Control strategies of a wave energy converter for the WECfarm project

De Beule Louis, Vervaet Timothy, Quartier Nicolas, Stratigaki Vasiliki and Troch Peter

Civil Engineering, Ghent University, Technologiepark 60, 9052 Zwijnaarde, Belgium
E-mail: Louis.DeBeule@UGent.be

This abstract refers to an ongoing master's thesis at the department of Civil Engineering of Ghent University (Belgium) on control strategies of a wave energy converter which is being prepared for the upcoming WECfarm project. A new experimental campaign within the WECfarm project is planned in a new wave basin; the Coastal & Ocean Basin (COB) in Ostend. WECfarm will deliver a database for validation of new advanced numerical models which are worldwide employed for WEC array modelling. The working principle of the WEC is the one of a point absorber operating in heave. The power take-off consists of a rack and pinion system in combination with a rotational Permanent-Magnet synchronous motor (PMSM). To control the WEC, a Simulink 'Real Time torque control' model is used. This model is built on a development computer and subsequently loaded on a Speedgoat Performance real-time target machine. In this context, real-time is the capability of the algorithm to execute within a prescribed update rate. The control model on the target machine processes the input signals from the laser sensor, accelerometer and load cells to provide, depending on the control strategy, the torque request as output to the drive. Within this master thesis, the performance of a single WEC (the so-called "Master WEC") will be evaluated for different control strategies. The baseline strategy will be a passive controller, consisting of a force proportional to the velocity. A literature study will identify possible other advanced strategies. Model Predictive Control (MPC), Latching control, Reactive loading control and Linear Quadratic (LQ) Control are among the possibilities [1], [2]. Although the performance evaluation will be for the single Master WEC, the later extension to an array of five WECs will be taken into account as this is the WEC number that will be used in the WECfarm project. The passive control and the selected advanced control strategies will be implemented in the MATLAB Simulink model. Firstly, the efficiency of the MATLAB Simulink control model will be evaluated in a dry set-up. Secondly, the passive controller will be evaluated in wave flume tests. Tests in a wave basin will allow to determine the power production for the passive control strategy. If possible, tests with the selected advanced control strategies will be executed to compare the power production relative to the baseline strategy. These consecutive steps will allow us to make recommendations for the control of the arrays of up to five WECs, to be experimentally tested at the COB in 2022.

References

[1] D. Wilson, G. Bacelli, R. G. Coe, D. L. Bull, O. Abdelkhalik, U. A. Korde, and R. D. Robinett III, (2016) A comparison of WEC control strategies. Sandia National Labs, Albuquerque, New Mexico, Tech. Rep. SAND2016-4293.

[2] Beatty, S., Ferri, F., Bocking, B., Kofoed, J.P., Buckham, B., (2017). Power Take-Off Simulation for Scale Model Testing of Wave Energy Converters. Journal Article, Energies.

Acknowledgements

This work is supported by the the FWO (Fonds Wetenschappelijk Onderzoek - Research Foundation Flanders), Belgium, through the following funding: 1) Timothy Vervaet is Ph.D. fellow (fellowship 11A6919N); 2) Nicolas Quartier is an SB Ph.D. fellow (fellowship 1SC5419N); Vasiliki Stratigaki is a postdoctoral researcher (fellowship 1267321N) and has been also granted an 'FWO Research Grant' for constructing the WEC experimental set-up (FWO-KAN-DPA376).

Keywords: WECfarm; Control strategies