RANS-VOF Modelling of Wave Energy Converters

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Introduction

The continued increase in the performance-to-cost ratio of modern computers has meant numerical models can now provide the quantitative description required for the engineering analysis of marine structures. However, unlike conventional structures, wave energy converters (WECs) are designed to develop specific motions under wave loading. Therefore it is unclear as to how much of the existing research is directly transferrable to cases involving dynamically responsive WECs.

In this work, a fully nonlinear computational fluid dynamics (CFD) approach as been used to numerically model the coupled behaviour of two existing WEC designs in waves [1]. In both cases, the simulations reproduce physical model experiments at scale.

Wavestar

A 1:10 scale model of a single float and arm, from the Wavestar concept, has been simulated in regular waves with a height of 0.25m and a period of 2.8s (Figure 1). The device is constrained to a single angular degree of freedom such that its motion is describe by the displacement in the hydraulic cylinder (Figure 2). In this case the motion is assumed to be free from damping.

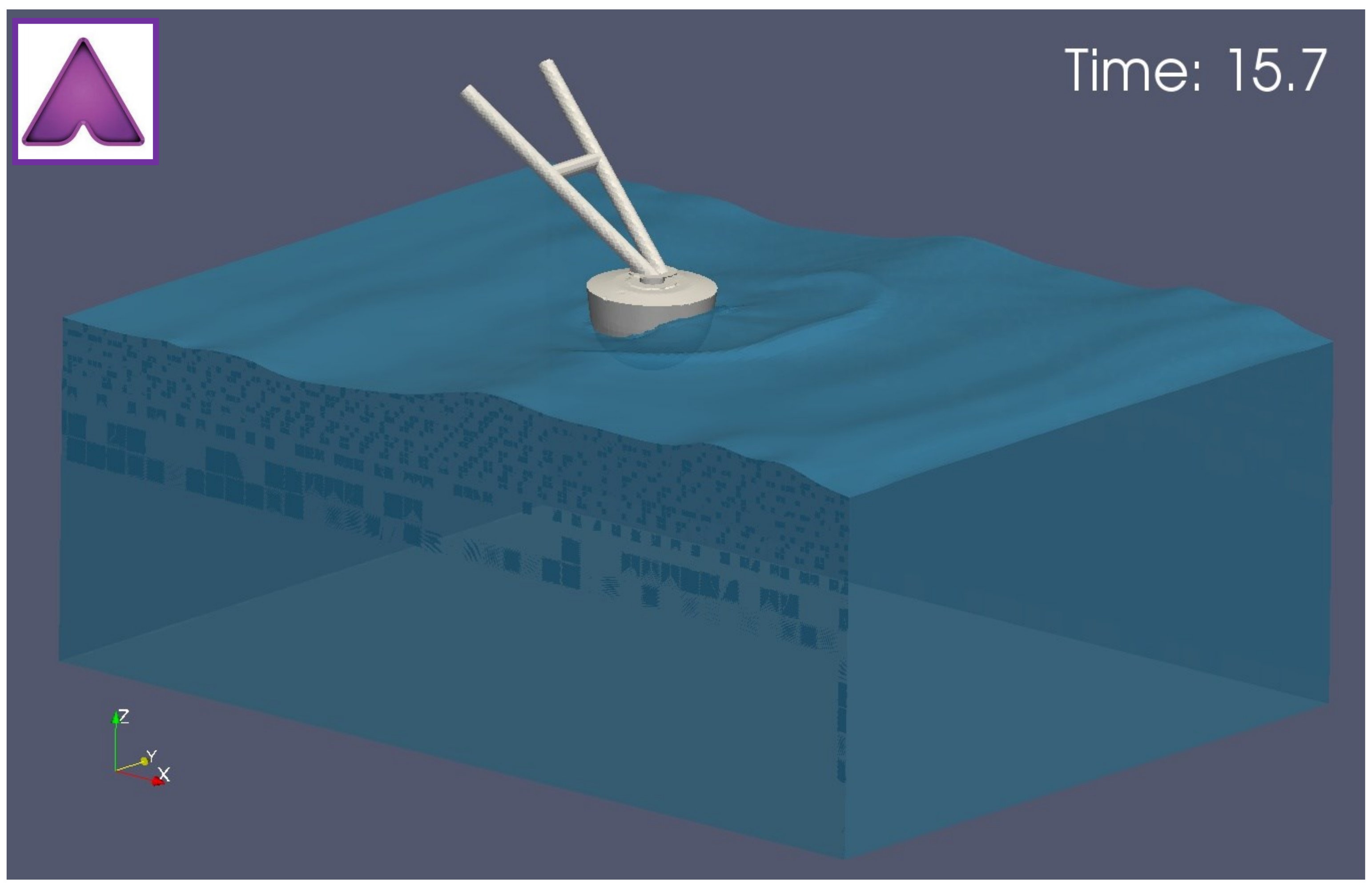

Figure 1: Screenshot from the numerical simulation as the float drops. This image is tagged with augmented content (see note below).

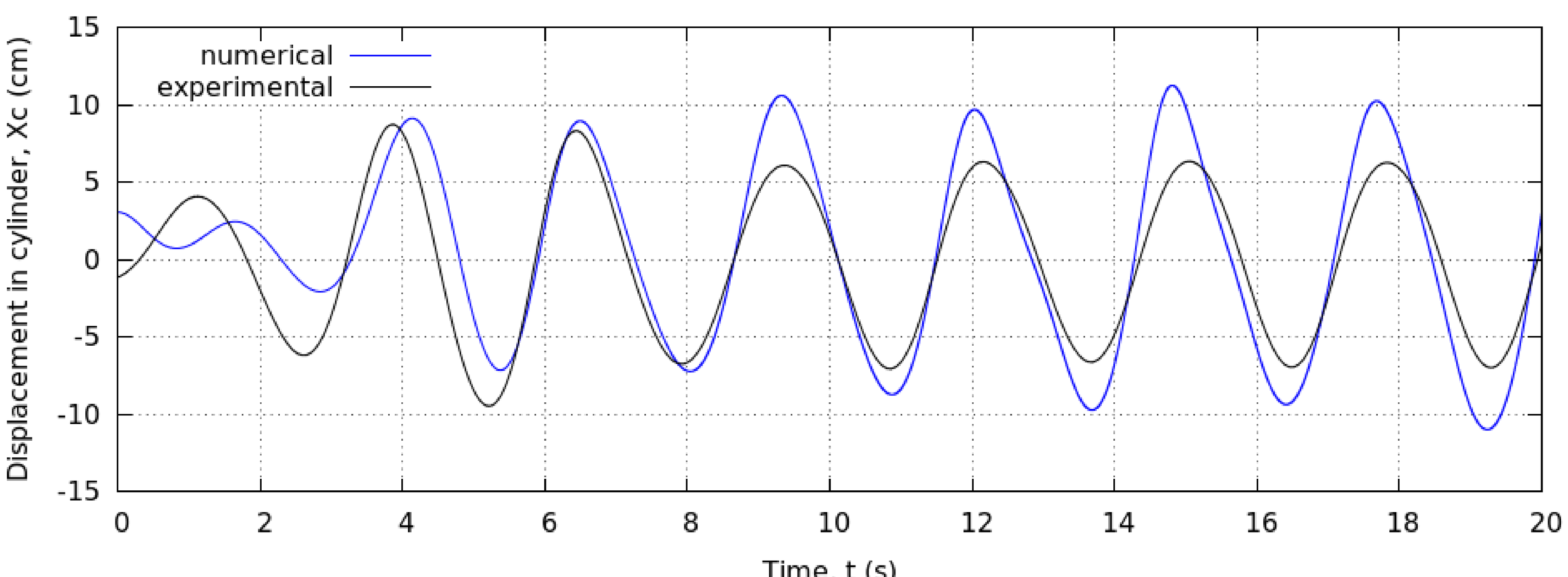

Figure 2: Displacement in the Wavestar cylinder with the PTO disabled. Numerical (blue), experimental (grey).

This poster is tagged with augmented content

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Seabased

A 1:20 scale model of the Seabased device was tested in regular waves with a height of 0.3m and a period of 2.4s (Figure 3). The float is able to move in all six degrees of freedom but is attached by a single inelastic line to the PTO system which consists of a translator, end-stop spring and a limited stroke length. A bespoke restraint was, therefore, created for the numerical model. Figure 4 shows results for the float motion and mooring load.

