ADVANCED WEC DYNAMICS AND CONTROLS PROJECT - MODELING, ESTIMATION, AND CONTROLLER DESIGN

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Abstract

This poster presents major achievements of a multi-year project 'Advanced WEC Dynamics and Controls' being studied at Sandia National Laboratories. This project mainly focuses on the implementation and performance of controllers for wave energy converters (WECs) and one of the project goals is to improve the design of WECs. The three main parts of control systems are modeling, estimation, and controller design, and the achievements of the project are detailed for each part in the poster. (Figure 1) This poster is intended to provide a single summary of project's research and a map to resources for the interested viewer.

The first part handles the modeling for a WEC system, which was carried out for 1 degree of freedom (DOF) – heave motion only – and 3 DOF – heave, surge, and pitch motions. The models could be obtained using numerical/analytical tools, but high-fidelity WEC models were also derived using experimental data and validated via system identification techniques for radiation/excitation components [1, 2, 3]. Second, parameter estimation was performed for subsequent controller design. Especially, a new approach using the pressure on the hull to estimate the excitation force is to be noted [2]. Finally, based on the obtained WEC models and estimated parameters, novel controllers that maximize the power absorption could be designed. Three different controllers were developed – proportional-integral (PI) controller, model predictive controller (MPC), and feedback resonating (FBR) controllers - and their performances were assessed and compared through extensive wave tank tests. For the embedded, real-time WEC control system to be most effective, hardware/software codesign techniques were applied and primarily the drivetrain and measurement/data-acquisition systems have been carefully examined [4]. Among the three control strategies,

it was shown that the FBR controller negates the need for wave prediction to improve WEC energy absorption and can achieve more than 90% of the theoretical maximum [5].

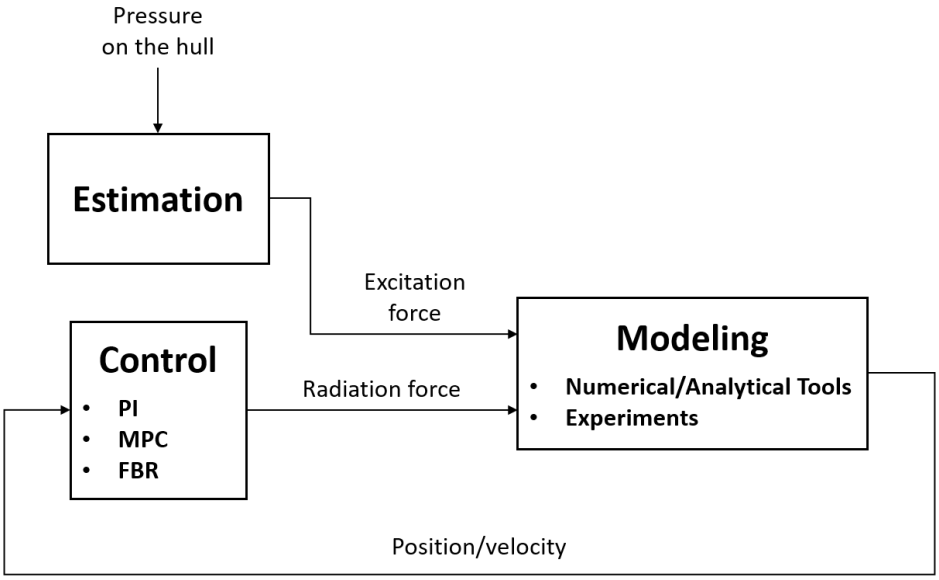

Figure 1: Block diagram showing the three main parts (modeling, estimation, control) investigated in the Advanced WEC Dynamics and Controls project of Sandia National Laboratories.

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References

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