Development of a fully coupled fluid structure interaction numerical tool for flexible structures

Summary

This PhD research focuses on the development of an advanced numerical tool for simulating fully coupled fluid-structure interaction (FSI) with flexible structures. Accurately modeling the interaction between fluids and structures is crucial in engineering fields such as offshore engineering, aerospace, and civil engineering.

The developed numerical tool integrates the DualSPHysics numerical code for fluid flow simulation and the Finite Element Method (FEM) for structural response modeling. DualSPHysics code runs on the Smoothed Particle Hydrodynamics method (SPH) which enables the simulation of complex fluid behavior, free-surface flows, and large deformations. The FEM provides a robust framework for capturing structural response, considering material properties and geometric non-linearities of flexible structures.

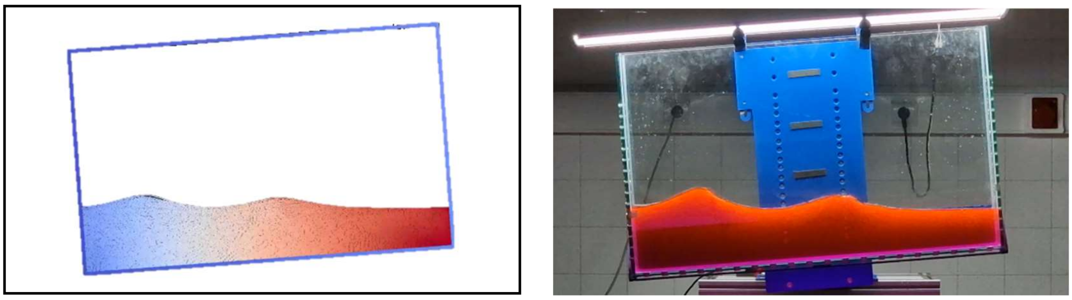
The primary focus of this research is to achieve a seamless integration between the fluid and structural solvers, ensuring accurate predictions of fluid-structure interaction while maintaining computational efficiency. This involves developing an effective coupling between both methods to exchange information between the fluid and structural domains in a consistent and stable manner. The aim is to capture the dynamic behavior and interaction effects between fluids and flexible structures under various loading conditions.

The numerical tool is thoroughly validated against experimental data from an experimental sloshing tank built exactly for this purpose to ensure accuracy and reliability. This validation will prove useful for diverse fluid-structure interaction problems, such as the response of offshore platforms to waves, the behavior of flexible membranes in fluid flows and offshore floating photovoltaic cells (PV).

The outcomes of this research have significant implications for the design and analysis of engineering structures subject to fluid flow, namely, offshore Wave Energy Converters (WECs) and offshore PV cells. The developed numerical tool provides engineers and researchers with a powerful computational framework to investigate complex fluid-structure interaction problems, leading to more reliable and efficient designs.

Keywords

Fluid-structure Interaction, FSI, flexible structures, smoothed particle hydrodynamics, Finite Element Method (FEM), computational fluid dynamics.



Simple comparison between the numerical and experimental sloshing tanks

(without a flexible floating body).

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