Numerical Wave Tanks - Comparison of different nonlinear models

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CONTEXT

The marine and maritime sectors are of primary importance in the local industrial context of the Nantes regional area. At the local, national and international levels, those sectors are still facing several challenges, due to the complexity and severity of the ocean environment.

A prominent one is to account for the extreme wave conditions in the design of marine structures. These environmental conditions, as well as the induced responses, exhibit complex physical processes. In this context, the present procedures for the evaluation of the extreme responses are known to be inaccurate. This forces the regulations of classification societies to introduce large safety factors that may be inadequate in some conditions.

The WASANO project, funded by the I-Site NExT initiative, intends to address the problem of an accurate and controlled description of extreme environmental conditions for ocean engineering. To overcome several identified scientific bottlenecks, the project proposes innovative methods to i) define the extreme sea states responsible for the ultimate responses of structures at sea and ii) reproduce them in water tanks or with high-fidelity numerical solvers. These will apply to environmental conditions in numerical simulations and physical experiments at model scale.

The WASANO project will create a large international consortium in view of establishing reference procedures, which are expected to be part of the future of regulations at international level. This international partnership involves for now 10 world-renowned international universities as well as 3 industrial partners.

MASTER'S THESIS CONTENT

In this context, Ecole Centrale Nantes is proposing a Master's thesis topic in the LHEEA Laboratory focusing on the comparison of different nonlinear wave models.

Different WASANO partners have developed so called Numerical Wave Tanks (NWT) to address the problem of the propagation of nonlinear water waves in wave tanks environment. Those models are based on the potential flow formalism but use different numerical strategies for the discretization of the set of equations.

The objective of the Master's thesis is consequently to compare different NWT in terms of efficiency and accuracy. The different models identified for now are:

- HOS-NWT, developed in ECN for the last 20 years, based on pseudo-spectral methods
- OceanWave3D, developed at DTU (Denmark), based on finite differences
- IITM-FNPT2D, developed by IIT Madras (India), based on finite elements

Comparisons will be achieved on a set of experimental tests already conducted in ECN. Different types of wave fields will be studied, with an increasing degree of complexity: regular waves, unidirectional

irregular waves and multidirectional irregular waves. In addition, the wave conditions will cover mild sea conditions up to extreme sea states, exhibiting breaking events. Each numerical model has a different methodology to take care of breaking event and it will be one particular focus of the Master's thesis.

The main objective is to report the pros and cons of each numerical model. Dependent on the available time, other NWT may be tested during the course of the project. Some interactions with the developers of the different models are expected in this international environment.

This work may lead to publication in an international conference.

PROFILE OF THE CANDIDATE

The candidate should be a 2nd-year Master's student (or equivalent degree) with a specialization in Ocean Engineering, Applied Mathematics, Mechanical Engineering or related topics. Appetence for numerical modelling is necessary and knowledge of the physics of the water waves is a bonus.

English fluency is mandatory.

SCHEDULE AND CONDITIONS

Schedule:

Candidates are invited to contact the supervisor, Dr. Guillaume Ducrozet (guillaume.ducrozet@ec-nantes.fr) via email, with a CV and a motivation letter.

Applications received after November 15th, 2022 will not be considered and the final decision should be available on November 30th.

The successful candidate is expected to start by March 1st, 2022 at the latest.

Conditions

The candidate will be funded for six months (at the French legal level for MSc theses: around 600€/month) and hosted within the LHEEA Lab. of Ecole Centrale Nantes.

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