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Body-less approach for the numerical modeling of wave energy converters

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Marie Skłodowska-Curie Actions (MSCA) – Research and innovation Staff Exchange (RISE)

H2020- MSCA-RISE-GA number 872442



Accurate Roms for Industrial Applications

Seconded: Battisti Beatrice

Dates: 28/11/2022 – 24/02/2023

Work Package:

Host Institution: Inria Bordeaux Sud-Ouest

Secondment Institution: Optimad

SCIENTIFIC REPORT

1. Purpose of the secondment:

In the wave energy sector, numerical simulations of wave energy converters (WECs) play a crucial role throughout the technology development process, from design to validation. However, conducting high-fidelity simulations becomes prohibitively costly, especially when dealing with wave energy converter farms involving multiple WECs. A significant portion of this expense arises from the complex model of the WEC itself, consisting of a body with multiple degrees of freedom, discretized using a moving overset mesh. The purpose of this secondment is to address this challenge by proposing a different approach. The idea is to replace the detailed WEC model in high-fidelity simulations with a more efficient forcing term in the governing equations, applied only at specific points in the mesh where the body is expected to be present. This approach lightens the simulation load, removing the need for the computation of the body and the overset in the mesh. To further reduce computational costs, we plan to train a model using Model-Order Reduction techniques or Neural Networks based on data from simulations of few different incoming waves. This model will then provide the appropriate forcing term for various wave scenarios, streamlining the simulation process.

2. Description of the transfer-of-knowledge activities and work carried during the secondment

Throughout the secondment, Optimad has been a key partner, providing essential computational resources and modeling expertise that greatly supported the project's development. We successfully conducted simulations of a body falling into the water using the "body-less" simulation approach with the

corresponding forcing term. A section of the meshes for the simulation with the body and with the body-less approach are displayed in Figure 1.

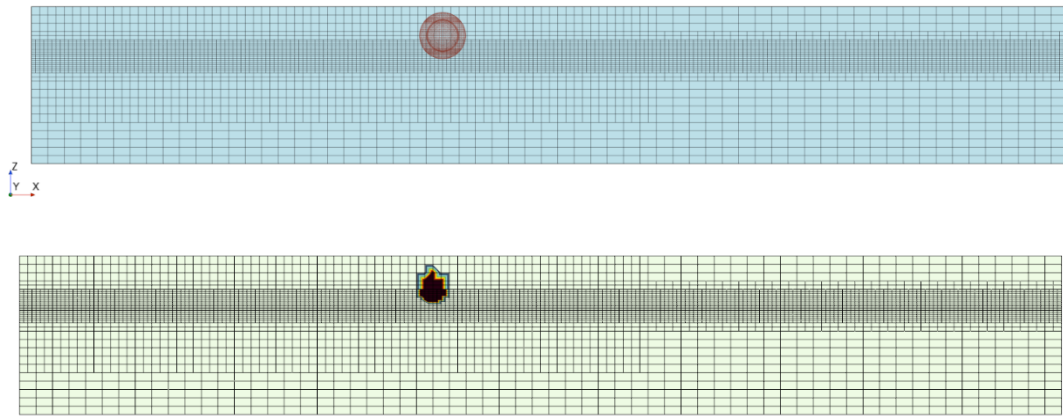


Figure 1: Meshes for the simulation with the body (top), and with the highlighted points where the forcing term is applied in the body-less approach (bottom), at initialization.

The results are compared with simulations incorporating the explicit WEC body model, and the findings are visually represented in Figure 2.

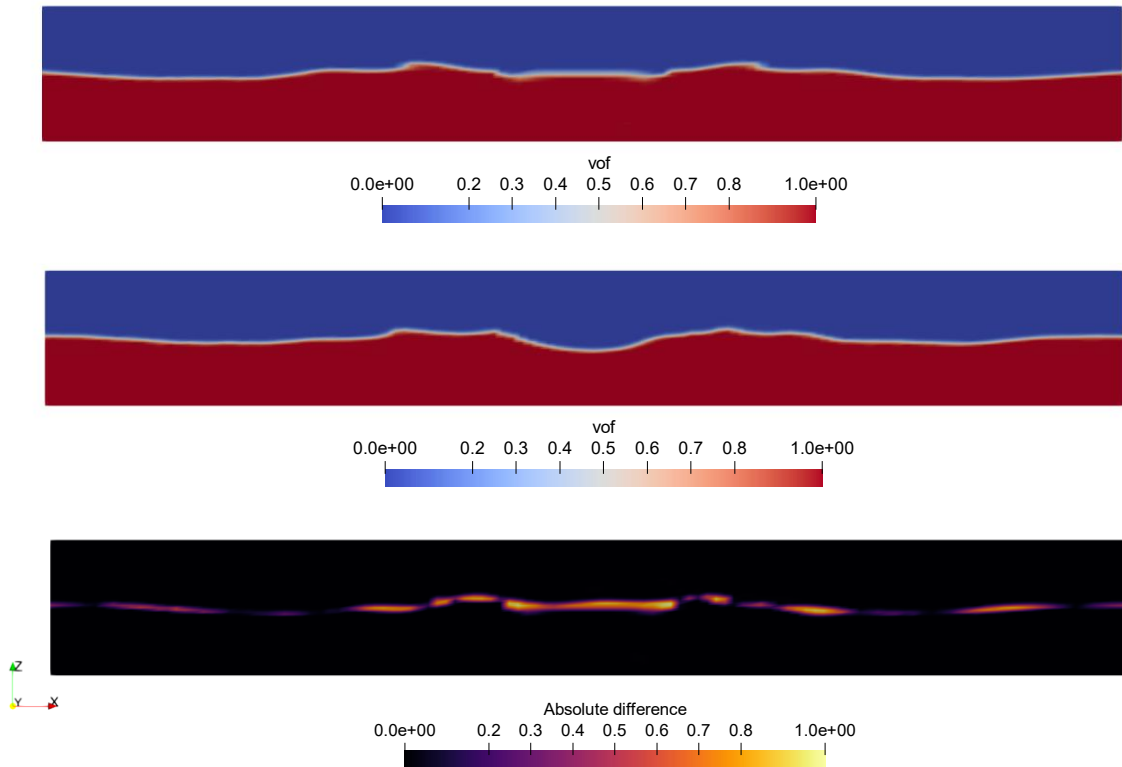


Figure 2: Wave elevation (in terms of Volume of Fluid) at time $T=8s$, for the simulation with the body (top), for the body-less simulation (center), and absolute difference of the two results (bottom).

Our next steps involve advancing towards simulating a real WEC scenario. This entails modeling an incoming wave, recording the WEC body dynamics, and applying the body-less simulation approach. By simulating different wave scenarios, we aim to create a comprehensive training dataset to enhance the model's accuracy and effectiveness.

3. Foreseen publications (of applicable)

Currently, the project is in its initial stages, and the collaboration initiated during the secondment is ongoing. The progress made thus far is promising, and we anticipate the achievement of compelling results that would merit a publication. As the collaboration continues, we expect to contribute significant insights to the wave energy sector, further solidifying the potential impact of this research.

Turin, 28/07/2023



Beatrice Battisti

Approval:

[Name], at Optimad, confirms that the secondment was completed as planned with regard to the research activities carried out by Beatrice Battisti from 28/11/2022 to 24/02/2023.

[Name] [Secondment Institution],