Condition monitoring of vessels to identify high-exposure operations

PhD Student: Casper Aaskov Drangsfeldt
Principal supervisor: Marie Lützen
Co-supervisor: Luis David Avendaño-Valencia
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Background

Crew Transfer Vessels (CTVs) are transportation vessels used in the offshore sector. The main purpose of CTVs is to transport technicians and cargo to offshore wind farms during maintenance and operation. It is inevitable to encounter strong currents, heavy winds, and high waves while sailing offshore. These conditions complicate the operation of the CTV and increasing the stress on the vessel. Manoeuvring in waters with wind turbines requires frequent starts and stops, varied speed, and swift navigation. Furthermore, during the transfer of crew to the offshore wind turbines it is required that the CTV is held stationary. The stationarity is achieved by bumping into the foundation of the wind turbine, which requires a constant high-level thrust. Despite being unwanted these bumps are an inevitable consequence of the crew transfer. As a result, heavy usage of CTVs comes with accelerated wear and tear, which sharply reduces the usable lifetime of several engine, propulsion line, and structural components. Additionally, there is an increased risk of larger breakdowns, which lead to unexpected stops and reduced availability. These factors increase the cost of operating and maintaining (O&M) these vessels, but at the same time have an impact in the O&M of offshore wind turbine farms.

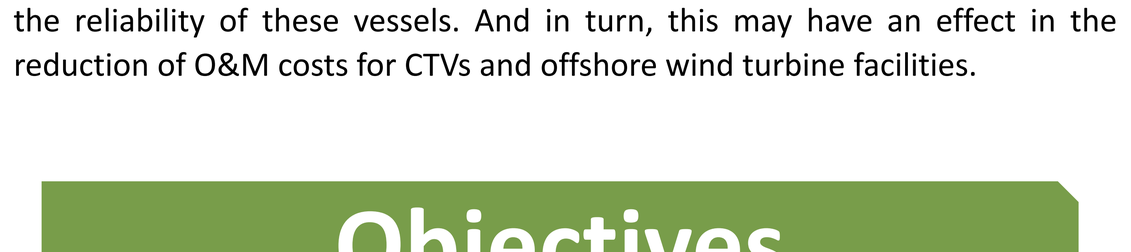
Identification of specific manoeuvers and assessment of crew decisions from operational CTV data could potentially provide crucial information to improve the reliability of these vessels. And in turn, this may have an effect in the reduction of O&M costs for CTVs and offshore wind turbine facilities.

Objectives

The main objective of this project is to identify specific operations exposing CTVs and critical components to accelerated deterioration based on operational data and expert knowledge. To accomplish the main objective, several steps are taken:

- Develop a comprehensive understanding of the workflow of a CTV through data collection, observations, and expert knowledge. Once an understanding is obtained, the identified workflow can be categorized into modes of operation.
- Determine modes of operation correlated to heavy usage. Parameters within these modes correlated to detected deterioration are identified.
- Evaluate and identify potential alterations to operational parameters which can mitigate extensive deterioration of the CTV.

Completing each of the steps is part of the general architecture of the developed system:



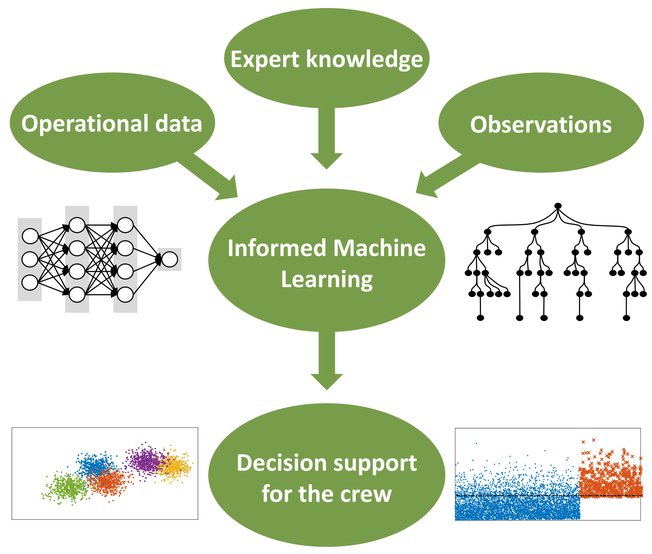
Methods

The research will be based on the operational data obtained from the monitoring system aboard the vessels, as well as observations and expert knowledge.

Mapping the workflow of a CTV by utilizing the collected data, observations and expert knowledge. Modes of operations are then identified through the workflow. To this end, various Machine Learning (ML) algorithms capable of clustering modes of operation will be considered. In this phase, it will be critical to combine expert knowledge with data within the ML method(s) to achieve accurate and explainable results.

Utilize appropriate ML algorithms to build models for the normal state of the CTV across operational modes. Each of these models would indicate the likelihood that a specific CTV component is operating in a normal and functional state. In this regard, it is essential to consider a broad range of environmental and operational conditions within the model training, to achieve a representative set of 'normal' models.

Identifying, tracking and correlating with environmental/operational parameters of detected component deterioration. Supporting the crew with knowledge regarding those operational parameters correlated to deterioration can yield longer lifetime of CTVs.



Collaboration

The PhD project will be performed in close collaboration with the industry. The development of the models requires deep insight into the operation of CTVs. MHO-Co is the owner of several CTVs and has allowed the sharing of their knowledge. Granly Diesel, who provide services to MHO-Co, are willing to collaborate and share their knowledge of maintenance.

MHO-Co

Granly Diesel

The PhD is a part of SDU Maritime Research Platform which was established in 2022 based on a donation from A/S Dampskibsselskabet Orient's Fond. The platform consist of maritime research projects in four faculties across the University of Southern Denmark. The research project are divided between PhD and Postdoc mostly. The work packages involved in the projects addresses cases in the maritime sector with a special focus on the offshore cluster. This enable the utilization of cross-disciplinary research. Furthermore, the involvement of multiple faculties will enable cross-disciplinary discussions.

Funding

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