

A non-conservative scheme for hyperelastic materials circumventing the involution constraint

vendredi 7 novembre 2025 10:45 (45 minutes)

This study focuses on the development of numerical schemes for a monolithic hyperbolic Eulerian model that combines fluid and hyper-elastic solid dynamics. Solid behavior requires an additional equation for deformation, and traditional approaches represent this model variable using the gradient of the backward characteristics rather than the characteristics themselves. While this ensures a conservative formulation and facilitates the accurate capture of discontinuities, it necessitates solving a larger system of equations, four equations in 2D instead of two, and nine in 3D instead of three. Furthermore, preserving the irrotational property of the integrated gradients introduces additional complexity. To address these challenges, we propose directly integrating the transport equation for the backward characteristics, leading to a non-conservative formulation. To ensure that the integration remains consistent with the weak solutions of the model, we explore a simplified approach based on the Jin-Xin relaxation method. The proposed strategy will be assessed against traditional conservative methods to evaluate its consistency, effectiveness and computational efficiency.

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