P4 - Wave Energy Converter Array Modelling via Harmonic Balance Methods

Wave energy converters will be deployed in large arrays of tens of devices in the near future. However, hydrodynamic interactions among the different devices must be carefully considered in order to optimise the final layout of the WEC array. Including several devices with a certain precision of the different effects in a computationally efficient model is a complicated task. Most array models neglect important nonlinear effects and/or losses in the hydrodynamic interactions, mooring lines and power take-off system.

A potentially interesting modelling technique that can handle these nonlinearities and losses within a reasonable computational time is the combination of time- and frequency-domain methods, such as Harmonic Balance method.

The student will design and implement a A mixed time-domain/frequency-domain method for modelling dense wave energy converter (WEC) arrays with non-linear power take-off system and nonlinear mooring line model

The model will be based on a harmonic balance method which describes the system response in the frequency domain, while evaluating the non-linear PTO force and solving the system equations of motion in the time domain. The non-linear PTO force will be computed with Lagrange multipliers. In order to apply the proposed method for WEC array responses in real sea states, the time series will be split into time windows and the simulation carried out individually per window.

Objectives

- Understanding the different interactions within a WEC array
- Understanding of the Harmonic Balance method
- Design of a WEC array model based on the Harmonic Balance model
- Evaluation of the optimal WEC array layout

Tasks

i. Modelling a single device with the Harmonic Balance model
ii. Implementing PTO and mooring effects into the single-device model
iii. Design and implementation of a small WEC array via the Harmonic Balance method
iv. Sensibility analysis of the different parameters of the Harmonic Balance method: length of time window, overlay method, harmonic components, …
v. Determination optimal layouts for different scale WEC arrays

Bibliography

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