Micro Homework Assignment 8

Question 1

Consider a constraint RHC problem with x_0 as the system initial condition, Assume that the optimization problem is feasible for the initial condition. How can we guarantee that the optimization problem will remain feasible for future time instants, i.e., how to guarantee recursive feasibility?

Answer:

The receding horizon controller is recursively (persistently) feasible if the feasible set $\mathcal{X}_N$ is positively invariant for the closed-loop system $x^+ = f(x, k_N(x))$, i.e.

$$x(0) \in \mathcal{X}_N \implies x(k+1) = f(x(k), k_N(x(k))) \in \mathcal{X}_N, \ \forall k \in \mathbb{N}$$

Assuming the initial state $x(0)$ is feasible

recursive feasibility is guaranteed.

Question 2

What are the pros and cons of having a really small terminal set, like $\mathcal{X}_f = 0$, versus a large terminal set, like $\mathcal{X}_f = \mathbb{R}^n$.

Answer:

Pros: 1. By having a large terminal set $\mathcal{X}_f$, we could have a large feasible set $\mathcal{X}_N$, hence could improve recursive feasibility!

2. By having a large terminal cost, we will have larger domain of attraction. (larger terminal region)

3. —"—, Stability could be improved.

Cons: 1. Having a large terminal set $\mathcal{X}_f$ will increase the total cost to find the V solution to MPC optimization Problem optimal

2. Setting the $\mathcal{X}_f = \{0\}$ imply a very strict constraints, hence heard to satisfy.

Question 3

Consider a constraint RHC problem with $x(0)$ as the system initial condition and X_f as the terminal constraint. Assume that the optimization problem is feasible for the initial condition. Can you guarantee that $x(k) \in X_f$ at time $k=N$? If not, suggest another strategy that insures $x(N) \in X_f$

Answer :

Since any unanticipated events to cause the state to become infeasible is possible, there is a need to have a feature that enables recovery from faults that cause infeasibility. this could be done by replacing the hard constraint, by a certain new softer constraint when the current state is infeasible, hence ensuring feasibility at that particular moments, and returning to the hard constraint as soon as they can be satisfied at current state.