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INTERACTION BETWEEN A RIGID BODY AND AN INCOMPRESSIBLE LIQUID WITH FREE SURFACE USING THE FINITE ELEMENT SYSTEM EDGECFD-ALE

Thomas Miras[1], Fernando A. Rochinha[1] , Renato N. Elias[1], José L.D. Alves[2], Carlos E. Silva[2], Alvaro L.G.A. Coutinho[1]

[1]High Performance Computing Center and Mechanical Engineering Department - mirasthomas@nacad.ufrj.br

[2]Laboratory of Computational Methods in Engineering Civil Engineering Department

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In the context of Fluid-Structure Interaction, offshore engineering presents a wide range of complex problems such as wave breaking on ships, green water on decks, or the sloshing of liquids in tanks. There still exists a need for some industrial sectors, where consequences of the liquid movements can be dramatic, to estimate the interaction between a structure and the moving liquid. One considers here a multiphysics simulation coupling a rigid body with an incompressible fluid with a free surface, in this problem, we have an interface transmission form of coupling; data exchange through boundary conditions allows the coupling between the fluid and structure equations. Moving mesh methods, within the framework of the Arbitrary Lagrangian Eulerian (ALE) method, is preferred as large body motions have to be taken into account. The software developed in [1] uses edge-based parallel finite elements for the Navier Stokes equations and the Volume-Of-Fluid method for the free surface. Turbulence can be treated by a simple Smagorinsky model or by the Variational Multiscale Method. Mesh updating is accomplished by a parallel edge-based solution of a non-homogeneous scalar diffusion problem in each spatial coordinate.
The works presented are in the continuity of previous publications [1] where an implicit-explicit time integration scheme for the rigid body motion was used. We extend the existing simulation capabilities focusing on the implementation of a fully implicit time integration scheme adapted for both translational and rotational rigid body motion. A particular attention is given for the rotational equation in order to take into account the non-commutative nature of a three dimensional rotation. The capabilities of this time integration scheme are evaluated in terms of accuracy and stability. These formulations are applied on two different test cases: the first one, is a vibrating plate in an incompressible liquid, inspired from [2] and which allows us to study the scheme in comparison with an analytical result. The second one is a more complex industrial case with a boat considered as a rigid body interacting with waves.

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