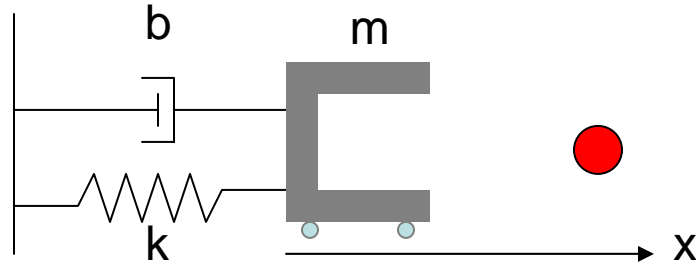


CSE 490 I: Design in Neurobotics

Problem Set 3

Due: 10:30am on 1/25/2007

You will use the same robot as Problem Set 2 to work with other controllers.



(Same explanation of the robot as the last problem set)

Here is a robotic gripper that can move along the  $x$ -axis. The gripper that weighs 1 kg ( $m = 1$  kg) has some resistive force caused by the spring ( $k = 1.5$  N/m) and dashpot ( $5$  N.s/m) to fight against to get to the ball (1 meter away). The gripper has some wheels on the bottom that is driven by a motor to move left and right. The objectives are to send a desired position in  $x$ -axis and observe the behavior with different controllers.

1. Try PD controller. You can use the code that was used in class on 1/16/07 (downloadable from the class webpage). Make sure to change the robot parameters in the code from the class example to this one.
  - a. Play around with the gains until the output reaches 90% of the desired value between 0.1 and 0.2 seconds. Report the gains you used and provide the output plot (with a star on the point where it crosses 90% of the desired value).
  - b. Try a reasonably low  $K_p$  and a reasonable high  $K_d$  until the behavior is undesirable. Provide the plot (and the gains you used) and comment (2-3 sentences) on the shape of the curve based on what you know of PD controller.
2. Try PI controller. You can use the code that was used in class on 1/16/07 (downloadable from the class webpage). Make sure to change the robot parameters.
  - a. Play around with the gains until the output reaches  $\pm 10\%$  of the desired value between 0.8 and 0.9 seconds (so none of the oscillations ever go outside of  $\pm 10\%$  from the desired output value). Report the gains you used and provide the output plot (with a star on the point where it crosses this boundary for the last time).

- b. Hold  $K_p$  at 100. Vary  $K_i$  from 400 to 600 (it helps to plot up to 10 seconds, and use the same time step (set  $t=0:0.01:10$ )). Plot two plots (with  $K_i = 400$  and  $K_i = 600$ ) and comment (2-3 sentences each) on the difference using what you know of PI controller.
3. Try PID controller. You can use the code that was used in class on 1/16/07 (downloadable from the class webpage). Make sure to change the robot parameters.
  - a. Play around with the gains until the output looks very similar to the desired output. You probably achieve this by setting many of the gains quite high. This is fine for MATLAB, but in real life, sending a very high current to the robot is not recommended (for both the cost and safety reasons). For this reason, assume that you can only have a total of 30 for all three gain values combined. As a robotic control engineer, come up with your one optimal controller and justify it. You should report
    - i. The output plot
    - ii. three gains you used
    - iii. How you came up with it, and
    - iv. Why this is your optimal controller (2-3 sentences)