CS 431 Lab #7
Balancing the steel ball in one dimension

Spring 2015

Demonstration due the week of April 8, 2015.

1 Overview

In this lab you will write a program to balance the ball on the FLEX board touchscreen in one selected dimension even when any external disturbance is introduced into the system. To do so, you will use discrete PID control, where your input comes from the touchscreen ADC and your output is sent to the PWM servo motors. You must write a program that does all of the following:

1. Initially set the Y-axis of the touchscreen platform such that the ball constantly touches an X-edge of the touchscreen.
2. Using lab06, manually find a touchscreen ADC value that represents the middle position of the X-axis and use this value in your code as the set point for the PID control.
3. Write a function to balance the ball at the middle X-position. You should use a timer interrupt to perform the following every 50 milliseconds
   (a) Read the ball position (the median value as in lab06).
   (b) Perform PID computation and set the appropriate duty of the X-servo.
   (c) Update the display values on the LCD.
4. You need to select floating point constants Kp , Kd , and Ki for the PID control and they may be hard-coded into the application.
5. Display the following information clearly on the LCD:
   - The PID coefficients K_p, K_d, and K_i.
   - The touchscreen set point X-position (Set_x)
   - The current X-position of the ball on the touchscreen (P_X)
   - the derivitive of the current X-position (D_x)
   - The integral of the current X-position (I_x)
   - the PID feedback (F_x)

2 Procedure

1. Before getting started, review how PID control works. In particular, a good reference for this lab is http://en.wikipedia.org/wiki/PID controller#Discrete implementation.

2. Use your code/project from a previous lab as a starting point for coding this lab and remove all unnecessary functionality. In particular, you may want to reuse parts of lab05 and lab06 for PWM and ADC, respectively.

3. A demo program that demonstrates the features that you need to implement is provided in compiled form on the course website.

4. Write lab07.c such that it fulfills the requirements specified in the Overview section.

   Use numerical differentiation and integration to approximate the position's derivative and integral. Recall that if $p(t)$ is the position at time t, then the derivative is $\frac{d}{dt}p(t)$ and the integral is $\int p(t)dt$ where dt is the period of the I/O task. The wikipedia reference above specifies how these approximations can be computed.

5. Experiment with your program to find some "good" values for K_p , K_d , and K_i.

At the start of Lab 8, each lab group will be asked to demonstrate and explain their Lab 7 code to the TA.