

Propeller Optimisation Using a Combined ML-ROM Approach

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Background

Optimising the design of a propeller for improved efficiency of marine vehicles is a difficult challenge. As the maritime industry moves to cleaner and alternative fuel sources and a zero-carbon approach, a key design challenge is the selection of the most efficient propeller geometry. The selection of a suitable propeller will directly affect a vessel's speed and sustainability by driving the appropriate choice of fuel and engines, affecting the energy efficiency design index (EEDI). Typically, propeller optimisation is a manual iterative process requiring the designers to have prior experience in propeller design. The process can be time-consuming, requiring multiple simulations to arrive at a final design.

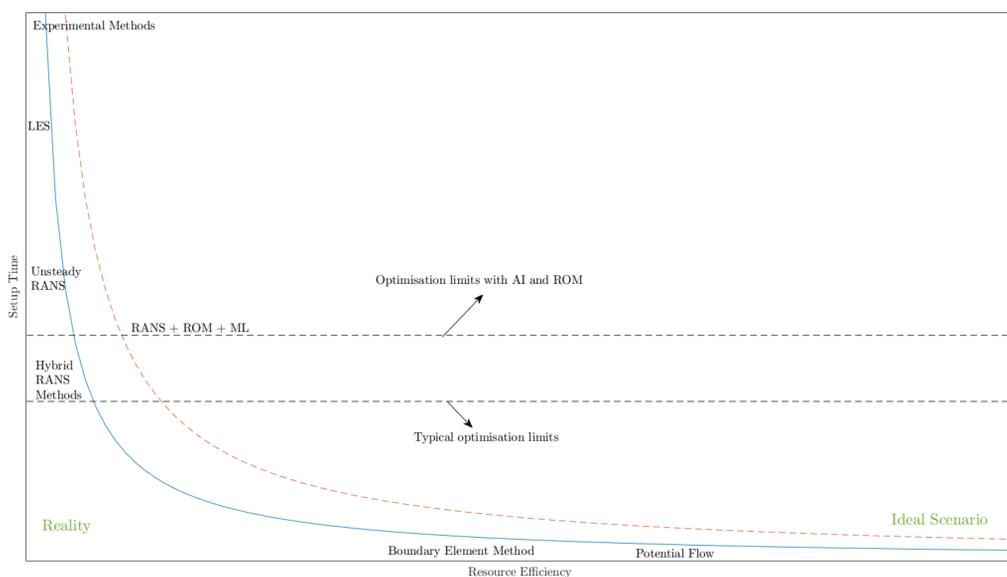


Figure 1. Proposed increase in resource efficiency using combined approach

Application

The primary use case is speeding up the design and optimisation process of marine propellers. With further work, the scope can be expanded to cover multiple propeller types, such as high-speed crafts, submarines, ferries, etc. and translated into a GUI-based version, making it easier to interact with.

