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A FINITE VOLUME METHOD FOR HIGH MACH NUMBER FLOWS ON HO GRIDS

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Reaching a higher order of spatial accuracy in the framework of Finite Volumes methods for compressible flow simulations has long been considered a major challenge. High order and truly multi-dimensional extensions of the low-order MUSCL scheme could not provide the level of robustness of the classical 2nd order formulations. These reference schemes extended well into high Mach number regimes and enabled efficient shock capturing. So the physical modeling capabilities of 2nd Order Finite Volume compressible CFD were further increased, for turbulence, boundary layer transition, combustion,… even if it was at a high CPU cost due to the huge number of cells needed for cases of industrial interest.

Conversely, the NXO cell-centered HO Finite Volume method presented here [1] demonstrates a stable and accurate space integration, without the need for a posteriori limiting of the highest derivatives of the reconstructed fields. For this, the weight distribution was calibrated in the WLSQ polynomial reconstruction procedure, the outcome of which is an unlimited projection and an improved diagonal dominance. This remains valid for HO grids.

This novel HO spatial reconstruction method, driven by the cell conservation objective, can then be associated with the most robust existing fluxes schemes, eventually dealing with discontinuous solutions. This is the case of the Jameson-Schmidt-Turkel (JST) scheme [2]. In our implementation, the sum, first and third grid difference operators can be computed optional from 2nd to 5th spatial order. Accurate expressions of the wall bc enable to reach high grid convergence indices for transonic flow computations around wing profiles.

These features [3], in subsonic, transonic and supersonic situations, could be compared with the element-based spatially HO reference methods (DG, Flux Reconstruction, stabilized CG,…) and standard 2nd Order FV formulations during the HO CFD workshop.

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