Lab 11: PI feedback control

This week's lab focuses on the use of PI feedback control to stabilize the incident light on a photodiode and the temperature of a thermistor.

1. Construct the circuit we used in Lab 10, part 4b. Use your circuit design from design exercise 11-1 to regulate the optical power incident on the photodiode. The circuit should be such that the incident optical power can be set with some control resistor.

a. Determine experimentally the integral and proportional gain that you need in order for the feedback to function.

b. Use a second LED attached to a square-wave generator to see how fast your circuit can respond and modify the intensity of its LED to keep incident optical power on the photodiode constant. Adjust the integral and proportional gain to optimize the response time of your feedback circuit. What is the fastest response time that you can obtain with your circuit? How does the feedback control respond to a step function change in incident optical power from an external source (an oscilloscope plot will suffice)?

c. If you have increase the proportional gain sufficiently, the feedback loop will go into positive feedback and start to oscillate uncontrollably. What is the frequency of this oscillation?

2. Attach last week's thermistor to one plate of a Peltier thermoelectric cooler with some Kapton tape. Construct the circuit you designed in design exercise 11-2 to regulate the temperature of the thermistor. You may incorporate the circuit of Lab 10 part 7 as well as parts of the circuit you constructed in part 1 (this week).

a. Verify that you can set the temperature of the thermistor a few degrees °C above and below room temperature.

b. Optimize the PI feedback loop experimentally and determine how fast the circuit can respond to small temperature changes. At what frequency does the circuit oscillate when the proportional gain is too large and the PI loop goes into positive feedback?