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Numerical Analysis of Fluid-Structure Interaction (FSI) for Semi-Submersible Floating Offshore Wind Turbines (FOWT)

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ABSTRACT

This study investigates the dynamic behaviour of a semi-submersible Floating Offshore Wind Turbine (FOWT) using a Computational Fluid Dynamics (CFD)-based Fluid-Structure Interaction (FSI) approach. The research aims to capture the coupled hydrodynamic and structural responses of the platform and enhance understanding of its dynamic performance. The validation study was conducted through CFD simulations of free decay tests, referencing the experimental data reported by Wang et al. (2022), which demonstrated excellent agreement with the simulations. The CFD results successfully reproduced the time histories of surge, heave, and pitch motions, showing strong consistency with experimental trends, natural periods, and damping behaviour, as illustrated in Figure 1.

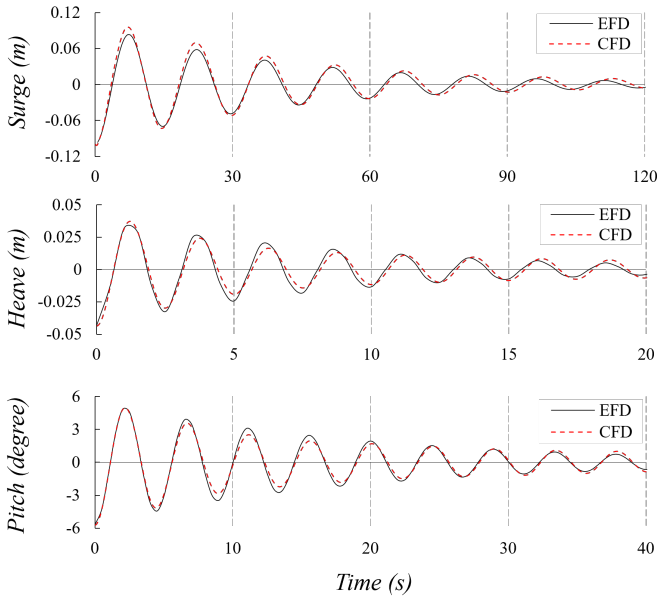

Figure 1: Free decay validation: comparison of CFD and experimental results for surge, heave, and pitch motions.

Building on these validated results, this research investigates platform responses under specific wave scenarios, including no-wave, regular waves, irregular waves, and extreme waves. The study aims to analyse how wave-induced forces, captured through the FSI method, influence platform stability and motions.

Additionally, this study seeks to develop a CFD-based FSI method suitable for simulating FOWT platforms, providing practical insights into the coupling between hydrodynamic forces and structural responses. The findings contribute to the advancement of simulation accuracy for predicting FOWT performance and support the development of optimised design strategies for offshore wind energy systems.

References

L. Wang, A. Robertson, J. Jonkman, J. Kim et al. OC6 Phase Ia: CFD Simulations of the Free-Decay Motion of the DeepCwind Semisubmersible. Energies, 15(1):389, 2022. ISSN 19961073. doi: 10.3390/en15010389. URL https://doi.org/10.3390/en15010389.