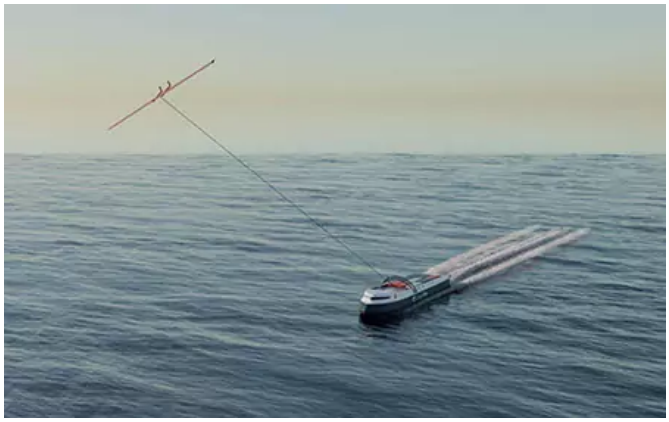
Motion Planning for Sustainable Autonomous Vessel

Background

Autonomous vessels is a research area enjoying increasing importance. Innovations from this field will make the oceans safer both for the crew and the environment and reduce pollution.

For example, did you know that one single container ship emits more CO2 than 65,000 cars? CargoKite is keen on changing this by developing the sailing ship of the 21st century. Their autonomous, micro container ship is powered only by wind and consists of two key components: a kite to pull the ship and a unique, patent pending ship design.



Concept of autonomous container ship powered by sustainable wind energy
Source: CargoKite[1]

One important task for autonomous ships is motion planning in a safe manner such that collisions are avoided and traffic rules [1] are not violated. There are many feasible approaches to implement motion planning for vessels (from regular control theory [2] to machine learning approaches [3]). However, there is no clearly best suited approach for all motion planning situations.

Description

The goal of this thesis is to develop a motion planner for the CargoKite prototype and test this planner in simulation and on the real prototype. For that, tools from the CommonOcean[2] benchmarking suite for motion planning on oceans can be extended and reused. The motion planner concept is to be determined through a literature review. The task under investigation is a docking scenario, in which the autonomous ship is to reach the docking site stably and without colliding with static obstacles. Optionally, the motion planner's capabilities can be extended such that dynamic obstacles can be handled as well.

Tasks

- Familiarize yourself with CommonOcean and the CargoKite prototype
- Perform a literature review on marine motion planning and identify the best suited motion planning approach (e.g., reinforcement learning, controller synthesis,...)
- Develop a motion planner for a docking scenario in simulation
- Test and evaluate the motion planner in simulation and on real traffic data
- Transfer the implementation to the prototype and conduct tests in a static environment
- *Optional:* Extend the motion planner's ability to dynamic environments

[1] cargokite.com
[2] commonocean.cps.in.tum.de

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Research project:
ConVeY

Type:
Master's Thesis

Research area:
Motion planning, marine traffic

Programming language:
Python, ROS

Required skills:
Good programming skills, interest in working with prototype ship

Language:
German or English

Date of submission:
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References

[1] Hanna Krasowski and Matthias Althoff. Temporal logic formalization of marine traffic rules. In *IEEE Intelligent Vehicles Symposium*, 2021.

[2] Agnieszka Lazarowska. A trajectory base method for ship's safe path planning. *Procedia Computer Science*, 96:1022–1031, 2016.

[3] Siyu Guo, Xiuguo Zhang, Yisong Zheng, Du, and Yiquan. An autonomous path planning model for unmanned ships based on deep reinforcement learning. *Sensors (Basel, Switzerland)*, 20(2), 2020.

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