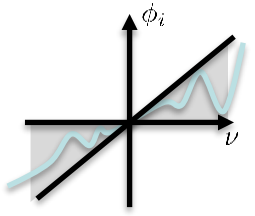
Robust Model Predictive Control using ellipsoidal sets for systems with uncertain nonlinearity and external disturbance

TECHNISCHE UNIVERSITÄT DARMSTADT

Seminar Project (2-4 students, Homeoffice)

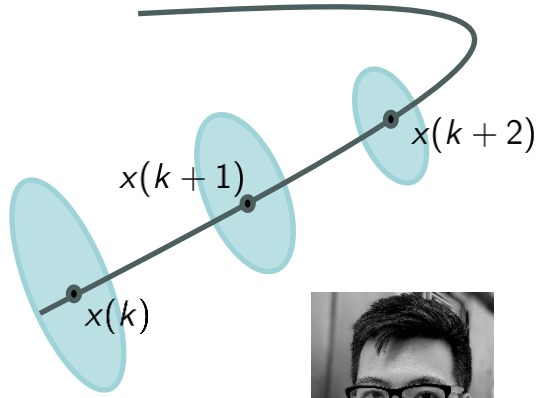
Model predictive control (MPC) has become one of the most popular modern control scheme thanks to the ability of efficiently handling constraints and performance criteria as well as the coherent implementation of multiple hierarchical layers. Since MPC uses a model of the system dynamics to compute the control input in each time step, the performance of MPC heavily depends on the model, which often do not perfectly describe the underlying dynamics. The main goal of Robust MPC is to design a controller with desired properties such as constraints satisfaction, closed-loop stability when the model is subject to dynamics uncertainty and external disturbances.



$$x^+ = Ax + Bu + G\gamma(z) + B_w w$$
$$z = Hx$$

One class of robust MPC approaches is tube MPC. In tube MPC, the effects of uncertainty and disturbances on the state trajectories are captured by a sequence of sets that, by construction, are required to satisfy the constraints. The most common approach is using polytopic sets, which have two disadvantages: number of hyperplanes and vertices growing with states and difficulty in computation of polytopic invariant sets.

This topic considers an alternative way to parametrize the state tube by using ellipsoidal sets. Depending on the number of the students, we may consider the following sub-topic: robust tracking using ellipsoidal sets, tube MPC using ellipsoidal sets, …



The tasks students need to do: Understand the approach and problem formulation, implement the algorithm and do simulation in Matlab to illustrate the method.

The student should have knowledge on Lyapunov stability and Linear Algebra. Knowledge on MPC is preferable, but not a must.

The language for discussion and writing is preferably English.

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