A Predictor-Multicorrector Scheme based on the BDF2 for Multiscale Finite Element Method for Compressible flow problems

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ABSTRACT

We present a nonlinear multiscale viscosity method to solve inviscid compressible flow problems considering Backward Differentiation Formula (BDF) schemes to advance in time. The basic idea of the multiscale method consists of adding a nonlinear artificial diffusion operator adaptively in all scales of the discretization. The subgrid scale space is defined using bubble functions whose degrees of freedom are locally eliminated by appling the static condensation procedure in favor of the coarse scales variables. The amount of viscosity added to the numerical model is based on the YZβ shock-capturing parameter [3], which has the property of being mesh and numerical solution dependent.

The temporal variation is solved using a BDF2-based predictor-multicorrector time integration method that considers second order approximation in both resolved and unresolved scales[1]. In applications exhibitting multiple time scales, the temporal approximation needs to have stiff decay property (L-stable). Since BDF2 scheme is L-stable, we consider a predictor-corrector method based on BDF2 scheme to solve compressible flow problem at low Mach numbers, in order to reduce the stiffness of the problem [2]. Performance and accuracy comparisons are conducted based on benchmark 2D problems.

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