Internship-Thesis: Model-Based Motion Planning for Autonomous Vessels with Stochastic Disturbances

Internship and **MSc. Project** Proposal at the Autonomous Multi-Robots Lab, Cognitive Robotics, TU Delft and Demcon Unmanned Systems, Delft

Description: You will work together with AMR and Demcon Unmanned Systems within TRiLOGy, a project that aims at unlocking the potential of transportation and logistics in waterways with electric and autonomous vessels by enabling safer, more sustainable and efficient operations.

Below we describe a **possible project**, but **different topics can also be discussed**, e.g. in perception.

Autonomously sailing on open waters is a challenging task, especially in adverse weather. The motion planner guiding the vessel has to be robust to disturbances, e.g. wind and currents, which are inherently stochastic.

Recently, a sampling-based MPC approach named Model Predictive Path Integral (MPPI) control has been developed to plan interaction-aware trajectories for vessels in crowded urban canals [1]. The same algorithm has been shown to be able to plan in environments where some model parameters are uncertain [2].

The goal of this internship-thesis project is to develop and apply a motion planner based on MPPI able to plan accounting for the nonlinear model of the vessel as well as stochastic disturbances.

To achieve this, you will first do an internship working hands-on at Demcon, with the goal of identifying a nonlinear dynamic model of their boat and eventually applying this to a PyTorch implementation of MPPI [3]. If all goes well, you will be able to test the motion planning algorithm on the real boat.

During your literature and thesis, you will work on estimating and modeling disturbances at sea, and then integrating such models with the motion planner to achieve robust navigation.

Desired qualities:

- Motivated and independent
- Keen to working hands-on
- Experience/interest in motion planning, autonomous vessels
- Experience in Python/C++ programming and Robot Operating System (ROS)

For further questions or to apply, please contact Ir. Elia Trevisan <e.trevisan@tudelft.nl>. When applying, please provide a short motivation, up to date CV, a transcript of your current degree program and intended start date.

References:

[1] L. Streichenberg, E. Trevisan, J. J. Chung, R. Siegwart, J.Alonso-Mora "Multi-Agent Path Integral Control for Interaction-Aware Motion Planning in Urban Canals," *IEEE International Conference on Robotics and Automation (ICRA)*, 2023.

[2] I. Abraham, A. Handa, N. Ratliff, K. Lowrey, T. D. Murphey and D. Fox "Model-based Generalization under Parameter Uncertainty using Path Integral Control", *IEEE Robotics and Automation Letters (RAL),* 2020.

[3] PyTorch MPPI: https://github.com/UM-ARM-Lab/pytorch_mppi