AR1 - RANS of the Common Research Model (5th AIAA Drag prediction workshop)

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[source:http://aaac.larc.nasa.gov/tsab/cfdlarc/aiaa-dpw]

General description

The common research model (CRM) is a wing-body configuration which was extensively studied with state-of-the-art CFD codes in the fifth drag prediction workshop (DPW-5).

The CRM is considered under transonic cruise conditions. The flow is assumed to be steady-state and fully turbulent. Computations are to be performed in a target lift mode, i.e. given a specified lift coefficient, the corresponding angle of attack has to be determined. The objective of the simulations is to obtain mesh-converged drag and moment coefficient values as well as pressure distributions in sections along the wing span.

In previous editions of the workshop on high order CFD methods, only second order DG results have been provided, thus a higher order contribution or at least some mixed order (e.g. in the form of hp-adaptive results) is highly welcome.

Flow and boundary conditions

This study corresponds to the first test case of DPW-5.

- Mach = 0.85
- C_L = 0.500 (±0.001)
- Re = 5×10^6 based on reference chord c_{ref} = 275.80 inch
- moment reference center at x_{ref} = 1325.90 inch, z_{ref} = 177.95 inch
- reference area (half model) for coefficient computations: A_{ref} = 297360 $(\text{inch})^2$
- fully turbulent flow, no transition
- steady-state RANS
- free air farfield boundaries, no modeling of support structures or wind tunnel walls

Geometry and meshes

A series of nested structured multi-block straight-sided (piecewise linear) meshes has been generated for DPW-5 (cf. AIAA Paper 2011-3508) and is available in various formats as well as converted to several unstructured meshes including split elements. However, these meshes are typically not suited for high-order computations due to their piecewise linear nature. Several groups have reported problems applying an agglomeration-and-interpolation-to-higher-order strategy to these meshes, even if this typically works for other block-structured meshes.

An alternative mesh has been provided by Marco Ceze, University of Michigan. The hexahedral mesh uses a piecewise cubic representation and thus a good geometry resolution, even though it is coarse enough (80k elements) to serve as starting point for adaptive algorithms. It is provided in GMSH format.

For reasons of comparability, all participants are motivated to use the provided cubic mesh for computations. Computations on a mesh sequence should be performed by uniform refinement of the initial mesh, keeping the fixed piecewise cubic geometry by interpolating it to the finer mesh levels. If participants cannot refine the mesh in their own codes, finer versions of the baseline mesh can be provided upon request. Mesh-adaptive results are highly welcome.

Additional results on meshes generated by the participants can be provided as well. In that case, the meshes should be made available in a common format (GMSH, CGNS) to interested other participants.

References

Geometry reference for the CRM:

- J.C. Vassberg, M.A. DeHaan, S.M. Rivers and R.A. Wahls, "*Development of a Common Research Model for Applied CFD Validation Studies*", AIAA Paper 2008-6919, AIAA Applied Aerodynamics Conference, Honolulu, HI, August, 2008

For further information, please refer to the DPW-5 web site and the references cited therein.