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Finite volume modelling of moored floating structured with fluid-mooring line interaction

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ABSTRACT

This study introduces a novel two-way coupled mooring line model based on the finite volume method for simulating moored floating structures. Unlike traditional approaches that consider the line as lumped-mass nodes connected by massless springs [1] or rely on finite element techniques [2], this model employs a finite volume formulation of geometrically exact Simo-Reissner beam theory [3, 4] to capture the interaction between a floating rigid body and its mooring lines, enabling the consideration of bending, tensile, and torsional loads. Furthermore, most coupled CFD-mooring models interact by exchanging position data and mooring forces at the mooring line attachment points, resulting in the mooring lines being unresolved in the CFD domain and treated as Morison-type bodies. In contrast, this work introduces a two-way coupling between the mooring lines and the CFD model, which directly samples the surrounding fluid data and eliminates the assumption of quiescent fluid around the mooring lines. This non-quiescent fluid approach enhances the accuracy of drag and inertia force predictions in both the mooring and CFD models. The coupled model is fully integrated within a unified finite volume framework and implemented using the OpenFOAM C++ toolbox for computational fluid dynamics, making it particularly effective for simulating extreme sea conditions, where it is challenging to assume that the surrounding fluid remains still.

References

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