

Recommended Assessment

LQR Balance Control

Exploring LQR Control Design

1. When using $Q = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ and $R = 1$, what are the control gains (K) generated?
2. With an LQR weighting matrix of $Q = \begin{bmatrix} 5 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$, attach a screenshot of the K control gain generated and describe how the control gain has changed from the gains in the question above. Does this make sense when considering the cost function?
3. When swapping diagonal elements in the weighting matrix like $Q = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 5 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$, describe how this change affects the control gains K .
4. What are the open-loop poles of the system? Comment on how the poles affect the system.

Testing the Model

5. Describe the procedure used for tuning the weightings in Q so that the criteria for overshoot and rise time was met.
6. Once the weights were tuned, what were the final Q matrix and the resulting control gains K used to achieve the performance criteria. Attach a screenshot of the scopes demonstrating the final behaviour of the pendulum system.
7. Was the pendulum response exactly centered about zero? If not, provide one reason why it wouldn't be.