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EXPLORATION OF GODUNOV-LIKE CELL-CENTERED SCHEMES AND FRAME INDIFFERENT LIMITATION PROCEDURE FOR SOLVING UPDATED LAGRANGIAN HYDRODYNAMICS EQUATIONS

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ABSTRACT : we present herein a class of Godunov-like cell-centered methods for solving hydrodynamics equations. These schemes are conservative and entropic so they capture intense shock waves. A high order extension using frame indifferent limiters inspired by vector image polygon (VIP) procedure is proposed.

The numerical modeling of high compressible hydrodynamics flows is a topic of great interest for industrial applications. Godunov-like schemes are widely used for solving this kind of problems since they are naturally conservative and correctly dissipative in the shock waves. In the frame of Eulerian formalism, it is common to extend the one dimension Godunov-like scheme by solving approximated Riemann problems along normal directions to the faces. In Lagrangian formalism, it is not appropriate to use this procedure since the geometric conservation law (GCL) would not automatically hold.

To overcome this issue, Després *et al.* [1] and Maire [2] *et al.* developed schemes (GLACE and EUCCHLYD, respectively) based on nodal velocities and nodal fluxes. They can be interpreted either as Godunov-like schemes in which a multi-dimension approximated Riemann problem is solved or in terms of entropy dissipation considerations. In fact, entropy dissipation is driven by velocity jumps projected on directions defined by the mesh, namely the corner normals or half-edge normals.
On the other hand, Luttwak *et al.* [3] introduced the VIP limitation procedure to avoid non physical oscillations when dealing with high order Godunov-like schemes. It is based on the projection on the convex hill which seems to be the natural extension on the notion of extremum from scalars to vectors or tensors. However, it is well known that computing a convex hull in 2D or 3D for an arbitrary set of points shall be very CPU costing.

In this work, we develop a Godunov-like scheme similar to GLACE and EUCCLHYD, in which the entropy dissipation is driven by directions defined by the flow physical variables, for instance the deformation rate tensor eigenvectors. The motivation is to get results as independent as possible of the mesh. In a second part, we present a limitation procedure for high order extension inspired by VIP, in which instead of computing the convex hull we approximate it using a Principal Component Analysis. This procedure presents the advantage of being much less costing than VIP and still remains frame indifferent. Finally, we present numerical experiments which prove the relevancy of our approach.

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