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Efficient Monolithic FEM for Compressible Flow and Conjugate Heat Transfer

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Abstract : This work presents an efficient monolithic finite element strategy for solving thermo-fluid-structure interaction problems involving compressible fluids and linear-elastic structure. This formulation uses displacement variables for structure and velocity variables for the fluid, with no additional variables required to ensure traction, velocity, temperature, and heat flux continuity at the fluid-structure interface. Rate of convergence in each time step is quadratic, which is achieved in this formulation by deriving an exact tangent stiffness matrix. The robustness and good performance of the method is ascertained by applying the proposed strategy on a wide spectrum of problems taken from the literature pertaining to steady, transient, two dimensional, axisymmetric, and three dimensional fluid flow and conjugate heat transfer. It is shown that the current formulation gives excellent results on all the case studies conducted, which includes problems involving compressibility effects as well as problems where fluid can be treated as incompressible.

Keywords : linear thermoelasticity, compressible flow, conjugate heat transfer, monolithic FEM
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