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OpenFOAM Case Study Project
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Fluid Solid Interaction (FSI) using solids4Foam

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Synopsis

Abstract

The objective of this case study project is to delve into the complexities and methodologies involved in solving Fluid-Solid Interaction (FSI) problems using the OpenFOAM toolbox, specifically solids4Foam. The study underscores the growing interest in FSI within the computational fluid dynamics (CFD) community due to its broad applicability across various engineering fields such as aerospace and mechanical engineering. This project emphasize the inherent challenges in FSI problems, primarily due to the dynamic mesh treatment required to accurately capture the interactions between fluids and solids. The core of the report is centered around the implementation and validation of the solids4Foam solver through two distinct case studies: the Hron-Turek benchmark and a Perpendicular Flap Case. The Hron-Turek case is a well-known benchmark in the FSI domain, used to evaluate the performance of different numerical methods and solvers. The Perpendicular Flap case involves a flexible flap interacting with a laminar incompressible flow within a rectangular channel, with the fluid inlet velocity varying parabolically. Both cases serve to validate the solver's accuracy by comparing the results against existing numerical data. Solids4Foam employs a partitioned approach to solve FSI problems, where the fluid and solid regions are solved separately, and a coupling algorithm enforces momentum and kinematic continuity at the interface. The report details the use of the Dirichlet-Neumann coupling algorithm, where the fluid domain is solved with a Dirichlet condition for velocity at the interface, and the solid domain is solved with a Neumann condition for traction. This method is crucial for ensuring stable and accurate solutions in FSI simulations.The report showcases the potential of solids4Foam as a powerful tool for solving FSI problems within the OpenFOAM framework. By addressing the key challenges and providing validated case studies, valuable insights into the capabilities and applications of this open-source solver are gained, reinforcing its utility for researchers and engineers in the field of computational mechanics.

Keywords: FSI, OpenFoam, CFD, solids4foam, HronTurek, Dirichlet, Neumann