Data-based modelling of nonlinear hydrodynamics for wave energy conversion systems

Master thesis proposal at the Marine Offshore Renewable Energy Lab

Department of Mechanical and Aerospace Engineering

Politecnico di Torino

Recommended profile:
Mechanical engineering, Mechatronic engineering, Applied mathematics

Topics involved:
Control theory and applications, modelling, model reduction, system dynamics, wave energy conversion

Proposal description

Wave energy conversion devices, commonly referred to as **wave energy converters** (WECs), need to be controlled in order to maximise the energy extraction from the ocean wave resource, hence directly lowering the associated levelised cost of energy.

Control for WEC systems departs from standard regulation/tracking objectives, commonly employed in control engineering: The objective is that of maximising energy extraction, and not that of following/tracking a given set-point/reference. As such, the vast majority of the WEC control techniques employ lie within the field of optimal control theory, where an associated optimal control problem (OCP) is solved in real-time to compute the corresponding control action. OCPs are virtually always model-based: That is, a dynamical model of the WEC system is required in order to predict future motion, enforce constraints, and maximise the energy objective. These models need to be parsimonious in terms of both computational and analytical complexity, in order to facilitate real-time calculations, i.e. to be implementable.

Nonetheless, being the Navier-Stokes equations the starting point for WEC modelling, computing control-oriented models can be a daunting task. As a matter of fact, recently, a particular class of wave-induced nonlinear effects has been deemed to be particularly relevant for controlled devices. This project will explore the use of data-based modelling for to compute parsimonious dynamical representations of WEC systems, based on mid-fidelity solvers. The resulting models will be used both for analysis and optimal control purposes.

Relevant reference: https://link.springer.com/article/10.1007/s11071-022-07530-3

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