REFERENCE MAPPING: APPLICATION IN EULERIAN HYDROCODES

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Abstract

In the simulation of coupled high-rate solid and fluid mechanical processes, the Eulerian frame for hydrodynamics has an advantage over the Lagrangian in that large deformations, fracture, fragmentation and collision can be modeled without the disastrous degradations caused by mesh tangling. A major disadvantage is the diffusion of material properties as material flows through the mesh. Related are the ambiguities in material history caused by mixing materials with different properties or states, such as yield strength, damage characterization, etc. in a computational cell. Finally, there is the disrepect of advection schemes for material subtleties such as maintaining deviators on a yield surface. The reference mapping technique promises to remedy all of these deficiencies by evolving the material reference coordinate system on the Eulerian mesh by means of a simple advection equation. It was first described in 2009 by Kamrin and Nave [1] and in successive publications by Kamrin and coworkers [2] to treat hyperelasticity and fluid-structure interactions. Vitali and Benson [3] independently described it in 2012 to treat the diffusion of rapidly varying material properties. Using it, material properties at a late-time grid point can be looked up on the reference grid, where they can be evolved in the Lagrangian frame, and mapped back to the current grid. We will discuss the details of an implementation in a typical Eulerian code. The effectiveness of the algorithm will be tested on engineering examples.

Keywords

Eulerian Code, Shock waves, Numerical diffusion, Reference Map

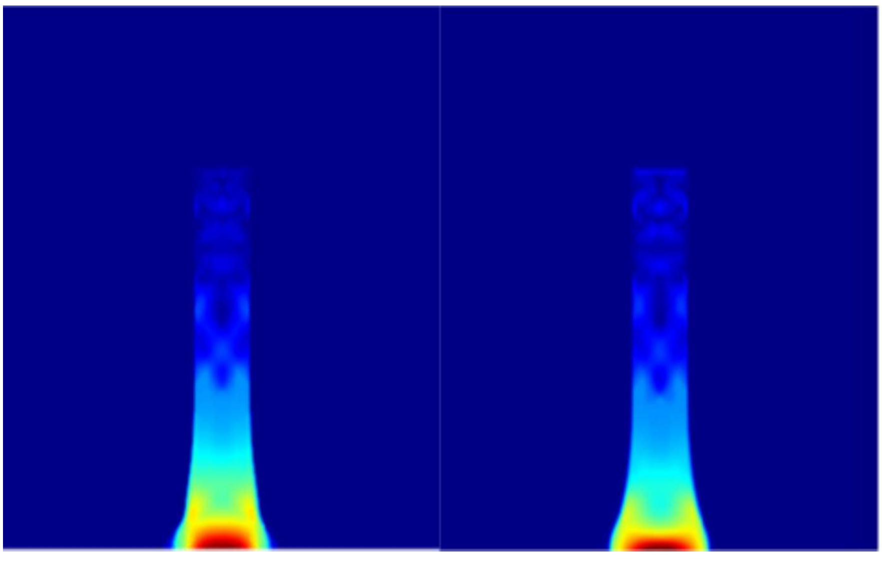

Figure 1: Comparison of the von Mises equivalent stress σ_v in a Taylor Anvil test. On the left the result with the reference map technique and on the right without the reference map. Observe the numerical diffusion near the bottom in the non-reference map result.

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References:

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