SSY281 Model Predictive Control

Assignment 5 - Explicit MPC and minimum time control

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Question 1 Linear MPC design

(a) We can use the Riccati equation to compute the terminal weight Pf, that can guarantee asymptotic stability:

$$Pf = \begin{bmatrix} 16.0929 & 32.9899 \\ 32.9899 & 93.9396 \end{bmatrix}$$

check the asymptotically stable by eigenvalue, this Pf makes system asymptotically stable.

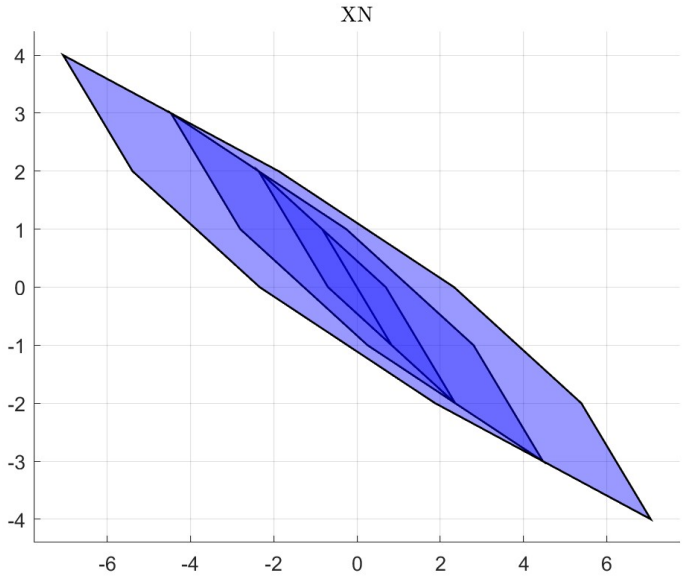

Figure 1: set of feasible initial states for horizon length 4

(b) With prediction horizon number N increase from 10 to 20, we can see the MPC control effect gradually catches up with the closedloop control, and they converge to the same points.

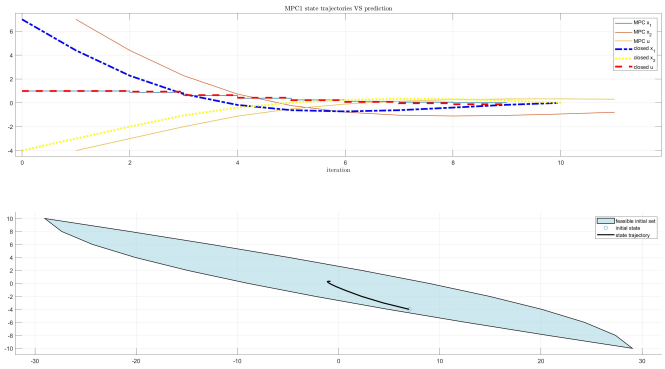

Figure 2: N=10,MPC vs closed loop

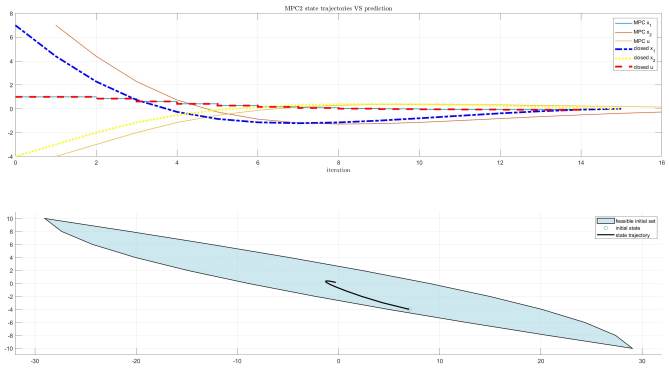

Figure 3: N=15,MPC vs closed loop

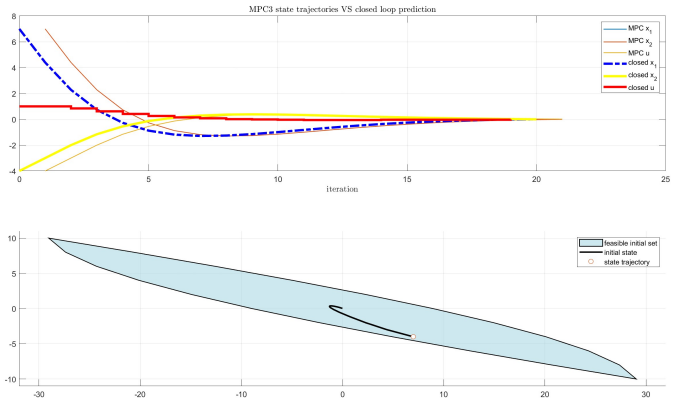

Figure 4: N=20,MPC vs closed loop

(c) Explicit MPC can be calculated by the "mpc.toExplicit()" function, and the terminal set we calculate it by the "Polyhedron" function.

