A HYBRID APPROACH TO CREATE LARGE COMPUTATION MODEL FOR FLUID-STRUCTURE INTERACTION SIMULATIONS

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Multiphysics, Fluid-structure Interaction, Water Quench Modelling, Large Model, Complex Geometry, Mesh Generation, Polyhedron Meshing, Hybrid Mesh

ABSTRACT

With the trending high demand in durability and performance, single physics simulations such as stand-alone CFD or FEA analyses are no longer sufficient to support the engineering requirements in automotive industry. Exchange of CFD and FEA data are already very common practices in applications such as to calculate distortion of exhaust manifold during engine operation or to predict quench-induced residual stress in cylinder head heat treat process. Although there are great advancements in both CFD and FEA modelling technologies, these advancements do not necessarily make data integration any easier than before.

There are several challenges in integrating fluid mechanics and structural analysis in computer simulations. The first one is that calculations are performed in two separate domains with very different meshing density/mesh quality requirements. The other one is that numerical methods in CFD and FEA utilize different mesh topologies in fully automatic meshing tools/software. Another one is that CFD mesh usually is much larger than FEA mesh due to the size of computation domain. When the size and complexity of geometries increase, it also makes the management of model and data more difficult.

The intent of this research is to explain aforementioned challenges that exist in automotive applications and explore different meshing strategies to streamline the engineering processes. It focuses two aspects of the mesh generation methodologies. The first one is the handling the mesh interface between solid domain and fluid domain. The other one is the comparison of fully automatic meshing using polyhedral cells and semi-automatic meshing using combination of common cells topologies that are shared with CFD and FEA. In addition to mesh generation efficiency comparison for different strategies, the computation results for water quench modelling as an example are also discussed and presented.

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