Performance prediction of wave propulsion applied to cargo ships.

Background and motivation

The IMO recently set the goal to half shipping's greenhouse gas (GHG) emissions by 2050 (compared to the 2008 levels). In the same year Sweden wants to become completely CO_2 free (zero net emission of CO_2). Both goals require drastic changes in ship design, focusing not only on the optimization of current systems but also the development of completely new, climate neutral, concepts. During recent years alternative propulsion in terms of sails, wave powered propulsion and battery powered electric motors where (re-) introduced and realized. Sails are an effective propulsion method in favorable winds; however, sails do not deliver any thrust in headwind conditions. On the other hand, wave propulsion delivers the best performance in head seas (i.e. head winds). Thus, a combination of the two assisted propulsion methods is of special interest, not only for fossil free ships of the future but also to increase the fuel efficiency of existing ships.

While wind-assisted propulsion is already applied to several vessels and included in several simulation models (e.g. ShipCLEAN), wave propulsion is more seldomly seen and only applied to smaller vessels. One challenge when predicting fuel savings from wave propulsion is, that current CFD-based simulation methods are very time consuming and can thus not be used in typical performance prediction programs.

Objectives and goals of the project

The objective with the project is to develop a method to predict the performance of wave propulsion on cargo ships. The methods shall be applicable without the need for extensive ship information, i.e. the necessary information shall be limited to the ship main dimensions and environmental conditions.

The goal is to present the potential of wave propulsion in case studies of ships traveling on realistic routes using the newly developed methods and the simulation model ShipCLEAN. It should be presented how wave and wind propulsion can interact.

Methods and tools

The tools to be used are Matlab and the simulation model ShipCLEAN (Matlab based model developed at the department). The report should be written in Word using a template provided by the department. The methods to be applied in the MSc project should include:

- Literature study:
    - Identification and comparison of methods to predict the ship motions of ships with limited input, i.e. main dimensions.
    - Identification and comparison of methods to predict the forces on a three-dimensional wing

- Implementation of the methods in Matlab and coupling to the simulation model ShipCLEAN

The MSc thesis project should incorporate (at least) the following tasks:
- Literature study:
    - Methods to predict the ship motions of ships with limited input, i.e. main dimensions.
    - Methods to predict lift and drag forces of three-dimensional wings

- o Available methods to evaluate wave propulsion
- o Available technology for wave propulsion
- Comparison of methods to predict the pitch motion of ships in a seaway regarding their applicability in ShipCLEAN (i.e. limited input) and their accuracy. Selection of one or several methods and implementation in Matlab/ ShipCLEAN.
- Comparison of methods to predict the forces of three-dimensional wings regarding their computational effort and accuracy. Selection of one or several methods and implementation in Matlab/ ShipCLEAN.
- Verification of the methods using simulation results for wave propulsion from the literature.
- Preparation of polar plots of fuel savings using suitable sized wave propulsion on at least two cargo ship types.
- Simulation of a vessel on a realistic route with and without wave propulsion.
- Identification of uncertainties in the prediction of the wave propulsion performance.

Contact persons:
Dr. Fabian Tillig (Fabian.tillig@chalmers.se)
Dr. Laura Marimon Giovannetti (Laura.MarimonGiovannetti@sspa.se)
Professor Jonas Ringsberg (Jonas.Ringsberg@chalmers.se) [Examiner]