Four Studies with Moving Meshes in OpenFOAM

- centrifugal pump, swirl generator, two-stroke engine, and whiplash motion

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Abstract

This work presents results, conclusions and experiences from four master thesis projects that were carried out during spring 2010.

The first is a detailed study of the ERCOFTAC Centrifugal Pump that was first presented as a case-study for OpenFOAM by Petit et al. at the 4th OpenFOAM workshop and later summarized at an IAHR workgroup meeting [1]. The present work extends that work with studies of different settings for the 2D and 3D steady frozen rotor, and unsteady sliding grid cases. All the available experimental results by Ubaldi [2-4] are used for the validation. Post-processing scripts, as well as selected case-setups, will be distributed to the community through the Turbomachinery Working Group space at OpenFOAM-extend.

The second is a new case-study, based on a swirling flow generator that is located at Politehnica University of Timisoara, Romania. Preliminary studies on this case with OpenFOAM have been done by Muntean et al. [5] and Petit et al. [6]. The swirl generator consists of leaned strouts, guide vanes, a free runner, and a convergent-divergent section resembling the geometry and flow in a Francis water turbine at part load. The runner spins freely with zero torque, and the rotational speed of the runner in the simulations has been adjusted to reach zero torque. The numerical results are compared with detailed velocity and pressure measurements.

The third is using OpenFOAM-1.5-dev and its built-in features for in-cylinder flow simulations in two-stroke engines [7,8]. It uses a deforming and sliding mesh, and layer addition-removal to capture the volume change of the cylinder during scavenging, compression and expansion.

The fourth is a study of blood flow in the venous plexus in the human neck during whiplash motion. In this case the blood flow is driven entirely by the motion of the spinal canal. The motion is predicted by a separate FEM simulation using the THUMS human body model (Ver. 3.0 Toyota R&D Lab. Inc.) in LS-DYNA [9], and written to files in a parametric way. The new library developed in OpenFOAM reads these files and moves all the mesh points according to that prescribed motion [10]. The present work is a refinement of an earlier model implemented in Fluent [11].

All four theses can be found at: http://www.tfd.chalmers.se/~hani/research/

Key words: Turbomachinery, Pump, Turbine, ICE, Two-stroke, Whiplash, Moving Mesh, Sliding Mesh, GGI

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