**Title: Numerical modelling and optimization of the dynamics of FOWT given met-ocean conditions and turbine loads for HIL testing in wind tunnels**

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**Background:**

Offshore wind turbines have access to higher wind speeds with lower turbulence, they are also not constrained by their vicinity to other restricting infrastructures. But, for water depth levels above 50m, the construction becomes unfeasible economically, here floating offshoring wind turbines (FOWT) present a viable solution [1].  However, this technology has engineering challenges since it involves loading from both winds and waves. Moreover, FOWTs exhibit six degrees of motion, impacting the performance of the turbine, the wakes followed by it and fatigue/loading. To investigate such phenomenon experimental testing using methods such as hybrid Hardware-in-Loops (HILs)  are instrumental.

At TU Delft, a hybrid-HIL test set-up is being developed at the OJF wind tunnel. Here a scaled-down wind turbine is tested on a 6-DOF parallel kinematics robot (hexapod) with physical wind and numerically modelled hydrodynamics [2]. The hexapod is modelled to behave as a floater simulating the dynamics of wave and current loads, the mooring line forces, and the inertial and gravitational impacts due to the movement of the FOWT - all actuated by the hexapod with a real-time numerical model.

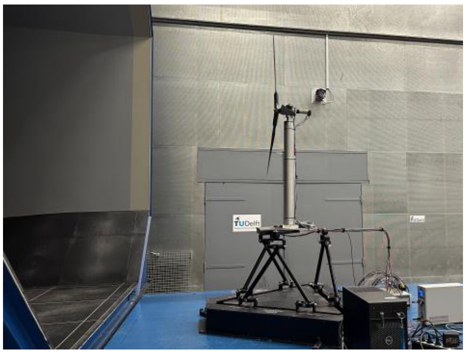

*Figure 1: Scaled wind turbine set-up for hybrid HIL tests [2]*

**Objectives:**

The primary objective of this thesis would be to create a comprehensive numerical model capable of real-time simulation of the dynamics of a multi-megawatt reference wind turbine with a semi-submersible floater, with given met-ocean conditions and turbine loads. The numerical model is validated with results from OpenFAST for an identical setup. Later, the model is modified for the scaled-down FOWT for hybrid- hardware in the loop testing.

The secondary objective of the thesis would be to optimize the model for enhanced computational efficiency. This would involve analyzing the influence of various forces involved with the dynamics such as mooring line forces, wave and current effects, viscous forces, among others. After the analysis, the forces with small influence can be simplified or neglected.

The third objective of the would be to make the model more versatile, allowing the accommodation of different floater designs. This would make the model more adaptable for wider applications.

**References:**

[1] Cheng, P., Huang, Y., & Wan, D. (2019). A numerical model for fully coupled aero-hydrodynamic analysis of floating offshore wind turbine. Ocean Engineering, 173, 183-196.

[2] Taruffi, F., Novais, F., & Viré, A. (2023). An experimental study on the aerodynamic loads of a floating offshore wind turbine under imposed motions. Wind Energy Science Discussions, 2023, 1-24.