Meshing With SALOME for Code_Saturne

Mixed meshing and tests

November 23 2010
Fuel assembly mock-up

We seek to mesh the “Nestor” mock-up

- Several types of grids: simplified spacer grids + realistic 5x5 mixing grids
  - Mixing grids may be rotated
- Area between grids may be meshed using a block-structured approach
  - Allows high mesh quality
  - Stretched cells possible
- Grid geometry is much more complex
  - Use automatic meshing in these areas
  - Generating a high quality semi-structured mesh is very costly and complex even with very mature meshing tools

Case seems well adapted to meshing by pieces and assembling using *Code_Saturne*’s conforming/non-conforming mesh joining
Bundle Mesh

- Simple to generate with SALOME
  - Built using the GUI + notebook
  - A purely programmed (Python-SMESH) or C (+MED export) version could be slightly simpler and easier to parametrize, as a refinement of this method.
Bundle Mesh

2D bundle, may be extruded
Bundle Mesh

- 2D bundle
  - may be extruded
  - Pyramids generated by modified *Code_Saturne* routine
Bundle Mesh

- 2D bundle, may be extruded
  - Extrusion along $\frac{1}{2}$ inter-grid space
Grid Mesh

- **Imported CAD**
  - Over 4000 faces
  - Partitioned for meshing control
Grid Mesh

- Imported CAD
  - Partitioned for meshing control
  - Post-partition, rename edges by type on top and bottom
  - Meshed with NETGEN 2D
Grid Mesh

- **Composite Surface mesh**
  - Grid – top – bottom meshed with NETGEN2D (796 374 triangles)
  - Pyramid surface extracted from *Code_Saturne* and merged with previous part to obtain closed surface (990 326 triangles)

- **Volume mesh with GHS3D** (7 894 214 tetrahedra)
Grid Mesh

Volume meshed with GHS3D, joined with pyramid and hexahedra bundle junction mesh.
Grid Mesh

Tests with HEXOTIC

- All features captured with fine enough resolution
- < 45 minutes and 5 Gb for Hexotic to dump output mesh, > 24 hours and 20 Gb for SMESH to load it and export it to MED format, of which > 12 hours running at 2 Gb
Grid Mesh

Tests with HEXOTIC
Grid Mesh

Tests with HEXOTIC
Grid Mesh

 Tests with HEXOTIC
Mesh assembly

Mesh is assembled in *Code_Saturne*

- This allows bypassing SALOME’s limits
- Mesh size for this case: 117,659,794 cells (2 types of grids + bundles)
  - 50,576,476 tetrahedra, 436,392 pyramids, 66,646,756 hexahedra, 170 polyhedra
- Maximum mesh size assembled by *Code_Saturne* so far: 1.1 billion cells
Mesh assembly

2 types of grid
- Grid can be repeated, with rotation (handled by assembly in Code_Saturne)
Mesh assembly

- Quality good enough for steady RANS, not for LES
Meshing limitations

- SALOME currently lacks a “boundary layer” functionality
  - Ongoing work
- Surface mesh with BLSURF may be constrained to pass through a set of points, but not to conform to a given set of edges
  - No guarantee that extra points are not added
- Mapping existing mesh edges to CAD edges would make methodology much simpler and scalable
  - Currently, hand selection and renaming of 120 CAD edges for 5x5 grid; wither 17x17?
  - TUI might allow this, but documentation would help, while GUI does not
  - This would allow meshing by pieces and would be very useful:
    - should be either better documented/added to the GUI if already possible, or developed
Future improvements

- Improve pyramid generation in *Code_Saturne*
  - In case of simple joining surfaces (such as here), putting pyramids “back to back” should avoid a large-small-large cell volume transition:
Conclusions

揭牌 “industrial” mesh generated with SALOME for Code_Saturne

- Most studies use other tools
- No meshing tool tested so far is fully satisfactory (i.e. easy + robust + powerful)

Requires further improvements, but level of robustness and functionality usable for “real” cases

- Other tools may still do better

Some steps easier to do in user code than under SALOME

- Pyramid junction
- Mesh joining

Do users of other tools require similar functionality?

- Joining under SALOME would not be a great improvement for us, but handling mesh transitions better would be