Graduation project summary – Ingmar Wever

This document includes a short description of the graduation project for my double degree at the TU Delft. Combining both my maritime knowledge and computer science knowledge during a project at Damen Shipyards. The project is worth 60 ECTS, of which 30 ECTS is shared and 15 ECTS specifically per degree. The responsible supervisors at the TU Delft are:

Dr.ir. Robert Hekkenberg Prof.Dr. Mark Neerincx

Ship Design Interactive Intelligence

Maritime Technology - DPO Computer Science – DST

Computer science becomes more relevant for the maritime industry, as more data is generated and stored. This involves software architecture, testing and cyber security. But what interests me is how the developments really support the desires and needs of the people using the software and data. Projects driven by the combination of computer science and maritime technology are predictive maintenance, autonomous vessels, development of sales strategies, and the generation of ship configurations.

Research will be conducted in a form where: Available information for a specific case is mapped, insight is acquired in collecting the data, how to store the data and finally how to use the data.

This specific project, will first consider and determine all relevant variables in a specific use case. Followed by a generalisation which can be used in a tool. This will be done in a iterative process which depends on the availability of time. To guide this process several milestones are defined beforehand. During the project is determined which are realistic to achieve. The initial milestones are:

* Predict safe area around a ship. Dependent on the manoeuvring properties of the ship, and on the expected manoeuvring properties of the encountered ship or obstacle. Considering for example the environmental conditions, ship type and failure cases.
* Develop model to predict warning domain for different vessel types.
* Improve warning system for crew to inform them about situation and determine needed awareness. Based on warning domain.
* Framework based on the tool to support more features, such as:
  + Warning signals for maintenance
  + Enable fleet management to supervise and set targets for captain

Required for the computer science part is the evaluation of human interaction with the developed tool. The tool can only be developed when there is knowledge on the input (data acquisition and database usage) and the output (user interface and visualisation of the data). In an iterative process, the tool will be improved, this is among other things based on evaluation tests with users. Leading up to a final design for an interaction design pattern.

The maritime technology part will be related to the models behind the tool. Having a good model for the warning domain around a vessel will help to improve AIS warning systems currently used, and the models are needed for the development of autonomous vessels. Different properties will be considered, including their impact on the final warning domain. The warning domaiMany feautres of the different Depending on the progress of the project, it is possible to look at more use cases for the comparison method used. Where the right data should be selected and presented in a clear manner.

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Ship Design Interactive Intelligence Research & Development

Maritime Technology - DPO Computer Science - DST Damen Shipyards

TU Delft TU Delft

Every vessel has still a captain to control the vessel, as something might go wrong. The captain is in this case always available and paying attention to its surroundings and the state of vessel. This could lead to loss of concentration due to fatigue and non-challenging jobs. This is mostly caused by the fact that most of the time the operations of a ship are not very complex. In those cases no intervention is needed from the captain. However in specific situation where the risk increases attention or even intervention is desired from the captain. To determine when this situation occurs the probability of an event leading up to a failure should be determined. This probability of the failure occurring depends on the complexity of the solution and the time till the event occurs.

The time till the event occurs is mostly based on the possibility to look ahead. When there is enough time to make adaptions there is a low probability for the failure to occur. While a sudden change in the environment: another vessel, undetected rock, windgust, etc. have a bigger impact on the probability something goes wrong.

The key factor is the complexity of the solution. This research will focus on developing a model for this complexity. An easy solution would be when not much has to change in throttle, speed and heading. While a complex solution would desire much changes in those variables while working at the capability limits of the vessel, often leading to a higher fuel consumption. Therefore inputs to the model are the inertia of the vessel, lay-out of the vessel, environmental conditions and the desired track or operation.

Different steps will be taken to validate and improve the model. First the model must be able to determine the complexity of a small segment straight and when steering. These can be validated with data available from tugs and fast crew suppliers on fuel consumption and 6 DOF movements. The second step is to do this for a planned route, without dynamic objects, showing critical moments as a vessel works there on its limits with certain environmental conditions. Finally the third step is a real-time simulation with dynamic objects.

The model will return the complexity of a specific situation. During the first step will be determined what interesting information for the captain could be in what situation. At the second step, it will be able to warn the captain when more attention is needed, based on the planned route. Using a tool can be shown what solutions the captain has with the corresponding risks and costs. In the final stages this can be tested during operation of the vessel, helping the captain to make the right decision in high pressure situations. While enabling him to relax when the risks are low.