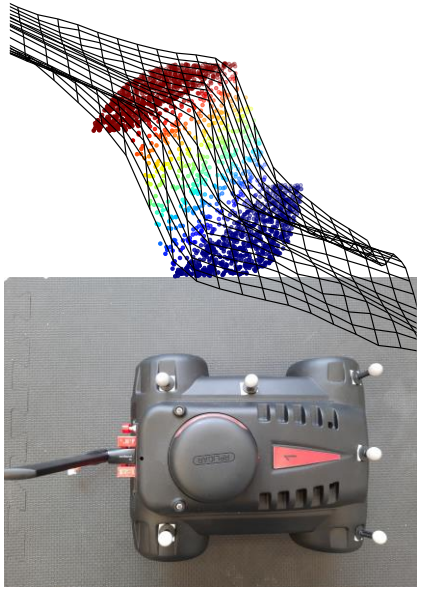
Approximate Model Predictive Trajectory Tracking for an Autonomous Vehicle

TECHNISCHE UNIVERSITÄT DARMSTADT

Master‘s Thesis

Model Predictive Control (MPC) is an advanced control method that can naturally handle nonlinear systems subject to constraints. However, for MPC, we need to repeatedly solve a complex nonlinear programming problem (NLP) online. Consequently, MPC is often out of reach for real-time application. This is especially limiting in autonomous driving situations, where fast decisions are needed.

To surmount this problem in this thesis the goal is to first design and then to approximate (imitate) the model predictive controller using kernel-based regression algorithms like Gaussian processes. The tracking controller as well as its approximation should be validated in experiments with the real vehicle. This work can potentially extend the results in [2] to the trajectory tracking case.



Requirements:

- Model Predictive Control, Gaussian Processes
- Good to very good programming skills (Matlab or Python); ACADO(S)

Tasks:

- Design of a trajectory tracking controller for the vehicle
- Approximate the tracking controller using kernel-based regression methods (e.g., GPs)
- Test and validate both controller on the real system
- Evaluate, compare and present the results

Resources:

[1] T. Faulwasser. Optimization-based solutions to constrained trajectory-tracking and path-following problems.
[2] A. Rose. Learning a Gaussian Process Approximation of a Model Predictive Controller with Guarantees.
[3] J. Nubert. Safe and Fast Tracking on a Robot Manipulator: Robust MPC and Neural Network Control.

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