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CastNet: GUI based modeling and solution control environment for OpenFOAM®

CastNet: CAD-based Pre-Processor for OpenFOAM®

Attributes: Concept of CAD associated mesh and solution set-up

Example: Model setup for CHT-Solver

OpenSource CFD Conference 2010
Munich, Germany
• Modeling and meshing environment for CFD and FEA
• CAD-Model based (reads Parasolid -xt, Acis –sat or Granite Pro-E parts) or discrete mesh data (e.g. stl)
• Builds internally non-manifold model based on CAD assemblies with conformal mesh transition between parts
• Generates hybrid meshes
• CFD specific features (boundary-layer-meshing, curvature controlled meshing, …)
• CastNet is based on commercial meshing, CAD import and abstract modeling technology (not open source)
Meshing:
Curvature controlled meshing with boundary layer
**CastNet for OpenFOAM®**

**Major goals:**
- Providing access to reliable, robust and high quality CFD-meshing based on CAD geometry
- Establishing complete GUI based environment: Access to strong OpenFOAM® -solution capabilities without editing text files or detail knowledge of keyword-structure (e.g., “turbulentMixingLengthFrequencyInlet”)
- Reducing the time from CAD model to OpenFOAM® run-ready case

**Fully compatible:** User can switch anytime from GUIs to text-based model setup
User can extend the CastNet model output for specific needs
Major features for OpenFOAM:

- Support of OpenFOAM® 1.5, OpenFOAM® 1.6.(x) and OpenFOAM® 1.7
- Direct generation of complete models (variables, controlDict, solver settings, materials etc.) for more than 17 solvers in 1.6/1.7
- Convenient definition of boundary conditions using derived OpenFOAM® patches
- Definition of local, initial conditions e.g. specification of volume fractions in particular regions
- Face and cell zones (e.g. baffle or fan faces, porous or MRF-zones)
- User support by “defaults” e.g. walls with zero-gradient or wall function selection
- SnappyHexMesh in case hex-dominant meshes are required
- Additional GUI for job-control during the run: Switching solvers, changing schemes, modifying underrelaxtion factors, plotting residuals,…
Example

Inflow

Outflow

Large number of flow obstacles, flow resistances (porous zones) and baffles

Direct modeling of baffle faces and porous regions
Meshing

Free-Mesh and extrude regions

Boundary-Layer

Note: More complex meshing examples of customer cases presented in Gothenburg
results

Visualization with Paraview
Example: Model setup for CHT-Solvers

Solid Zone

Fluid Zone
General characteristic of the cht-Solvers

- Each region: subdirectory in time-directories and system-directory
  - e.g. 0/fluid1 system/fluid1 and 0/solid1 system/solid1
- Region allow local solution settings:
  - e.g. 0/fluid1/fvSchemes and 0/fluid1/fvSolution

Result: Extremely flexible
But high effort for case setup

Model approach in CastNet:

Geometry:
- Transfer of parts of CAD assembly into geometry regions
- Geometry regions can be assigned to CHT-regions
- CastNet detects interfaces between CHT-regions automatically

Solution parameter:
- Can be assigned locally to each individual CHT-region (high flexibility)
- Or globally defined settings can be used (reduced definition effort)
Example: Model setup for CHT-Solvers

Parts of a CAD assembly can be picked and assigned to CHT-Zones
Example: Model setup for CHT-Solvers

Solution and properties settings for CHT-region can be defined locally or global.
Example: Model setup for CHT-Solvers

E.G: Entries for Control Dict and properties
Example: Model setup for CHT-Solvers

Definition of boundary condition
Associated with CAD geometry
Example: Model setup for CHT-Solvers

Script export
Case is generated with a single command:
Fully automatic case generation depending on the settings in CastNet

```bash
cp system/fvSolution_2 system/fvSolution
mv rho_solid 0/rho
mv cp_solid 0/cp
mv K_solid 0/K
splitMeshRegions -cellZones -overwrite >logs/splitMeshRegions.log
mv regionProperties constant/
rm 0/fluid1/K
rm 0/fluidd1/zho
rm 0/fluidd1/cp
mkdir constant/fluidd1
mv thermophysicalProperties_defaultfluid constant/fluidd1/thermophysicalProperties
cp constant/RANProperties constant/fluidd1/
rm 0/fluidd1/cp
rm 0/fluidd1/K
rm 0/fluidd1/zho
mv fvschemes_defaultfluid system/fluidd1/fvschemes
mv fvsolution_defaultfluid system/fluidd1/fvsolution
# Fixes bug in splitMeshRegion for omega turb-inlet and wall
sed -i 's/value uniform 0;/value $internalField;/g' 0/fluidd1/omega
# Fixes bug in splitMeshRegion for p in OF 17
sed -i 's/value uniform 0;/value $internalField;/g' 0/fluidd1/p
mv changeDictionaryDict_fluidd1 system/fluidd1/changeDictionaryDict
changeDictionary -region fluid1 >logs/changeDictionary_fluidd1.log
mv fvschemes_defaultsolid system/solid1/fvschemes
mv fvsolution_defaultsolid system/solid1/fvsolution
# Fixes bug in splitMeshRegion for rho zero values
sed -i 's/value uniform 0;/value $internalField;/g' 0/solid1/rho
# Fixes bug in splitMeshRegion for T zero values
sed -i 's/value uniform 0;/value $internalField;/g' 0/solid1/T
rm 0/solid1/p
rm 0/solid1/rho
rm 0/solid1/omega
rm 0/solid1/K
rm 0/solid1/mu
rm 0/solid1/alphat
mv changeDictionaryDict_solid1 system/solid1/changeDictionaryDict
changeDictionary -region solid1 >logs/changeDictionary_solid1.log
mv fvsolution_global system/fvsolution
mv fvschemes_defaultsolid system/
mv fvsolutionsDefaultsolid system/
mv fvsolution_defaultfluid system/
mv fvsolution_defaultsolid system/
```
Example: Model setup for CHT-Solvers

Or scripts can be executed using a GUI (plots also residuals and allows change of solution settings during runtime)
CastNet for OpenFOAM®

- Further support of CastNet features: Easy identification of cell and faces zones for multi-region applications

- Adding solvers and OpenFOAM functionality:
  Target solvers: reactingFoam, rhoReatingFoam, fireFoam, rhoPorousMRFPimpleFoam, simpleWindFoam

- Extending the runGui: Allowing a detail job control and manipulation (e.g. plotting probes, switching more schemes, ...)

- Support further features for 1.6-extended as soon as this version is available
  - GGI
  - Sliding meshes
  - Windows Version
  - more schemes, patches and solver
CastNet for OpenFOAM®

- Reliable CAD-based CFD meshing
- Reduces the set up time for run ready OpenFOAM case significantly
- Helps to learn “OpenFOAM”
- Provides a modeling and solution control environment:
  - Creating OpenFOAM input comparable to commercial systems
  - Without restricting OpenFOAM functionality

Thank you for your attention!

For more information (e.g. movies „CastNet for OpenFOAM®“) please visit:

http://www.dhcae-tools.com/OpenFOAM.htm