CAD geometry based pre-processing for CFD using abstract modeling techniques

Dr. Ulrich Heck ulrich_heck@dhcae-tools.de	DHCAE-Tools UG (haftungsbeschraenkt) DE-47800 Krefeld, Deutschland

Abstract

OpenFOAM offers excellent problem solving capabilities and a great potential in terms of building, adapting or extending solvers for specific tasks. However, the pre-processing with regard to the CAD meshing of workflows in industries is to be designed for even more effectiveness. CFD is particularly attractive in process or product development, as it allows the numerical investigation of a higher number of geometry cases before building any prototype. The widespread usage of OpenFOAM is often restricted due to the relatively high effort regarding case setups. The abstract modelling approach can be one way for a CAD-geometry related OpenFOAM case generation. The method is demonstrated on the basis of the meshing and modelling tool “CastNet”.

This preprocessing tool uses CAD-kernel geometry in order to enable the user to define the OpenFOAM input at a graphical user interface (GUI): Solver settings, fluid properties and boundary conditions (including interior zones such as porous and MRF regions) are defined in association with CAD geometries. CastNet either generates classical hybrid meshes using tetrahedral, hexahedral, pyramidal or prismatic elements or supports the snappyHexMesh-based meshing approach for those OpenFoam solvers that perform better with hex-dominant grids. Meshing parameters and solver inputs for OpenFOAM cases are organised by means of so-called attributes: E.g. the attributes “boundary layer” or “boundary condition - inlet” require CAD faces, whereas, for example, OpenFOAM solver settings are associated with the global CAD model. Applying the abstract modelling approach, the relationship between meshing or solution attributes and CAD geometry can be defined independent of a specific CAD model.

An abstract model can even be built at an early stage when only a rough idea of a certain geometry exists. Several algorithms are available in order to establish the relationship between abstract problem definition and final geometrical entity. By implementing the abstract model the complete case definition (e.g. mesh settings, boundary conditions and solution settings) can be associated with very different CAD designs. This results in a fast and reliable model generation for studies of geometry variants including meshing parameters, boundary conditions and solver settings. Furthermore, it reduces the risk to bias the design study by mesh dependency. The abstract model for a specific application condenses the particular CFD-specific requirements as well as the OpenFOAM expert knowledge regarding the meshing, solution settings and physical models. Finally, both the application of the abstract model to different CAD-geometries and the appraisal of various design cases with respect to target parameters can be performed by trained design builders, e.g. a design engineer without advanced CFD knowledge.

Key words: CAD, abstract modeling, pre-processing, mesh, GUI, CastNet