Mesh Generation in OpenFoam® with SnappyHexMesh
An User Experience

Organization:

1st OpenFOAM® Users' Meeting - Brazil
December 3rd 2010 @ LCFT-ITA
São José do Campos - SP - Brazil
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(*) This presentation is based only in user experience and it is not approved or endorsed by the producers of the OpenFOAM® software.
• Introduction
• Run blockMesh
• STL Body Geometry
• Run snappyHexMesh
• Conclusions
Objectives

- Introduce some OpenFoam® mesh generation strategies;
- Present `snappyHexMesh` to audience;
- Transfer knowledge acquired by ATS4i;
- Discuss results;

Presentation focus

- Very quick overview due to time constraint
- Use of the software only
- Mesh generations with open source tools
- This is not a manual or user guide
Mesh Generation in OpenFoam®

- **Open Source Tools Used**
  - BlockMesh
  - SnappyHexMesh
  - EnGrid (Gmesh+Netgen+prisms)

- **Commercial Tools Used**
  - Metacomp's MIME® export to cgns
  - cgnsToFoam and autoPatch
EnGrid
(Gmesh+Netgen+Prisms)
MIME + cgnsToFoam + autoPatch
blockMesh
Edit BlockMeshDict

Run blockMesh

pyFoamDisplayBlockMesh

The STL file goes in triSurface directory
STL Geometry
STL Geometry Tips

- Check the quality of the STL file. The surface needs to be as smooth as possible, without any humps.
- Check the orientation of the STL file. Are the coordinate axes aligned correctly?
- Check the position of the STL file. Is the origin of the STL file located, where it is supposed to be?
- Check the scaling of the STL file. Guess...
- Check the format of the STL file. It should be ASCII and not binary. You can have multiple surface groups in your STL file, but the naming should be without whitespaces, such as...
Correct Scaling and Origin

EnGrid or Paraview may help you fixing STL geometry
snappyHexMesh
Define the surface to be loaded from triSurface directory

Define refinement region
Define surface refinement min and max levels

Define refinement level in region selected
Define location in Mesh.

It must be inside the volume to be meshed (here outside the body)

Paraview may help you to find the coordinates!!!
Define Layers

// Settings for the layer addition.
addLayersControls

// Are the thickness parameters below relative to the undistorted
// size of the refined cell outside layer (true) or absolute sizes (false),
relativeSizes true;

// Per final patch (so not geometry!) the layer information
layers

"cylinder_ascii"

nSurfaceLayers 3;
expansionRatio 1.4;
timLayerThickness 1.9;

"side1"

nSurfaceLayers 11;
expansionRatio 1.7;
minThickness 0.0001;

"side2"

nSurfaceLayers 11;
expansionRatio 1.7;
minThickness 0.0001;

"topbottom"

nSurfaceLayers 9;
minThickness 0.0001;

topbottom2

nSurfaceLayers 9;
minThickness 0.0001;

// Expansion factor for layer mesh
expansionRatio 1.4;

// Wanted thickness of final added cell layer. If multiple layers
// is the thickness of the layer furthest away from the wall.
finalLayerThickness 1.5;

// Minimum thickness of cell layer. If for any reason layer
// cannot be above minThickness do not add layer.
minThickness 0.0001;

// If points get not extruded do nGrow layers of connected faces that are
// also not grown. This helps convergence of the layer addition process
// close to features.
nGrow 1;

// Advanced settings

// When not to extrude surface. 0 is flat surface, 90 is when two faces
// make straight angle.
featureAngle 30;

// Maximum number of snapping relaxation iterations. Should stop
// before upon reaching a correct mesh.
relaxIter 3;

// Number of smoothing iterations of surface normals
nSmoothSurfaceNormals 1;

// Number of smoothing iterations of interior mesh movement direction
nSmoothNormals 3;

// Smooth layer thickness over surface patches
nSmoothThickness 10;

// Stop layer growth on highly warped cells
maxFaceThicknessRatio 0.5;

// Reduce layer growth where ratio thickness to medial
// distance is large
maxThicknessToMedialRatio 0.3;
Recommendations

- Pay attention to scaling and origin of STL file
- Quality of STL file may be an issue also
- Visualize STL file
- Visualize blockMesh and try to make it balanced 1:1:1
- Change one parameter per time in snappyHexMeshDict
- Take care because the layers will not grow if it is inconsistent or distorts too much the mesh (quality control)
- Use caution when defining the refinement levels because they are exponents! So level 2 is $2^2$, level 3 is $2^3$....
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Acknowledgments

Jens H. / Shipbuilding Student / 1984 / windsurfer, owner of http://www.hydroniumion.de/category/openfoam/ - great tutorials there!

The team acknowledges to Prof. Marcelo Lemos and ITA organization for the opportunity;
Thank you!