Sub-cycling strategy for a Lagrangian finite Volume methods, applied to fluid-structure interaction

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We are interested in the numerical simulation of shock waves interacting with deformable structures. This problem presents many difficulties, particularly due to its multi-scale nature in both space and time.
The monolithic method involves solving this problem within a single domain using a unified numerical approach. The time step in this method is constrained by the fastest wave velocity within the domain. Conversely, the coupling method involves dividing the simulation domain into several parts to tailor the numerical strategy to the local physics. This approach allows for the selection of the most suitable numerical method for solving the problem. We model the fluid using Euler equations and the solid using a hyperelasticity model.
We propose a coupled method that employs conservative and entropic schemes for both domains (issued from [2] or [5] for the fluid, and from [1, 3, 4] for the solid) and incorporates local time stepping for each domain. Furthermore, we extend this method to achieve second-order accuracy in both time and space. We use an Arbitrary-Lagrangian-Eulerian (ALE) framework, which ensures the Lagrangian behavior of the fluid-solid interface. This method is being extended to incorporate a semi-conformal approach at the interface. We discuss how to address the interface problem in a way that preserves the numerical methods' properties, with a particular focus on the conservation of mass, momentum, and total energy.
We assess this method through examples of fluid-structure interaction.

Références

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