Linear Controls Homework

ROB7785

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Due: Before Finals Week - Fall 2011

In class we studied the world's simplest robot, namely

$$\ddot{p} = u,$$

where p is the position of the robot. If want to include a linear friction term in the models, we would instead get

$$\ddot{p} = -fp + u,$$

where $f > 0$ is a friction coefficient.

1.

Under the assumption that $y = p$, produce a linear state space model of this system.

2.

Design a state feedback controller $u = -Kx$ such that the closed loop system has both its eigenvalues in $-\zeta$, where $\zeta > 0$.

3.

Design an observer for this system such that the estimation error dynamics has both its eigenvalues in -10ζ.

4-5

Go to Tsquare/Resources/Controls and download helicopter.m and open it up in matlab. What you need to do in this problem is design state controllers and observers for this large system such that certain performance constraints are met.

4.

Is the system controllable and observable? Is the uncontrolled system stable? (The commands `rank, ctrb, obsv,eig` might come in handy.)

5.

Using the matlab command `place`, place the observer and controller eigenvalues in such a way that $\|x\| \leq 1$ before $t = 3$. At the same time, we need that $\|u\| \leq 50$ all the time. (Note, `place` does not allow for all closed-loop eigenvalues to have the same value.)

The only place that you should touch the code is where it says

```
%%%%%%%%%%%
%% HERE IS WHERE YOU COMPUTE YOUR GAINS
K=zeros(4,8);   % Note - this needs to be replaced!!
L=zeros(8,6);   % Note - this needs to be replaced!!
%%%%%%%%%%%
```