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# Towards Model Predictive Control for Inland Ferries and Vessels

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## Abstract

Automating inland vessels and ferries has great potential to increase safety and energy efficiency and relieve the strain on ship masters during traveling. Besides robust navigation, efficient path planning, and reliable perception, accurate path following is necessary for the autonomous operation of inland vessels in confined waters.

Current industry solutions based on traditional control methods can guide ships along a predefined reference path. However, when there are obstacles along the reference path, traditional control methods often cannot take evasive action and safely steer the vessel along the obstacle while also respecting the fairway boundaries. Even if the path planning module already roughly considers the fairway and obstacles, real-world disturbances often force deviations from the reference path. Furthermore, due to the large inertia and limited actuation, foresighted driving is necessary to safely steer the ships through the waterway. Thus, the control module should also consider obstacles and fairway boundaries as well as the ship's dynamics to ensure that the ship always remains in the allowed fairway and does not collide with obstacles. Due to the possibility of considering constraints and predicting future system behavior, model predictive control (MPC) is a promising control approach for this task.

The first part of this presentation focuses on a nonlinear MPC for safe path following for large rudder-steered inland vessels in canals [1] as part of the research project FernBin. Path following is achieved by minimizing the cross-track error in the cost function. For fairway compliance, a constructive solid geometry (CSG) approach, similar to [2], is used. Collision avoidance with an obstacle is achieved using the dual formulation from [3]. Simulations have shown that the MPC can steer a vessel safely through a section of the Dortmund-Ems Canal.

The second part of this presentation gives a quick outlook on the new research project AutoFerry. The AutoFerry project succeeds the AKOON project [4], where a rhine ferry was partially automated. The objective of the AutoFerry research project is to automate an overactuated ferry traveling between Rügen and Hiddensee on the coast of the Baltic Sea. In this operation environment, there are strong winds and currents that need to be considered by the MPC as well as the heterogeneous traffic, like sport boats and surfers. From a control perspective, the MPC approaches developed in FernBin [1] and AKOON [5] will be adapted and experimentally validated for the overactuated ferry and the challenging environment of the coast of the Baltic Sea.

## Literature

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