CH 5120: Modern Control Theory Mini Project 2

Part A (2 marks)

For the mini project 1 part A on Kalman filter, compare the plots by using an EKF, considering typically 10 discrete points for linearization(obtaining Jacobians). Use the same dataset.

Part B (8 marks)

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 = $20^*[1 \quad 1]^T$;
  - Ymin
  - Ymax
- 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.
- Submit the MATLAB simulation file and a pdf of your report before the deadline.

a) Implement using actual calculations, the unconstrained MPC with prediction horizon and control horizon chosen with some heuristics for the following case:

a. Controlled Variables are h1, h2 when all states are measured for a set-point for [h1 h2] of [13.4 13.7]
b. Give justification for the heuristics.
c. Analyze closed-loop stability of the unconstraint MPC system at two places:
    i. When the first move was implemented
    ii. When the system stabilizes close to its set-point

b) Implement Constraint MPC to control

a. Control h3, h4 when h1, h2 are measured; set-point for [h3 h4] is [2.8 2.4]
b. Analyze how Kalman filter performance affect MPC performance by experimenting with Kalman gain parameters.

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] as [13.7 2.8]

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

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