Case C3.1

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1 Code Description

The solver utilized in this work is a high-order discontinuous Galerkin(DG) solver. The solver can solve the Euler, Navier-Stokes,and RANS equations in two dimensions. The equations are solved using a fully implicit Newton solver which uses GMRES as the linear solver. For this case a colored Gauss-Seidel preconditioner was used. The solver is parallelized using MPI where METIS splits the meshes for parallel processing. Goal-oriented *hp*-adaptation is used and the adjoint is solved using the same linear solver as the flow for each case.

2 Summary

In all cases the residuals for the flow and adjoint equations are converged 12.5 order of magnitude. The machine used in this work is a Linux cluster with AMD 8132 Magny Cores processors at 2.3 GHz. The number of cores used is 32 and 64. The taubench timing result for this machine is not known(it could not configure on this machine). For a reference the work units in this case will be determined using $T_1 = 9.47$.

3 Meshes

- The domain is 200x200 chords with the farfield boundary located at 100 chords from the airfoil surface. The farfield boundary condition is characteristic in/out-flow.
- The meshes are fully unstructured mixed-element meshes.
- During refinement the curvature remains constant because the mesh is initially curved to suitably high order($p_{curve} = 4$).
- The meshes are curved by using the geometry definition from the mesh generator which gives extra points on the boundary for curvature. Anisotropic meshes are curved by curving the lines used in the line-implicit linear solver.
- The coarsest mesh has $N = 55,964$ elements at $p = 1$ which gives $N_{DoF} = 195,899$. The finest mesh contains $N = 536,261$ elements with $p = 1$ to $p = 3$ which gives $N_{DoF} = 2,505,810$.

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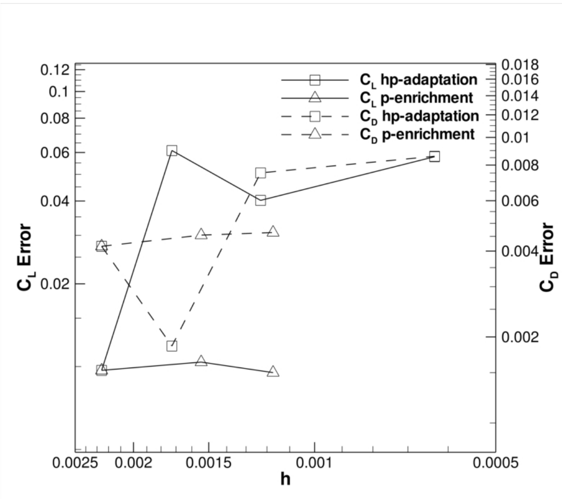
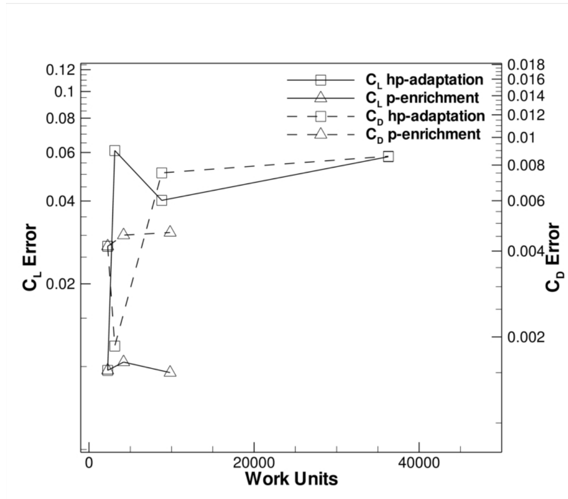
4 Results

4.1 Case C3.1: MDA 30P-30N

This cases considers the turbulent flow over the MDA 30P-30N with the flow conditions $M_\infty = .2$, $Re = 9,000,000$ and $\alpha = 16.0^o$. The Spalart-Allmaras turbulence model is used. The turbulence model is discretized to first order in order to make it robust enough to handle this problem. The mean flow is discretized with p order DG. hp-adaptation with lift as the objective is carried out. For comparison uniform p-enrichment is also considered. The lift and drag errors vs. both h and work units are depicted below in Figures 1(a) and 1(b) respectively. In addition the lift and drag values vs. h are also shown in Figure 2. The error in this case is computed using a reference value that was computed



(a) Lift and Drag Error vs. h



(b) Lift and Drag Error vs. Work Units

Figure 1: Lift and drag error for the turbulent flow over the MDA 30P-30N configuration.

using a second order finite-volume code. Ideally for this case the reference answer should be common to all results across the workshop. If the workshop provides a reference I will recompute the errors using that reference. Since the lift and drag values seem to be heading towards a fixed value, then the error results are most likely corrupted by a poor reference.

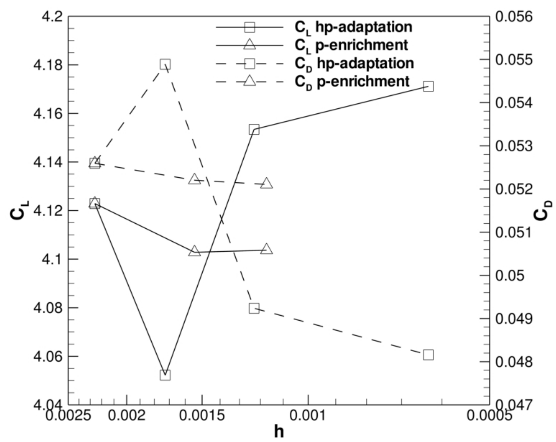


Figure 2: Lift and drag value vs. h over the refinement history for the turbulent flow over the MDA 30P-30N configuration.