Data-driven models for vessel motion and behavioral prediction

Summary

Blending of machine learning approaches, onboard measurements, and numerical simulation data present an opportunity to develop predictive models for vessel motion forecasting. Such predictive, or surrogate models, embedded in the decision support systems (DSS) of manned and/or unmanned vessels will be an integral part of next generation control or compensation systems as well as digital twin based applications. Ships and other marine vessels have already in most cases access to ship motions (heave, pitch, roll, accelerations etc). Based on vessel trajectory the control system has access to wave forecast and hindcast data which could be further combined with on-board wave identification systems. Combination of these data sources offers an opportunity to optimize vessels performance in terms of safety and efficiency. The goal of this work is to develop predictive data-driven model for ship motions using numerical simulations and test its applicability in real-world conditions.

Research field:	Environmental, marine and coastal technology
Supervisors:	Kristjan Tabri Mihkel Kõrgesaar
Availability:	This position is available.
Offered by:	School of Engineering Kuressaare College
Application deadline:	Applications are accepted between June 01, 2024 00:00 and June 30, 2024 23:59 (Europe/Zurich)

Description

Blending of machine learning approaches, onboard measurements, and numerical simulation data present an opportunity to develop predictive models for vessel motion forecasting. Such predictive, or surrogate models, embedded in the decision support systems (DSS) of manned and/or unmanned vessels will be an integral part of next generation control or compensation systems as well as digital twin based applications. Ships and other marine vessels have already in most cases access to ship motions (heave, pitch, roll, accelerations etc). Based on vessel trajectory the control system has access to wave forecast and hindcast data which could be further combined with on-board wave identification systems. Combination of these data sources offers an opportunity to optimize vessels performance in terms of safety and efficiency. The goal of this work is to develop predictive data-driven model for ship motions using numerical simulations and test its applicability in real-world conditions.

Tasks (preliminary, not exhaustive)

- Database generation (virtual experiments) for surrogate model predicting ship response at different sea conditions
- Development of ML based surrogate model for ship response prediction including the comparison of different ANN (NN, RNN,LSTM etc) alternatives
- Identification of common core in behavioral ML model (for instance a sea state) for reducing the training dataset size and enable transferability of the ML models.
- Enhancing the surrogate model by combining with physics-based modelling approaches.
- Validation and testing of the models with measured data (real data w/o stochastic field effects (wave tank) and w/ measured data on sea)

Supervision

Mihkel Kõrgesaar
Kristjan Tabri

Requirements

The performed work combines computational and experimental research. The applicant should have good understanding of physics related to sea loads and ship hydrodynamics. Since positions presumes development of data-driven models a prior experience in machine learning methods and/or statistical analysis is considered a plus, but not strictly required. Experience in coding and programming (e.g. python) is considered beneficial. The candidate should prove his/her capabilities in writing the technical report and scientific papers in high quality journals. Good skills in

English, writing and oral, are required. Experience in collaborative research/publication with the existing TalTech staff is also a plus. The applicant for the position must have a Master's degree and must fulfill the requirements for doctoral students at the Tallinn University of Technology (https://taltech.ee/en/phd-admission). During the assessment emphasis will be put on your potential for research, motivation, and personal suitability for the position.

Employment & Funding:

The position is at the Tallinn University of Technology and includes some work as a teaching assistant in our courses. The expected duration of doctoral studies is four years, but following a standard practice the contract is first made for 4 months. The extension is subject to the advance of studies and research. The base salary is according to the salary system of Tallinn University of Technology, but flexible depending on the candidates capabilities.

How to apply to this position:

Follow the instructions in https://taltech.ee/en/phd-admission and for hybrid meeting email mihkel.korgesaar@taltech.ee

1. Motivation letter (maximum one A4 page, important: provide clear, but honest evidence of your skills related to the job description and requirements above)
2. CV and other proof of scientific activity (publications, conference papers etc.)
3. A copy of the master´s degree certificate and an official transcript of records, and their translations, if the originals are not in English.
4. An English abstract or summary the MSc thesis.
5. Introducing two referees who can be contacted, directly.
6. Proof of proficiency in English
7. A copy of the identification page of your passport

Further information

- Application open until suitable candidate is found.
- Job location: Kuressaare and Tallinn, Estonia

Relevant literature:

Krata, P., Gil, M., Hinz, T., & Kozioł, P. (2024). A multiparameter simulation-driven analysis of ship response when turning concerning a required number of irregular wave realizations. Ocean Engineering, 302, 117701. https://doi.org/10.1016/ J.OCEANENG.2024.117701

Schirmann, M. L., Gose, J. W., & Collette, M. D. (2023). A comparison of physics-informed data-driven modeling architectures for ship motion predictions. Ocean Engineering, 286, 115608. https://doi.org/10.1016/J.OCEANENG.2023.115608

Schirmann, M. L., Collette, M. D., & Gose, J. W. (2022). Data-driven models for vessel motion prediction and the benefits of physics-based information. Applied Ocean Research, 120, 102916. https://doi.org/10.1016/J.APOR.2021.102916

Bremer, K.S., 2018. Using neural networks to predict the response of a floating structure. (Master's thesis). Norwegian University of Science and Technology.

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