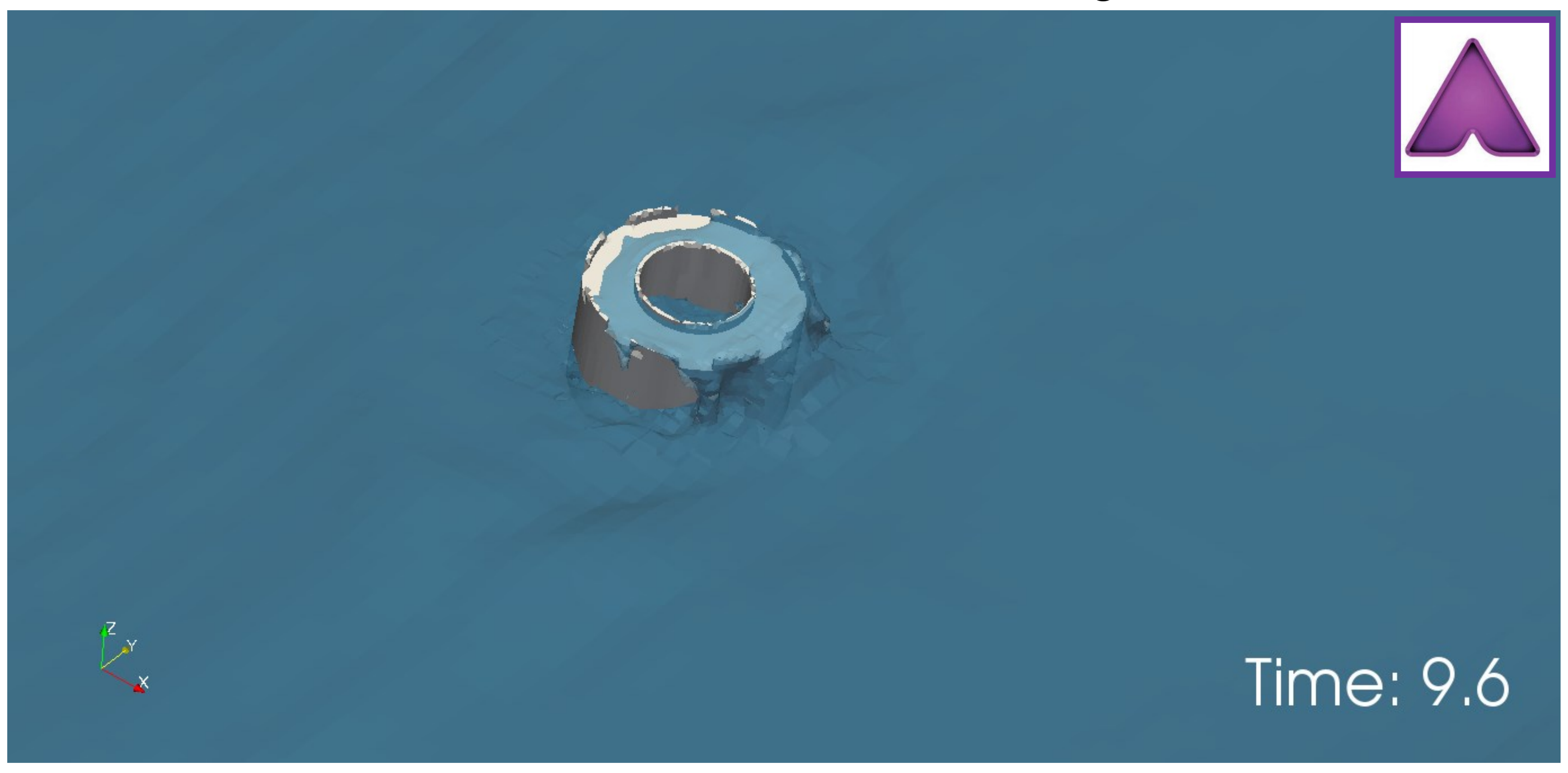

Figure 3: Screenshot from the numerical simulation. This image is tagged with augmented content (see note below).

