A First Assessment of the Interdependency of Mesh Motion and Free Surface Models in OpenFOAM Regarding Wave-Structure Interaction

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ABSTRACT

Mesh motion is of key importance in assuring adequate CFD modelling of wave-structure interaction problems, such as wave impact on floating offshore wind turbines and seakeeping of ships. Wave forcing often leads to large displacements of floating structures. As a consequence, the fluid domain boundaries need to move in order to accommodate for these wave-induced displacements. The mesh quality needs to be preserved at all times to guarantee accurate and stable results for the rigid body displacements as well as for the fluid variables.

Mesh deformation techniques, in particular algebraic mesh motion methods, have been widely used within the OpenFOAM framework during the last decade [1]. Unfortunately, stability is easily jeopardized in case of large displacements. Large mesh deformation gives rise to computationally demanding and unstable results. Sliding meshes have been used to address this issue [2], but they are cumbersome for multi-degree of freedom motion. Therefore, overset methods have been implemented in recent versions of OpenFOAM. Especially, the newly implemented overset methods in the OpenFOAM branch `foam-extend`, have shown to give good results for an acceptable runtime [3].

Simultaneously, considerable progress has been made on the development of alternatives for algebraic volume-of-fluid methods for free surface modelling, which notoriously suffer from smearing effects [4]. Although it seems reasonable to expect that the choice in free surface model combined with a certain mesh motion technique will have an influence on the overal result, the interdependency between mesh motion techniques and free surface modelling has not been studied yet.

This paper aims at taking the first steps towards a better understanding of this mesh motion-free surface interdependency and, as such, facilitate an informed choice.

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