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Control of floating flexible structures interacting with waves

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ABSTRACT

Floating flexible structures have a great potential for a wide range of applications in offshore and coastal engineering. Some prominent application are their deployment as floating breakwaters, as a support for floating photovoltaic energy or as wave energy harvesting devices. These structures offer several advantages, including lightweight construction, ease of deployment, re-usability, and minimal impact on critical coastal processes such as sediment transport and fish migration. In some of these applications, the ability to control the motion of such structures could be very beneficial. For example, one might be interested on reducing the motion of floating flexible platforms to guarantee the stability of certain superstructure.

In this work we present a framework for controlling the motion of flexible floating structures that combines a Model Predictive Control (MPC) algorithm with a monolithic Finite Element (FE) model for wave-structure interaction problems [1,2]. To accelerate the control input optimization within the MPC, we develop a reduced order model using Dynamic Mode Decomposition with Control (DMDc), trained on open-loop FE model data. In addition, we implement a Kalman filter to reconstruct the system response from sparse and noisy measurement data. In this contribution we also demonstrate the behavior of the proposed approach for a floating flexible structure with an elastic hinge subject to regular and irregular waves.

References

[1] Colomés, O., Verdugo, F., & Akkerman, I. (2023). A monolithic finite element formulation for the hydroelastic analysis of very large floating structures. International Journal for Numerical Methods in Engineering, 124(3), 714-751.

[2] Agarwal, S., Coloés, O., & Metrikine, A. V. (2024). Dynamic analysis of viscoelastic floating membranes using monolithic Finite Element method. Journal of Fluids and Structures, 129, 104167.