LPV modelling and control of 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, robust control, 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.

In the pathway towards building these control-oriented models, a number of potentially limiting standing assumptions are often adopted. These modelling hypothesis, which aim at simplying the dynamical description of the WEC system, inherently introduce a large degree of uncertainty in the control design problem. This project will explore the use of linear parameter varying (LPV) representations for WEC systems in order to achieve robust performance for controllers aiming at maximising energy extraction from the wave resource. LPV systems feature a closed-form representation of a system in terms of a set of scheduling parameters, offering the possibility of incorporating dynamical behaviour which is often neglected in purely linear models.

Relevant reference: https://ieeexplore.ieee.org/abstract/document/1058058

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