

SSY281 - Model Predictive Control

Micro-Assignment MA08 - MPC practice

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Question 1 Consider the RH controller in slide 46. If the initial state of the plant x_0 is admissible, will the RH controller be feasible at all time?

Unfortunately, even if the initial state is feasible, there is no guarantees that the successor state will also belong to the feasible set.

Question 2 How can we guarantee that the state of a dynamical system, in closed-loop with a MPC controller, evolves along trajectories such that the optimization problem will remain feasible at all times?

In theory, we need the feasible set \mathcal{X}_N to be positively invariant for the close loop system:

$$x(0) \in \mathcal{X}_N \Rightarrow x(k+1) = f(x(k), \kappa_N(x(k))) \in \mathcal{X}_N \quad (1)$$

then it is guaranteed that the optimization problem to be solved at every time instant is feasible, provided the initial state is feasible.

In addition, a sufficient condition for recursively stability is satisfied if the terminal constraint set \mathbb{X}_f is control invariant:

$$x \in \mathbb{X}_f \Rightarrow \exists u \in \mathcal{U} \text{ such that } x^+ = f(x, u) \in \mathbb{X}_f \quad (2)$$

where \mathcal{X}_N might be defined as $\mathcal{X}_N = K_N(\mathbb{X}_f)$

Question 3 What are the pros and cons of having a really small terminal set, like $\mathbb{X}_f = 0$, versus a large terminal set, like $\mathbb{X}_f = Rn$.

The main advantage of using a large terminal constraint \mathbb{X}_f and a large prediction horizon N is that this results in a larger feasible set \mathcal{X}_N . On the other hand, the smaller \mathbb{X}_f , the better the controller performance.

Question 4 Consider a RH controller, with a terminal set constraint \mathbb{X}_f . How can you prevent infeasibility other than with the method you proposed in Question 2? Explain pros and cons of your solution.

Another option is to make use of constraint management, such that the constraints are softened. In this way, there will be always a feasible solution, however the constraints might be slightly violated.