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Overview of Numerical Methodology in OpenFOAM for Industrial CFD Applications

Prof. Hrvoje Jasak
University of Zagreb, Croatia

Abstract

In this talk, some recent improvements in numerical handling of various CFD models in OpenFOAM shall be presented. Of particular interest is the modelling of free surface flows in naval hydrodynamics, solution methodology for the coupled problems, and strongly non-linear solid mechanics applications.

The major challenge in naval hydrodynamics simulations is a problem of capturing a free discontinuity with a sharp jump in properties within a Finite Volume framework without deterioration. A new implementation of the Ghost Fluid Method for polyhedral FVM will be presented and applied to modelling of wave-structure interaction for fixed and floating structures, with various free surface capturing techniques.

In basic design principles, OpenFOAM is perfectly suited to solving individual partial differential equations, with complex non-linear inter-equation coupling typically resolved using Picard iteration. In this presentation we shall review the multi-equation and multi-domain coupling framework which combines the efficiency of close multi-variable or multi-domain coupling with the flexibility of operator-based discretisation.

A critical aspect of application of CFD tools in industrial setting is the ease of mesh generation and ability of the solver to deal with geometries of varying shape. To facilitate this, two new techniques have recently been implemented as a part of the OpenFOAM tool-kit: Overset Mesh and Immersed Boundary Surface method. Theoretical basis and examples of practical implementation, together with implications on geometrical flexibility and simulation accuracy shall be presented for both methods.

Presentation will include examples of industrial simulations and validation/verification studies in naval hydrodynamics, turbo-machinery and coupled solver performance in external aerodynamics, as well as examples of lubricated contact simulations in tribology and metal forming.