PHYS375 F10: Matlab and LabJack Programming Exercise

LabJack

Matlab can read analog voltages from a data acquisition unit ("LabJack") through USB. The goal of this lab is to learn to use Matlab with the LabJack to record the optical intensity of a laser with a photodiode – an operation we will be using for the experiments in PHYS375 over and over again throughout this semester. The major components are:

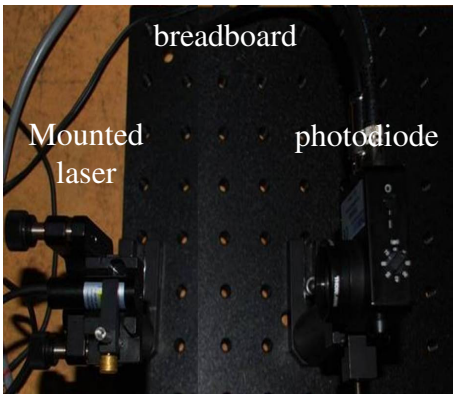

Diode laser

- A semiconductor diode laser, driven by electrical injection from a voltage source, produces a directed optical beam of coherent 635nm (red) light. This diode is "edge-emitting", resulting in a beam of elliptical cross-section.

Amplified photodiode

- An amplified photodiode converts the optical intensity into a proportional voltage.

After securely mounting your laser, turn it on. Use the thumbscrews to align the laser beam level with the breadboard. Mount the photodiode so that the aperture is at the same height as the laser beam. Turn on the photodiode.



Matlab needs to find the LabJack with `h=load_labjack`. This returns a "handle" for the LabJack into the variable `h`, which is then used to receive analog voltages from the input labeled AIN0 (with `lj_get(h)`). [Note that you can use a different variable name for the handle!] Connect the photodiode to the LabJack input with a BNC cable.

Write a script that measures the voltage from the photodiode every 0.1 seconds (type `help pause` for a hint) and use it to align the laser into the aperture by maximizing the signal in real time. Notice that the voltage is always below ~10V, which is the LabJack input limit; it has an input range of -10V to +10V. Adjust the *gain* of the photodiode amplifier so that the signal is below this limit. You may notice that even without adjusting the alignment, the voltage fluctuates between 2 or more exact voltages. This is because the Labjack discretizes the input voltage from the photodiode using a 12-bit analog-to-digital converter and does not have unlimited resolution.

Q: How many possible values can it read? Why is it important for your experiments (where you will be measuring fluctuations in laser intensity) that the maximum signal is close to the largest possible input value?

What happens when you open and close the aperture, or pass your hand in front of the photodiode? If you turn off the laser, the photodiode voltage will not be zero; this is the background "noise" due to room lights, computer monitor, light through the windows, etc. Q: What is the signal-to-noise ratio for your measurement, and how can you maximize it?

Use your script to plot the photodiode voltage as a function of time while varying the laser signal, room lights, monitor position, your location, etc. Remember to label the axes. Save the script, data, and an image of your plot figure to your directory.

Assemble a report of this exercise including answers to the underlined questions above and your plot using MS Word, LaTeX, etc. You must also include the M-file script and data as separate files in a ZIP file containing this information and email it to the TA for grading.