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Title

A high-order accurate framework for thermal fluid-structure interaction

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Abstract

A novel high-order accurate embedded-boundary computational framework for solving the thermal fluid-structure interaction problem is presented. The framework uses block-structured Cartesian grids where both the fluid and the solid regions are represented implicitly via level set functions. This leads to a mesh that comprises a collection of standard d-dimensional rectangular elements and a relatively smaller number of irregular elements at the fluid-solid interface, which is resolved with high-order accuracy thanks to the use of high-order accurate quadrature rules for implicitly-defined domains and boundaries [1,2].
The fluid is assumed compressible and governed by the inviscid Navier-Stokes equations; as such, it may develop flow discontinuities, which are accounted for via suitably-introduced damping terms [3]. On the other hand, the solid region obeys the equations of thermo-elasticity within the small-strain regime.
The space discretization of the governing equations, including the fluid-solid coupling, is performed via variable-order discontinuous Galerkin methods, whose key features are high-order accuracy with generally shaped mesh elements, block-structured mass matrices and massive parallelization. Time integration is performed via Runge-Kutta algorithms.
The framework is implemented using AMReX [4], a software library that provides functionalities to write massively parallel applications using adaptive mesh refinement. Two- and three-dimensional examples are provided to assess the capability and accuracy of the proposed approach.

References

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