

A New Digital Twin Concept for Floating Offshore Structures

A digital twin is a virtual model that replicates a physical object or system, allowing for improved design and operation through computer simulations.

In this project a new digital twin concept for floating offshore structures, such as wind turbines and wave energy converters, is to be developed. The aim is to create a highly efficient and accurate simulation framework using advanced mathematical and computational techniques prepared for high performance computing, i.e. that can run on massively parallel computing systems. Within this framework, high-order spectral element methods (SEM) will provide the flexible basis for implementing state-of-the-art numerical schemes such as fully nonlinear potential flow (FNPF) models for free surface modelling and will -- ultimately -- be able to run efficiently at regional scales for offshore engineering applications allowing for simulations of water waves and their interaction with floating offshore structures.

Such floating structures can be renewable devices such as wind turbines, wave energy, and even ship structures. Through enabling parallel simulations, it will be possible to use such simulations to produce data. New models for simulation of water waves and their interaction with structures will be used to research data-driven methods that falls in the scope of the emerging research area of Scientific Machine Learning (SciML) that combine physical modelling with data science methods.

Specifically, Scientific Machine Learning (SciML) is an emerging area that aims to deliver new robust, scalable, and interpretable tools that can utilize (noisy) data in the modeling of physical systems. Thereby, SciML that has potential for significantly reducing the cost and time of designing offshore structures.

The project aim is to explore the use of data-driven multi-fidelity predictive modelling techniques as well as explore the design of nonlinear dimensionality reduction techniques. Ultimately, the goal is to enhance the development of renewable energy sources and contribute to addressing the global climate crisis by providing sustainable energy solutions.