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Adaptive Stabilized Finite Elements for Compressible Flows

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In this work, we derived an adaptive finite element method for compressible flows. First, a mixed formulation is described for both the continuity and the momentum conservation equations. The main reasons for this choice of global description of the flow are stability, robustness, and computational efficiency. The total energy is then computed in a segregate manner and coupled to the system. Second, the obtained system is solved using a new derived Variational MultiScale (VMS) stabilized finite element method. It consists of the decomposition for both the momentum and the density fields into coarse/resolved scales and fine/unresolved scales [1], needed to deal with convection dominated problems and density instabilities. Note that this choice of decomposition is extended here to the energy equation which in return is shown to be favorable for simulating flows at high Mach number and to remove spurious oscillations due to the high discontinuity. Finally, we combine this new VMS formulation with an a posteriori error estimator for dynamic anisotropic mesh adaptation [2]. It involves building a mesh based on a metric map. It provides both the size and the stretching of elements in a very condensed information data. Consequently, due to the presence of high gradients in the solved variables, it provides highly stretched elements at the shock interfaces and at the boundary layers, and thus yields an accurate modeling framework for compressible flows. We assess the behavior and accuracy of the proposed formulation in the simulation of several benchmarks.

REFERENCES

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