Master study
Systems and Control Engineering
Department of Technology
Telemark University College
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SCE4006 Model Predictive Control with Implementation

Exercise 1

Task 1

Given a system described by the state space model

$$x_{k+1} = ax_k + bu_k \tag{1}$$
$$y_k = x_k \tag{2}$$

and a control criterion

$$J = q(r_{k+1} - y_{k+1})^2 + pu_k^2 \tag{3}$$

Here, the system parameters are given by $a = 0.7$ and $b = 0.8$.

a) Find the optimal (MPC) control, u_k^*, which minimizes the control criterion subject to the process model.

b) Simulate the optimal control system subject to varying weighting ratio $0 < \frac{q}{p}$ and a constant reference signal $r_k = r = 1$ for all $k \geq 0$.

Task 2

Given a system described by the state space model

$$x_{k+1} = ax_k + bu_k \tag{4}$$
$$y_k = x_k \tag{5}$$

and a control criterion

$$J = q(r_{k+1} - y_{k+1})^2 + p\Delta u_k^2 \tag{6}$$

where $\Delta u_k = u_k - u_{k-1}$ is the control rate of change. Here, the system parameters are given by $a = 0.7$ and $b = 0.8$.

a) Find the optimal (MPC) control, Δu_k^*, which minimizes the control criterion subject to the process model.

b) Simulate the optimal control system subject to varying weighting ratio $0 < \frac{q}{p}$ and a constant reference signal $r_k = r = 1$ for all $k \geq 0$.

c) Discuss the steady state error properties of this controller.

Tips: Se example 5.2 for theory regarding this task.