Department of Chemical Engineering
University of California, Santa Barbara

ChE 152B **Winter, 2010**

Lab 2: PID Controller Tuning

1. Introduction

In this lab, you will design a PID controller for the cart component of the pendulum experiment. You will employ tuning methods from your textbook. In this particular exercise, the pendulum control is not addressed, so you can treat that as a disturbance.

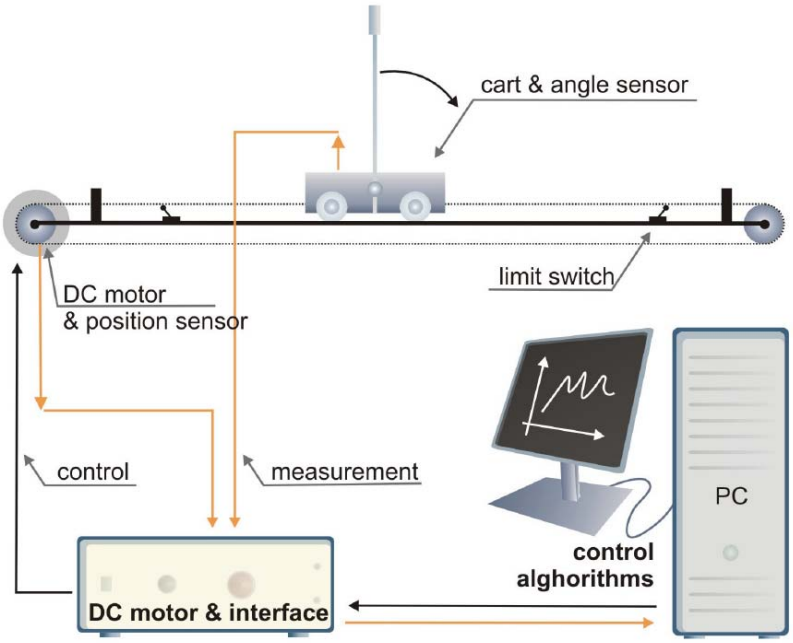

Figure 1 – Pendulum Control System
[from Feedback Instruments, Ltd. manual]

2. Pre-lab Analysis

Review the documentation provided to the groups for lab 1, so that you are familiarized with the mechanics of the pendulum/cart experiment.

Using the Simulink model file provided, you should run simulations to tune your controller before testing it on the experimental system.

Treat the model as a "black box", and attempt to generate data (in simulation) for design of a controller (e.g., step test, etc.). You may use any of the methods in Ch. 12 in SEM2 to design the controller; however, you should document very clearly in your report, and your personal notes, the procedure you are employing.

Test the controller response for some simple simulation commands (step changes, etc. in the cart position). Quantify the performance of the controller.

3. Experimental Activities

In this set of exercises, you should evaluate the performance of your control design on the actual experiment using the real-time model named *CartControlGroup#.mdl* where # is your group number. In your experiments, you should monitor the actual cart position, the cart control voltage, and the desired (setpoint) cart position.

You should test your controller for a variety of changes in the command signal (step change, ramp of various slopes, sine waves of varying frequency and amplitude). This is achieved by modifying the setpoint subsystem. You should also test your controller subject to disturbances by changing the initial angle of the pendulum.

Given some preliminary experiments, you will likely want to refine the values for your controller parameters (P, I, D), and re-run the experiments. In your report, be careful to document the comparisons of different controller tunings.

Once you have achieved reasonable response for the nominal case (no pendulum action), try to repeat some of the setpoint changes under the influence of a disturbance (use your hand to introduce a gentle swing in the pendulum prior to the setpoint change).

Report on the effectiveness of the controller tuned for a setpoint change to reject a disturbance. Retune as necessary.

4. Lab Report

Analyze your results and prepare a lab report using the memo/personal file format described in previous handouts. (Recall the limits on the maximum numbers of figures and tables in the Memo.) Compare the controller settings for different design/tuning methods. Which controller design/tuning method provided the best results?

5. Appendices

- Model for cart, with appropriate parameters, *Lab1_W10_pendulum_results.mat*
- Simulation study file, *Lab2_W10_PID_CartModelN.mdl*