EE6225, CA3

Due Date: Friday, 12 November 2021

Please submit to NTULearn Course Site

INSTRUCTIONS TO CANDIDATES

(1) This is a take home assignment and it is open-ended in nature.

(2) Answer as many questions as you can, and *expand* on them.

(3) You are to submit your assignment, either as (a) a MATLAB live script (both pdf and mlx files), or (b) a ZIP package containing your answers in PDF format, and all MATLAB code necessary to reproduce your results.

(4) Submit your assignment to the NTULearn course site. Make sure you get an acknowledgement from the NTULearn.

(4) The assignment is due as stated above. Late submissions will be penalised.

In Part 1, you have used Decentralised, Sparse, and Decoupling control methods for a 3×3 process. In this assignment, you will design a MPC for the same 3×3 process:

$$G(s) = \begin{bmatrix} \frac{-0.98}{12.5s+1}e^{-17s} & \frac{-0.36}{15s+1}e^{-27s} & \frac{-0.14}{15.2s+1}e^{-32s} \\ \frac{-0.43}{14.7s+1}e^{-25s} & \frac{-0.92}{13s+1}e^{-16s} & \frac{-0.11}{15.6s+1}e^{-33s} \\ \frac{-0.12}{15s+1}e^{-31s} & \frac{-0.16}{15s+1}e^{-34s} & \frac{-1.02}{11.8s+1}e^{-16s} \end{bmatrix}$$

The main aim of this assignment is to let students compare (a) the multivariable control design techniques learned in Part 1 and (b) the Model Predictive Control (MPC) method learned in Part 2.

Answer as many questions as you can.

1. Compare your best MPC design with those you obtained in Part 1. Simulate the closed-loop step responses for the set-point profile:

$$\begin{cases} R_1(t) = 1, & t > 0 \\ R_2(t) = 1, & t > 50 \\ R_3(t) = 1, & t > 100 \end{cases}$$

2. Discuss how did you select an appropriate sampling time for your MPC design. What were your considerations?

3. Include the MATLAB code you have used to obtain the state space representation of the plant model (with $u(k)$ as input). What are the dimensions of the A_p, B_p and C_p matrices.

4. Include the MATLAB code you have used to obtain the plant model A, B, and C for your MPC design with $\Delta u(k)$ as input. What are the dimensions of the A, B and C matrices.

5. Discuss the effects of the MPC tuning knobs, N_2, N_u and λ on the closed-loop step response performance. Support your observations with simulation examples.

6. Comment on the pros and cons of the MPC method based on this case study.

Bonus:

7. If you had knowledge of the future set-points at the start, how would you modify your MPC to take account of this future set-point information? Perform a simulation to compare with and without future set-point scenarios.

8. Does your MPC design has integral action? How can you demonstrate this?

9. Any other investigation or innovation not mentioned above.