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Abstract for IS05 - Artificial Learning for Marine Engineering: Methods and Applications
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Machine Learning for the interactive Design of a Fast Monohull

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ABSTRACT

A fast pilot boat has been optimized within the European R&D project AutoPlan (www.auto-plan.net). The monohull was designed by UZMAR (Turkey) for planing mode at a displacement of 9.5ton, featuring two tunneled propellers with conventional shaft lines and brackets along with two spate rudders. CAESES was utilized to create fully-parametric models of both the bare hull and the tunnels while STAR-CCM+ was employed for viscous free surface RANS simulations. A Design-of-Experiment (DoE) for 18 geometric parameter was set up in CAESES and performed with a Sobol sequence of 100 samples at the design speed of 27.5kn. The boat was free to trim and rise, making use of an overset grid for a good comprise between high resolution and acceptable turn-around time.

The data set – geometric variants, corresponding flow fields and integral values – was taken to train a machine learning (ML) model, opening up a variety of new options for fast design processes. In addition to predicting scalar quantities such as thrust and resistance, field quantities (e.g., pressure, velocity) and sensitivities can be determined from the ML-model within fractions of a second. This allows engineers and designers to work together interactively and evaluate a large number of iterations in a very short time without having to wait for new CFD results from their HPC system, simulation times for the planing hull set-up being around 60 to 70 CPU hours per variant and speed.

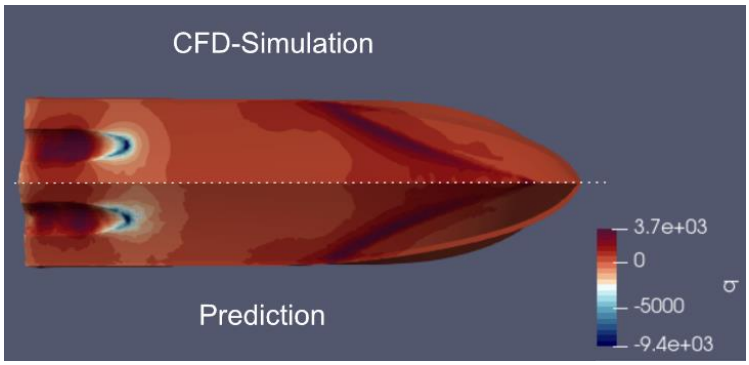

Fig. 1: Comparison of CFD results (upper part) and ML-model prediction (lower part).

Figure 1 shows the dynamic pressure distribution computed from the high-fidelity CFD simulations along with the predictions from ML-model. The actuator disk and the resulting trim and rise of the hull create complex pressure distributions, which are very well “learned” and represented by the model.

This contribution will briefly discuss the design project, the parametrics and the CFD simulations and will explain in detail the creation of the ML-model, its accuracy and possible use cases.

REFERENCES

[1] O. Ahmed, “Speeding-Up Simulation Driven Design for High-Speed Planing Boat”, *MasterThesis*, École Centrale de Nantes, (2022).