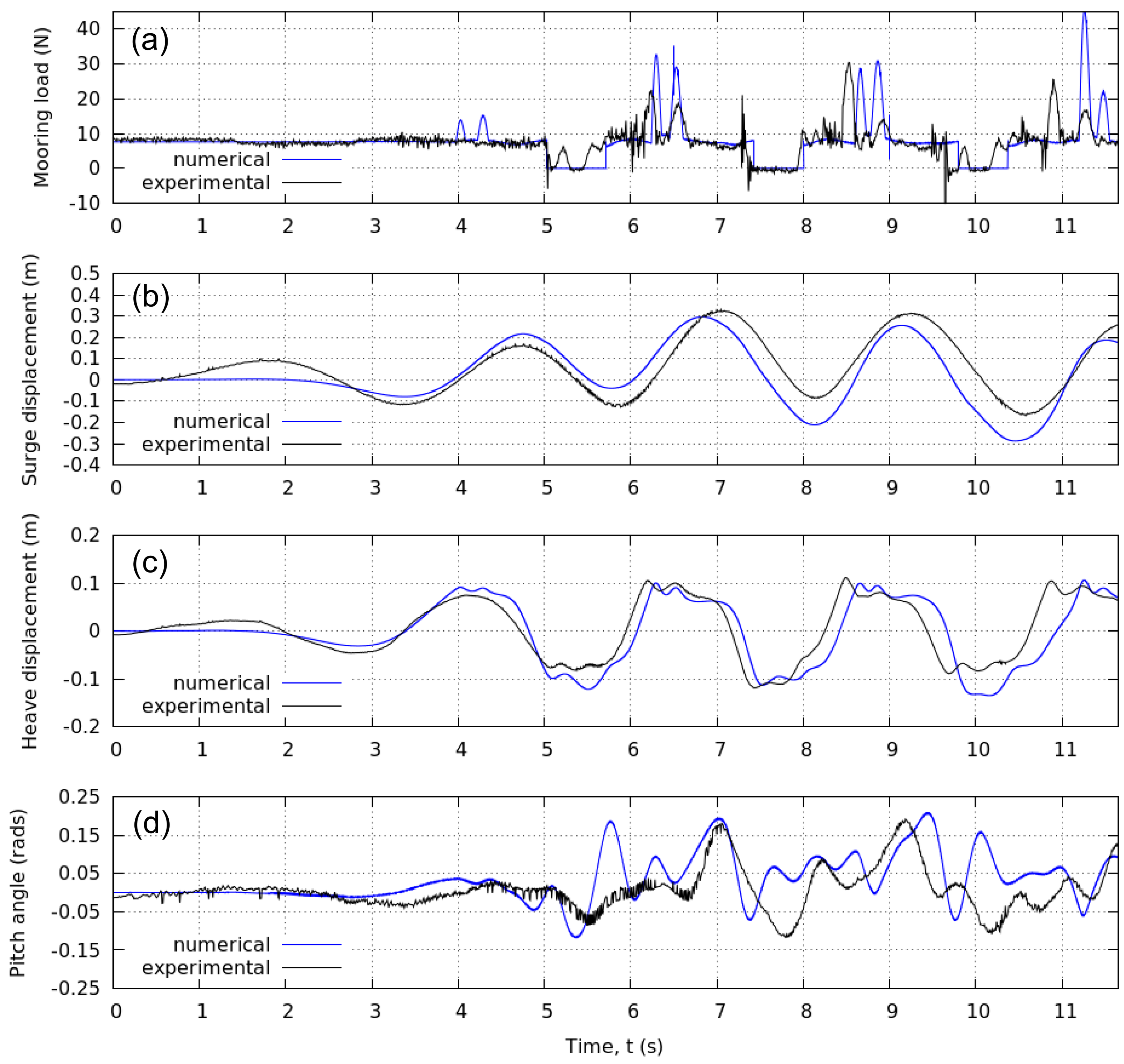

Figure 4: Numerical (blue) and physical (grey) results from simulation of the Seabased wave energy generator. (a) mooring load, (b) surge displacement, (c) heave displacement, and (d) pitch angle.

Conclusion

In conclusion, the numerical wave tank (NWT) developed by Ransley [1] has been shown to be capable of simulating the coupled behaviour of both the Wavestar and Seabased WECs. However, for such complex systems, a precise reproduction of the results relies heavily on the specifics of the experiment.

References

1.E J Ransley (2015) "Survivability of Wave Energy Converter and Mooring Coupled System using CFD", PhD Thesis, *2015: Plymouth University*, UK.

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