And we plot the empc by "empc.partition.plot()" function;

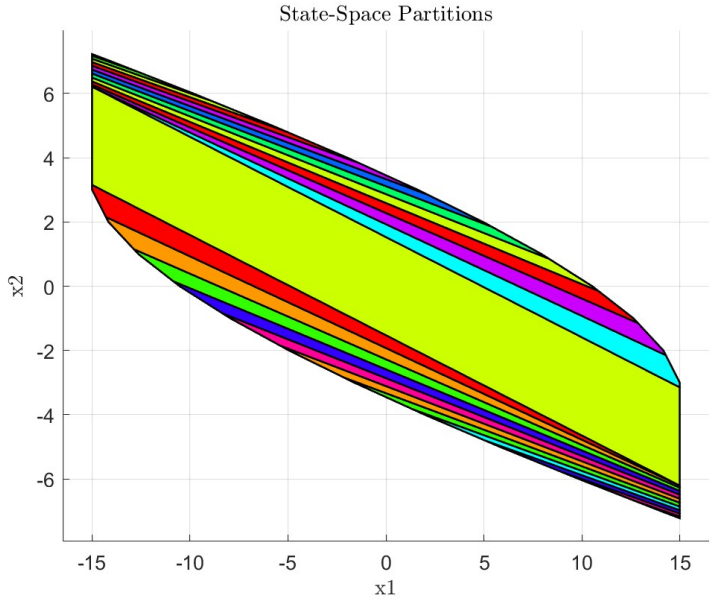

Figure 5: reach the target set

(d) yes, the C_{inf} can contain x_0, we can use "C_{inf}.contains(x0)" function to check it:

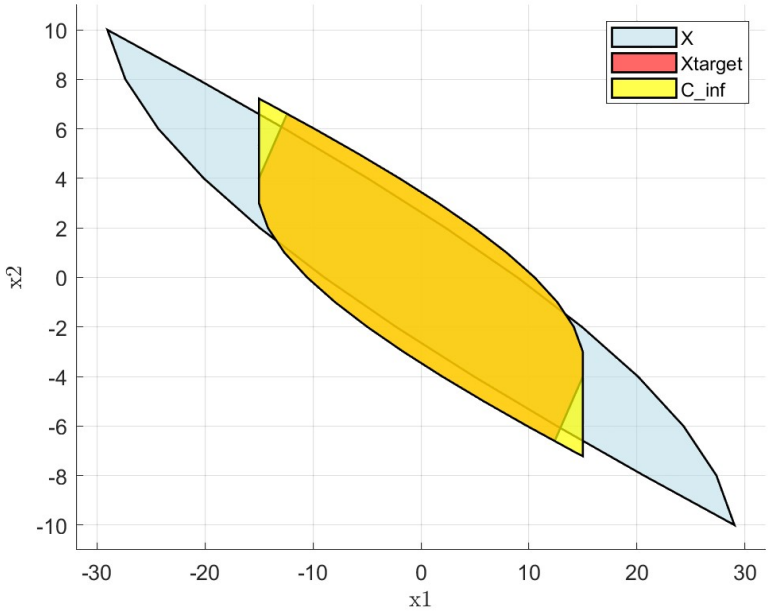

Figure 6: target set Xf

Question 2 Finite time control of a DC motor

(a) By converting the continuous system matrix into discretized matrix representer, we can get:

$$A_d = \begin{bmatrix} 0.7626 & 0.0872 & 0.0118 & 0.0003 \\ -4.4281 & 0.6764 & 0.2214 & 0.0086 \\ 0.4444 & 0.0159 & 0.9778 & 0.0621 \\ 7.1286 & 0.4285 & -0.3564 & 0.3449 \end{bmatrix}$$

$$\mathrm{B}_d = \begin{bmatrix} 0.0000 \\ 0.0003 \\ 0.0036 \\ 0.0621 \end{bmatrix}$$

$$\mathrm{C}_d = 1.0e+03 * \begin{bmatrix} 1.2802 & 0 & -0.0640 & 0 \end{bmatrix}$$

(b)