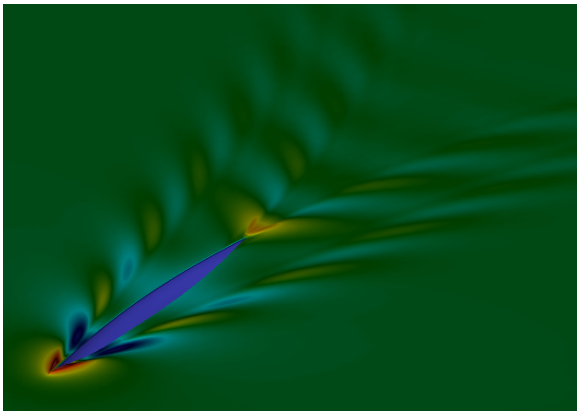
Efficient simulation of steady two-fluid flow

There is an opportunity for M.Sc. graduation work within the ship hydrodynamics group of 3ME.



Steady wave pattern around a wigley hull

Project background

In the maritime and offshore industry two-fluid flows are ubiquitous. CFD simulation of these type of problems are becoming more and more common. Often these problems are of a steady nature, but the computational infrastructure forces these solutions to be obtained by integrating in time for 1000s or even 10000s of steps. The steadiness of the obtained solutions is often questionable, not the speak of the obvious waste of computational resources.

The question arises whether steady solutions of the two-fluid can be found without integrating in (pseudo) time, but instead solving the problem with a quasi-newton method. Recently, a new level-set formulation [1] is introduced that avoids redistancing difficulties traditionally associated with level-set approaches. This level-set formulation allowed for monolithic time-integration of the problem [2], leading to improved stability and energy characteristics. This level-set formulation will simplify the construction of a quasi-newton solver for two-fluid problems.

[1] I. Akkerman, Monotone level-sets on arbitrary meshes without redistancing. Computers & Fluids, 146:74 – 85, 2017.

[2] I. Akkerman, M.F.P. ten Eikelder, Toward free-surface flow simulations with correct energy evolution: An Isogeometric level-set approach with monolithic time-integration. Computers & Fluids, doi: https://doi.org/10.1016/j.compfluid.2019.01.015

Tasks

Implement the novel level-set formulation [1] in MFEM. Combine this Level-set with an existing VMS Navier-Stokes solver. Formulate and linearize the overall problem in such a way that a quasi-Newton approach can be used to find a steady solution. Alternatively, a version of Pseudo-Transient-Continuation could be considered. The final approach should be assessed and its performance should be compared with the traditional transient approach.

Whats in it for you

You will learn the ins and outs of two-fluid simulation using level-sets. You will gain experience in programming in C++ using a generic finite element software stack. This software is suitable for extremely large scale simulations (100k cores) and has NURBS-based Isogeometric Analysis capability.

Contact

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