Offset-free learning of predictive controllers

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. One approach to counter the computational demand is to use supervised learning methods to approximate the MPC law [2]. However, approximation errors can often cause a steady state offset when employing the learned controller [1, 3].

The goal of this thesis is to develop methods to learn an offset-free predictive controller, while maintaining low computational complexity.

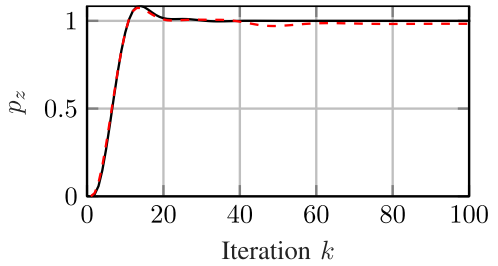
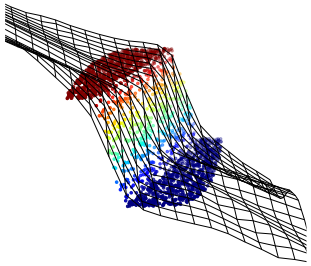


Figure: The quadrocopter controlled by the predictive controller flies from the ground position to a height of 1 meter as outlined with the black line. The learned controller never steers the drone to a height of 1 meter but stops with a small offset as indicated with the red dashed line.



Requirements:

- Critical and creative thinking
- Programming skills in Matlab or Python
- Model predictive control and machine learning

Tasks:

- Literature review on offset-free MPC.
- Propose methods for offset-free approximation of MPC.
- Illustrate the proposed methods through case studies.
- Evaluate, compare and document the results.

Resources:

[1] Kimberly J. Chan, Deep Learning-based Approximate Nonlinear Model Predictive Control with Offset-free Tracking for Embedded Applications.
[2] A. Rose. Learning a Gaussian Process Approximation of a Model Predictive Controller with Guarantees.
[3] G. Pannocchia, Offset-free MPC explained: novelties, subtelties, and applications.

M. Sc. Alexander Rose

E-Mail: alexander.rose@iat.tu-darmstadt.de
Web: https://www.ccps.tu-darmstadt.de

CCPS Control and Cyber-Physical Systems