Model Predictive Control: Theory and Applications

Assignment 11

In Assignment-6, you used the Dynamic Matrix Control (DMC) algorithm to solve the cases of set-point tracking and rejection of measured disturbance. On similar lines, you will now use MPC toolbox to solve three cases in state-space MPC (third being that of model-plant mismatch). Note that you can directly use MPC toolbox for this assignment.

Use the following parameters (note that they are slightly different from Assignment-6):
Sampling interval: $\Delta t = 0.5$; MPC horizons: $m = 5$, $p = 12$; setpoint: $r(k) = 0.8$
Output and input-rate weights: $Q = 1$, $R = 0.1$
Constraints: $-0.4 \leq u(k) \leq 0.4, \quad |\Delta u(k)| < 0.025$.

Problem 1: SISO State-Space MPC **(3 marks)**

Consider the following system from Assignment-6:

$$G = \frac{1.25e^{-1.4s}}{5s+1}$$

Starting at origin, run the MPC algorithm to control the system at setpoint of $r = 0.8$.

Problem-2: Extension to Measured Disturbance Case **(4 marks)**

Modify the above problem to simulate the case of measured disturbance:

$$y(s) = \frac{1.25e^{-1.4s}}{5s+1}u(s) + \frac{0.2e^{-0.7s}}{6s+1}d(s)$$

with a step change of $d(k) = 0.5$ in the measured disturbance occurring at $k = 0$.
Use the same setpoint, constraints and tuning parameters as in Problem-1.

Problem 3: Extension to Model-Plant Mismatch Case **(3 marks)**

Finally, let's consider the case of model-plant mismatch, with rest of the study being similar to Problem-1. Specifically, let us assume that the true *plant* is represented as:

$$G = \frac{1.2e^{-1.2s}}{5.5s+1}$$

Thus, the *model* used by MPC is the same as the one given in Problem-1, whereas the *true plant* differs in the gain and time constant of the transfer function. The system, initially at the origin, needs to be controlled at $r = 0.8$. Please simulate the case of MPC control in presence of model-plant mismatch, with other parameters being the same as in Problem 1.

Submission of Assignment: Please include the MATLAB code as well as input and output profiles (u vs. t and y vs. t plots) for all the three problems in this assignment.