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On the importance of advanced mesh motion methods for WEC experiments in CFD-based numerical wave tanks

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Extensive numerical modelling is required during the development of wave energy converters (WECs). A range of numerical models exist, with varying computational cost and fidelity, whose selection depends on the application and the available computational resources. While lower fidelity models, based on linear hydrodynamic modelling techniques, are computationally efficient, their accuracy decreases when the amplitude of the waves and WEC motion increases, violating the linearising assumptions. In contrast, higher fidelity models, such as CFD-based numerical wave tanks (CNWT), remain accurate over a wide range of operational conditions by considering the relevant non-linearities, at the expense of increased computational cost.

To be commercially viable, it is well known that WEC devices have to be (a) installed in array configuration and (b) equipped with energy maximising control systems (EMCSs). EMCSs increase the operational space of the WEC, resulting in increased device motion, pushing lower-fidelity numerical models beyond their limits, and makes the application of higher-fidelity models vital.

Although the hydrodynamic model in a CNWT is able to capture all relevant hydrodynamic non-linearities, even when the WEC motion is increased, large body motions can introduce numerical instabilities. Widely applied mesh morphing methods, for the capturing of dynamic mesh motion, deform the control volumes in the vicinity of the moving structure. These deformation can deteriorate the mesh quality (e.g. large aspect ratio or high skewness), ultimately resulting in simulation crashes. Recently, more advanced mesh motion methods, such as overset grid methods, have become available.

This paper aims on presenting the importance of advanced mesh motion methods, in particular overset grids, for the analysis of WECs in CNWTs under controlled conditions. A case study based a generic moored point-absorber WEC is presented, highlighting the limitations of classical mesh morphing methods. Furthermore, two overset grid methods are employed to assess their feasibility for WEC experiments.