CH 5120: Modern Control Theory

Project 2

Team project with 4 person per team

Implement MPC for various cases mentioned below to control the level of four tanks present in the quadruple tank process mentioned in project 1 (Kalman filter). Use the linearized discrete state space model used in project 1.

- h1, h2, h3, h4 are the levels of the respective tanks.
- Kc value is 1(V/cm).
- Assume the initial state values as $[12.4 \quad 12.7 \quad 1.8 \quad 1.4\ ]^T$ in the order h1, h2, h3, h4 respectively for the Kalman filter and the plant model.
- Ts = 0.1s.
- The constraints are
  - DUmin = $5^* \quad [-1 \quad -1\ ]^T$;
  - DUmax = $5^* \quad [\ 1 \quad\ 1\ ]^T$;
  - Umin = $0^* \quad [-1 \quad -1\ ]^T$;
  - Umax = $20^*[\ 1 \quad\ 1\ ]^T$;
- Add appropriate integrated white noise as state noise and white noise as measurement noise in plant model and implement the Kalman filter from project 1 as estimator.
- Use only the commands mentioned in the lectures. Do not use any MATLAB Toolbox.
- Submit the MATLAB simulation file and a pdf of your report with necessary plots (max of 10 pages) before the deadline.

a) Implement Constraint MPC to control
   a. Case 1: h1, h2 when h3, h4 are measured; set-point for [h1 h2] is [13.4 13.7]
   b. Case 2: h3, h4 when h1, h2 are measured; set-point for [h3 h4] is [2.8 2.4]
   c. Case 3: h1, h2 when h1, h2 are measured; set-point for [h1 h2] is [13.4 13.7]
   d. Case 4: h3, h4 when h3, h4 are measured; set-point for [h3 h4] is [2.8 2.4]

i) Comment on the MPC performance when used to control the above four cases.

ii) Do you see good control performance in all these cases?

iii) If there are performance deteriorations between cases, is it due to Kalman filter performance or MPC performance?

iv) Experiment few ways you improve the overall performance and report the same

b) Report the effect of changes in control horizon and prediction horizon on the MPC performance for Case 3 and Case 4.

c) Implement Constraint MPC such that it can be used to control

   a. h2, h3 when h1, h4 are measured with set-point for [h2 h3] is [13.7 2.8]

   b. h1, h3 when h2, h4 are measured with set-point for [h1 h3] is [13.7 2.4]

      Comment if the MPC is able to achieve set point tracking along with reason if required.

Note: if any assumptions made, mention them clearly along with the reason.