Contribution to HiLiftPW-3

Moens Frédéric
Aerodynamics Aeroelasticity Acoustics Dept. (DAAA)
Civil Aircraft Unit (ACI)
ONERA-France

#018

3rd High Lift Prediction Workshop
Denver, CO June 3-4, 2017
Summary of cases completed:

<table>
<thead>
<tr>
<th>Case</th>
<th>Alpha=8, Fully turb, grid study</th>
<th>Alpha=16, Fully turb, grid study</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a (full gap)</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GRIDS: Committee_Grids/B2-HLCRM_UnstrPrismTet_PW/FullGap/CGNS/  
  - Woeber_Pointwise_HLCRM_FullGap_PrismTets_Coarse.cgns  
  - Woeber_Pointwise_HLCRM_FullGap_PrismTets_Medium.cgns  
  - Woeber_Pointwise_HLCRM_FullGap_PrismTets_Fine.cgns (*)

(*) : Computations still running – Results not provided at that time but will be shared when available.

<table>
<thead>
<tr>
<th>Case</th>
<th>2D Verification study</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GRIDS : CGNS grids

Code : elsA – v3.7.03  
Unstructured solver  
Turbulence : Spalart-Allmaras  
No QCR correction
Solver used: elsA v3.7.03

elsA is the ONERA software for complex external and internal flow simulations and for multi-disciplinary applications involving aerodynamics. It is basically based on the structured multi-block grid techniques, including chimera-overset. Recently, a new fully integrated environment for compressible flow simulation on structured and unstructured zones coexisting within the same hybrid mesh has been introduced in its capabilities.

Structured zones are kept for sake of accuracy in boundary layers, wall clock efficiency and low memory consumption.

Unstructured zones enable an easier mesh generation / adaptation process / detailed technology effects. In the hybrid capability, structured zones are solved using structured solvers, and unstructured zones with unstructured solver.

However, in order to have the full potential of the hybrid capabilities, some inputs have to be provided in the cgns file into account at the grid generation process.

At that time, most of the applications carried out with this hybrid capabilities are for turbomachinery. For aircraft applications, we are mostly considering the unstructured solver capabilities.
Solver used : elsA v3.7.03 : UNSTRUCTURED SOLVER

Cell-centered finite volume spatial discretization

Explicit : Roe  (Jameson JST also available)
  Limiter used : Venkatakrishnan

Implicit : LUssor scheme associated with an Euler backward time integration scheme
  Cfl =10.0

Turbulence model : Spalart-Allmaras (no QCR)

Run on parallel (256 or 480 cores) on the Onera super-scalar computer

No parametric study of the effect of the different coefficients (limiters, dissipations, turbulence models, ...) at present. This will come in a future phase of the project.

It is also planned to compute the fully structured grids provided using the “standard setups” in order to have a “good” CFD reference for comparisons.

All calculations performed without MG (capability not yet validated for unstructured grid in the version of elsA used for this exercise)
REFERENCES


doi: 10.1051/eucass/201304417 © Owned by the authors, published by EDP Sciences, 2013
Verification study results
(Case 3)

Results from Onera DAAA/CLEF
(C. Caillaud / B. Michel / M. Soismier)
Grid system used

For case 1: Onera used the provided committee grids for B2-HLCRM referred as “UnstrPrismTet” as it seems close (in term of topology) to an hybrid grid.

The only modification done for the computations was to transform the x/y/z provided from inches to meters. This was in order to work in S.I. units for flow initialization ...

Special thanks to B. Maugars from Onera DAAA/CLEF for the support on HL-CRM computations
HL-CRM case
Convergence (Residuals)
HL-CRM case
Convergence (Force Coefficients)
HL-CRM wing sections used

Cp and Cf extraction locations for HiLiftPW-3 (clean HL-CRM config)

(span=1156.75 inches)

- y=1050 (eta=0.908)
- y=947 (eta=0.819)
- y=792.5 (eta=0.685)
- y=638 (eta=0.552)
- y=483.5 (eta=0.418)
- y=380.5 (eta=0.329)
- y=277.5 (eta=0.240)
- y=174.5 (eta=0.151)

(y values in full-scale inches)

Picture from HLPW3 web site
HL-CRM results – Alpha=8°
Effect of grid density (Coarse / Medium)

Computed pressure coefficients
HL-CRM results – Alpha=8°
Effect of grid density (Coarse / Medium)

Computed friction lines
HL-CRM results – Alpha=16°
Effect of grid density (Coarse / Medium)

Computed pressure coefficients
HL-CRM results – Alpha=16°
Effect of grid density (Coarse / Medium)

Computed friction lines

COARSE GRID
Alpha=16°

MEDIUM GRID
Alpha=16°
HL-CRM computations by Onera

Summary

Effects of grid density observed on flow solution computed on the flap:

Due to Mesh ? Numerics ?

Computation on Fine grid to be completed.

As there are no experimental data available (yet), it is planned to carry out computations on the structured multi-block grids provided in order to have reference numerical solutions.

No major difficulties encountered to run computations on cgns grid provided.