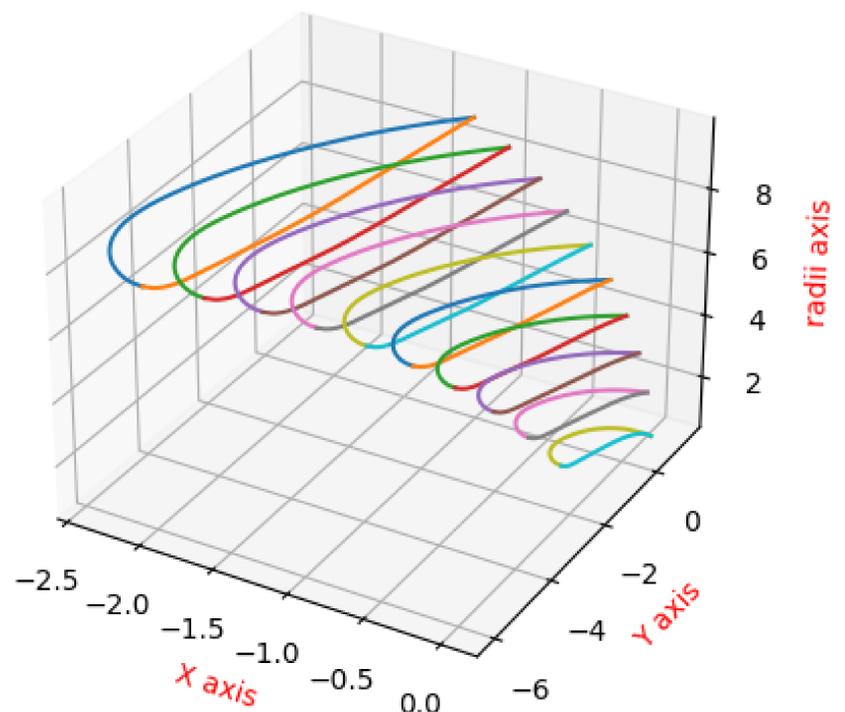


Figure 2. Sample propeller section to be optimised

Output

The goal is to harness the capabilities of Reduced Order Models (ROMs) to speed up the simulation process and combine it with an ML model to improve the optimisation capabilities of the workflow. The ML component will be trained on the surface thrust and drag maps to help reconstruct the deformed propeller. The final output will utilise an open-source framework using OpenFOAM for the CFD simulations and Python to develop this combined ML-ROM pipeline. Although the workflow will be created for a small number of propeller parameters, the user can tweak the optimisation parameters to suit their needs by adding/removing variables of concern.

Commercial Potential

Modern design software relies heavily on the user to modify the design parameters to identify optimal propeller designs. Significant computational resources are expended when deciding if the design is suitable. By suggesting an optimal starting point, designers can skip the iterative design process and have a better starting point from which to begin. The user can judge if the design is feasible to manufacture and, accordingly, tweak the parameters to change the output. This pipeline has the potential to significantly speed up the design phase and free up designers to work on other critical aspects. The pipeline is expected to enable significant person-hour savings and translate to cost savings.

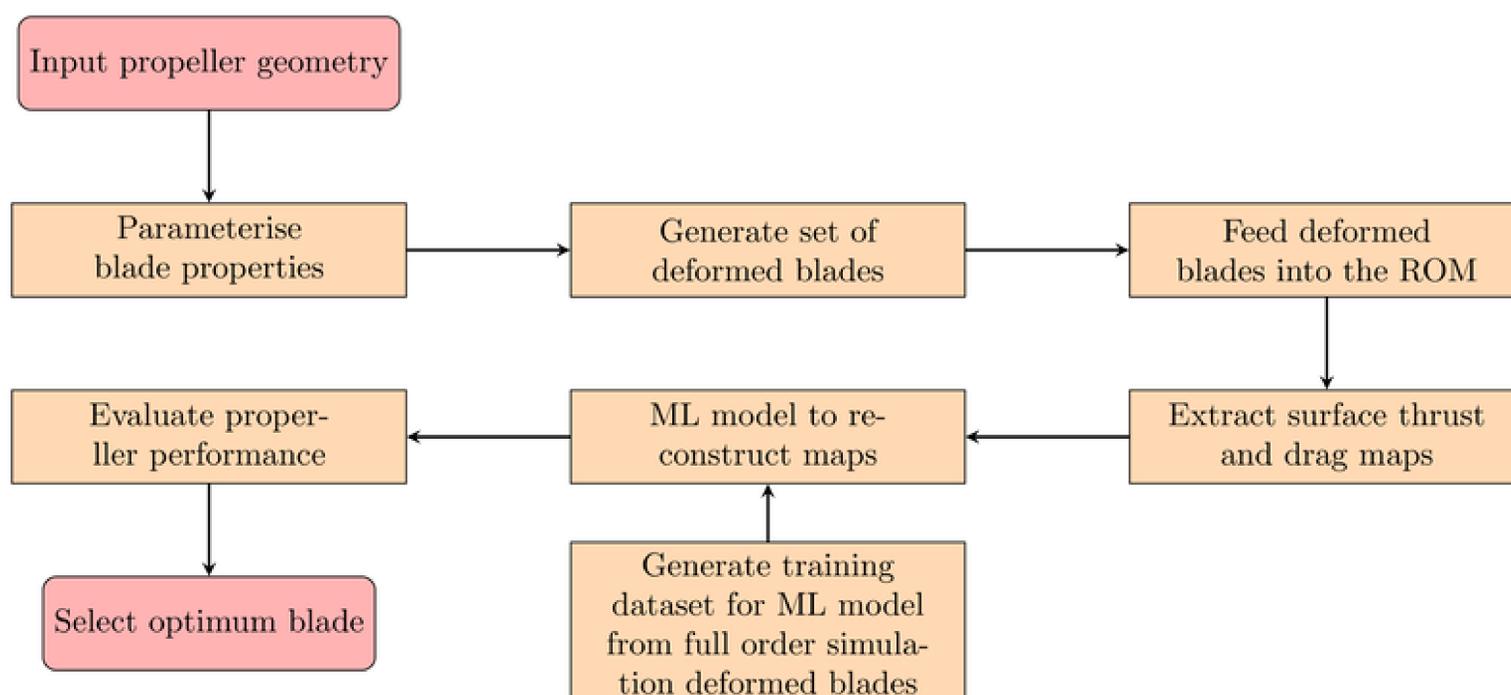


Figure 3. Optimisation pipeline