Well balanced Arbitrary-Lagrangian-Eulerian finite volume schemes on moving nonconforming meshes for nonconservative hyperbolic systems

Abstract
We present a novel second order accurate well balanced Arbitrary-Lagrangian-Eulerian (ALE) finite volume scheme on moving nonconforming polygonal grids which avoid the typical mesh distortion caused by shear flows in Lagrangian-type methods. The main feature of the proposed algorithm is the capability of preserving many of the physical properties of the system. Indeed, in the case of Shallow water equations and Euler equations with gravity, besides being conservative for mass, momentum and total energy, also steady equilibria can be exactly maintained up to machine precision, thank to the introduction of expressly designed well balanced techniques. Perturbations around such equilibrium solutions are resolved with high accuracy and with minimal dissipation on moving contact discontinuities even for very long computational times. Furthermore, our ALE finite volume scheme is based directly on a space-time conservation formulation of the governing PDE system, which completely avoids the need of an additional remapping stage and preserve the GCL conditions by construction. A large set of different numerical tests has been carried out in order to check the accuracy and the robustness of the new method for both smooth and discontinuous problems, close and far away from the equilibrium. Lastly, the method has been extended in order to treat free surface flows (using the Baer-Nunziato model and a parallel implementation in CUDA) and to analyze the impact of angular momentum conservation on vortical flows. Preliminary results on these topics will be shown.

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