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Study of ENO schemes for Lagrangian Hydrodynamics in the context of Inertial Confinement Fusion simulation

Project proposed by

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The use of Lagrangian hydrodynamic schemes is a cornerstone for the simulation of Inertial Confinement Fusion (ICF).

Recent works, such as [3] or [4], have proposed interesting alternatives to the historical scheme [5], by generalizing the Godunov scheme to higher dimensions and computing node fluxes. Since these schemes are of order 1, MUSCL-like order 2 extensions have been developed.

Simultaneously, J. Cheng and C.-W. Shu have proposed in [2] a high order ENO scheme for unstructured grids [1] to solve Euler equations in Lagrange coordinates.

The work will consist, first, to implement and evaluate the scheme [2] in dimension 2 for 2D compressible hydrodynamics representative test cases. These simulations will be both academic (Sod, Noh and Saltzman shock tubes, Kidder's isentropic compression,...) and representative of ICF configurations (shell implosion,...).

Second, improvements of the scheme [2] will be considered, for instance concerning the node velocity computation which seems to be the weak point of the approach proposed by J. Cheng and C.-W. Shu. We may use the ENO reconstruction for the fluxes defined in [3] or [4] or any appropriated alternative. We will evaluate the benefits considering the tests of the first part of the work.

References :

[1] R. Abgrall. On essentially non-oscillatory schemes on unstructured meshes: analysis and implementation. Journal of Computational Physics, 114:45–58, 1994.
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[3] B. Després and C. Mazeran. Lagrangian gaz dynamics in two-dimensions and lagrangian systems. Archive for Rational Mechanics and Analysis, 178:327–372, 2005.
[4] P.-H. Maire, R. Abgrall, J. Breil, and J. Ovadia. A cell-centered Lagrangian scheme for two-dimensional compressible flow problems. SIAM Journal on Scientific Computing, 29(1781-1824), 2007.
[5] J. von Neumann and R.D. Richtmyer. A method for calculation of hydrodynamics schocks. Journal of Applied Physics, 21:232–237, 1950.