CH5120: Course Project 2

Submission deadline

- Submit the assignment on or before **November 27th 2022**
- Submission link for the course project will be opened in Moodle.
- Ensure the filename is in the format **<Group_groupnumber.pdf>**

Note

- It is a group project (3 per team), fill in the details of the group in the link below https://docs.google.com/spreadsheets/d/1qGU2DeNS1HiF7oY09dJht4YFdqo-i4TSj3Kc_X1Q-ak/edit?usp=sharing
- Individual contributions by the team members have to be mentioned.
- Make a detailed report (max 10 pages) describing the results and inferences.
- Attach the codes and results, if MATLAB or any software is used.
- Do not use any MATLABToolbox.

Problem Statement

Implement MPC for various cases mentioned below to control the level of four tanks present in the quadruple tank process mentioned in Course Project 1. Use the linearized discrete space model used in Course Project 1.

h1,h2,h3 and h4 are the levels of the respective tanks with [12.4 12.7 1.8 1.4] (cm) as their initial states for the Kalman filter and plant model. Kc value is 1 V/cm and the sampling time is 0.1 s. Add appropriate integrated white noise as state noise and white noise as measurement noise in the plant model and implement the Kalman filter from project 1 as an estimator.

The constraints for the system are

DUmin = $5*[-1 \ -1 \ ]^T$

DUmax = $5*[\ 1 \ \ 1 \ ]^T$

Umin =$0*[-1 \ -1 \ ]^T$

Umax = $20*[\ 1 \ \ 1 \ ]^T$

A. Implement Constraint MPC to control

Case 1 : h1, h2 when h3, h4 are measured; set-point for [h1 h2] is [13.4 13.7]
Case 2 : h3, h4 when h1, h2 are measured; set-point for [h3 h4] is [2.8 2.4]
Case 3 : h2, h3 when h1, h4 are measured; set-point for [h2 h3] is [13.7 2.8]
Case 4 : h1, h3 when h2, h4 are measured; set-point for [h1 h3] is [13.7 2.4]

Questions

1. Comment on the performance of MPC for cases 1-4 and whether the set point is achieved.
2. Do you see good control performance in all the cases? If there are any performance deteriorations between cases, is it due to the Kalman filter or MPC performance?
3. Experiment few ways to improve the overall performance and report the same.
4. Report the effect of control and prediction horizon on MPC performance for cases 1 and 2.

B. Implement Constrain MPC to control Case 1 along with the output constraints

Ymin = $[12 \ \ 12]^T$

Ymax = $[13.9 \ \ 14 \ ]^T$

Questions

1. Comment on the performance of MPC and whether the constraints are met.
2. Report the overshoot observed in the response and reduce it by 10% by two different ways.
3. Vary the Ymin values (Increase and decrease from the given values) and comment on the feasibility of the process.