle positions. Finally, computational examples are discussed. We demonstrate that good resolution of the error fields may be achieved, both during a Lagrangian step and after a remapping step. Furthermore, we show that it is possible to distinguish between the impact of the remapping error and the Lagrangian discretization error.

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. LLNL-ABS-646678.