Real-Time Model Predictive Control of an Inverted Double Pendulum on a Cart

TECHNISCHE UNIVERSITÄT DARMSTADT

Project Seminar (2 – 4 students)

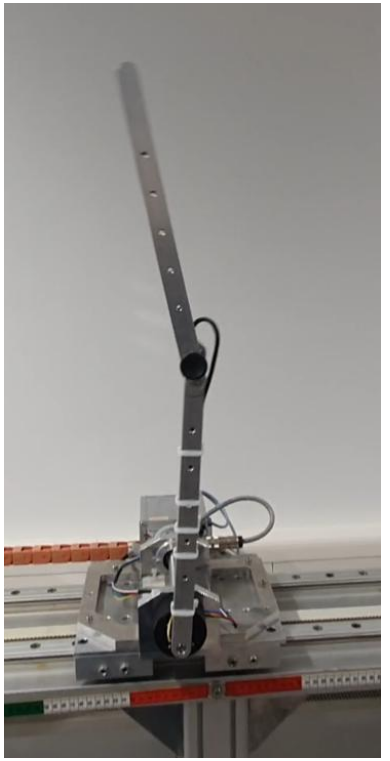
The inverted double pendulum on a cart is a challenging benchmark system in control engineering. Typical tasks include damping the pendulum in the downward equilibrium (like a loading bridge) and performing swing-up maneuvers to reach and stabilize the upright equilibrium.

In principle, these tasks can be solved with an LQR controller and a precomputed swing-up trajectory. However, such approaches cannot explicitly handle constraints on states and inputs and might perform poorly in the presence of friction. Model Predictive Control (MPC) addresses these drawbacks by optimizing the system's future behavior online while taking constraints directly into account. Yet, applying MPC on a real system is not straightforward: each control action requires the solution of a numerical optimization problem within a very short time frame.

Based on the preceding work that addresses the single pendulum case, the task of this project seminar is to implement and evaluate MPC for the double pendulum. This includes designing MPC controllers for different objectives (loading bridge damping and swing-up). Practical issues such as computation time and communication delays need to be considered, e.g., by employing efficient toolboxes for real-time MPC, such as acados.

Required skills/knowledge:

- Basic knowledge of control theory is required, prior experience with Model Predictive Control is advantageous
- Programming skills (e.g., Python, C++) are required, experience with Linux is helpful



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