Hybrid Overset Meshing of the HL-CRM Geometry

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Pointwise, Inc.

PID: 13
Summary of Grids

<table>
<thead>
<tr>
<th>Case</th>
<th>Code(s)</th>
<th>Starting Geometry Model</th>
<th>Grid Type</th>
<th>Grids Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>HL-CRM full gap</td>
<td>Pointwise</td>
<td>IGES</td>
<td>Overset Unstructured Tetrahedra, Prism, Hexahedra</td>
<td>M</td>
</tr>
</tbody>
</table>

• Pointwise
  • Full-featured mesh generator capable of creating unstructured tet, unstructured hybrid, overset (unstructured, structured), structured multi-block mesh types.
  • Unstructured meshes use an advancing layer technique called T-Rex to extrude regular layers of high-quality right angle tets from surface mesh based on user prescribed growth and wall spacing parameters.
  • Remaining volume filled with equilateral tets using a modified Delaunay method.
  • Right angle cells extruded in viscous layers can be combined into prisms and/or hexahedra
  • For more information: [http://www.pointwise.com](http://www.pointwise.com)
Mesh Generation

- Leverage overset grid connectivity and unstructured mesh topology to automate efficient meshing of external aero models
  - Divide model into near-body and off-body regions
  - Mesh type matched to region
  - Progressive levels of automation
    - Surface mesh – leverage CAD solid model
    - Near-body viscous mesh – leverage surface mesh
    - Off-body mesh – leverage near-body mesh
Mesh Generation

• Near-Body Mesh
  - Hybrid unstructured
    - High quality, body fitted
    - Automated viscous resolution
    - Trimmed to $C_{ref}$ distance from geometry

• Off-Body Mesh
  - Voxel meshing
    - Hierarchical recursive meshing to target length scale
    - Highly automated, fast
    - Efficient - ~80% hexahedra
    - Transition elements between layers provide full point and face matching
    - Buffer layer parameter controls transition rate
Near-Body Mesh

GMGW-1, Denver CO, June 2017
Off-Body Mesh

• Automated from simple farfield boundary shape and near-body surface mesh
# Mesh Generation

<table>
<thead>
<tr>
<th>Grid</th>
<th>Total Volume Cells</th>
<th>Total Volume Points</th>
<th>Tets</th>
<th>Prisms</th>
<th>Hexes</th>
<th>Pyramids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near-body Prism Tet before Split</td>
<td>63,818,650</td>
<td>26,404,472</td>
<td>16,684,279</td>
<td>45,684,928</td>
<td>0</td>
<td>1,449,443</td>
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<tr>
<td>Near-body Prism Tet after Split</td>
<td>56,414,097</td>
<td>25,183,924</td>
<td>9,279,726</td>
<td>45,684,928</td>
<td>0</td>
<td>1,449,443</td>
</tr>
<tr>
<td>Off-body before assembly hole cut</td>
<td>30,121,779</td>
<td>24,164,167</td>
<td>5,046,610</td>
<td>0</td>
<td>22,471,449</td>
<td>2,603,720</td>
</tr>
<tr>
<td>Off-body after assembly hole cut</td>
<td>23,425,777</td>
<td>19,654,866</td>
<td></td>
<td></td>
<td>22,471,449</td>
<td>2,603,720</td>
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<tr>
<td>Combined composite assembly</td>
<td>79,839,874</td>
<td>44,838,790</td>
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<td></td>
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</tr>
</tbody>
</table>
## Mesh Generation

<table>
<thead>
<tr>
<th>Grid</th>
<th>Volume Mesh Initialization Time (Hrs)</th>
<th>Total Labor (Hrs)</th>
<th>Total Elapsed Time (Hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium Full Flap Gap - All Tets</td>
<td>1.92</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>Medium Full Flap Gap - Prism Tet</td>
<td>1.96</td>
<td>1.96</td>
<td>1.96</td>
</tr>
<tr>
<td>Segregation of Near-Body Portion</td>
<td></td>
<td>0.1</td>
<td>0.25</td>
</tr>
<tr>
<td>Cartesian extent box and refinement target definition</td>
<td>0</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Hierarchical mesh</td>
<td>0.25</td>
<td>0</td>
<td>0.75</td>
</tr>
<tr>
<td>Overset grid assembly definition</td>
<td>0</td>
<td>0.5</td>
<td>1.25</td>
</tr>
<tr>
<td>Overset grid assembly</td>
<td>0</td>
<td>0.5</td>
<td>1.75</td>
</tr>
</tbody>
</table>
Near-Body Y=277.5
Near-Body $Y=277.5$
Off-Body Y = 277.5
Off-Body Comparison $Y = 277.5$
Near-Body Y=638
Near-Body Y=1050
Near-Body Y=1050
Future Direction

• Near-Body Mesh
  - Optimal trimming distance from geometry
  - Multi-component hybrid unstructured
    - Facilitates moving geometry, e.g. slats
    - Overset interpolation of significant flow features

• Off-Body Mesh
  - Voxel meshing
    - Conservative connection to near-body mesh – tetrahedra stitching
    - Difficult with anisotropic faces