AUTOMATED LASER TUNING

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OBJECTIVE
The main purpose of this project was to create a series of programs in LabVIEW that could be used to automate laser tuning for a Mira 900 laser from Coherent Inc. Currently, in order to go to specific wavelengths, a micrometer on the laser needs to be turned manually. Ultimately, we would like to have a permanent setup in the lab geared towards automation. This instrumentation will be used to automate absorbance spectroscopies of condensed matter systems.

EQUIPMENT
The Arduino UNO is a microcontroller board that enables communication between various types of inputs and outputs. One can write C code in the Arduino IDE, and then compile it into machine code, which is looped over and over on the Arduino. In addition, the Arduino allows the stacking of other boards called “shields” to add further functionality (such as GPS and WiFi).

For this project, we used the Adafruit Motorshield v2 (Figure 1); shield stacking headers were soldered to the board, so that it could be attached to the Arduino UNO. Each Adafruit board can drive up to two stepper motors. A USB2000 spectrograph from Ocean Optics was used to read the wavelength of light emitting from the laser.

LabVIEW was used for most of the programming and to make the graphical user interface.

PROJECT DESCRIPTION
This project involved planning and executing several key sub-steps such as:
• acquiring the stepper motors and drive shafts
• designing machine parts for the flexible drive shaft to fit over the micrometer and knobs
• writing Arduino code to move the stepper motor
• establishing serial communication between the Arduino, USB spectrograph, and LabVIEW

At the heart of the project is the program, which employs several layers of abstraction. In particular, the main algorithm utilizes the idea of a negative feedback loop. For example, if it is above the desired wavelength, it will decrease the current wavelength.

When the program begins, the spectrograph reads the laser light. It takes snapshots of the spectrum (each time increasing the integration time) until the peak intensity passes a certain threshold. Then, the peak wavelength is passed to LabVIEW.

LabVIEW calculates the difference between the current wavelength and desired wavelength. By doing so, it can compute the number of steps to move. That number is passed to the Arduino, so it can move the motor. After the motor turns the micrometer, the spectrograph reads the light again, and the entire process is repeated until the current wavelength is within a specified error margin.

ACKNOWLEDGEMENTS
I would like to thank my mentor Dr. Stephen McGill along with his graduate students Carlos Garcia and Joshua Holleman for their guidance and help throughout the summer, without which this project would not be possible.

This research is sponsored by DMR 1157490.

SETUP
The Arduino and Adafruit Motorshield are attached to each other and are connected to the laptop via USB. An optical fiber feeds the laser light to the Ocean Optics USB2000 spectrograph, which also communicates with the laptop by USB. The stepper motor is mounted and wired to the Adafruit Motorshield, and it is connected to the micrometer using a flexible drive shaft.

FUTURE
Further work may be needed to improve the peak wavelength search algorithm.

In addition, although we do have a working program that can tune the laser to various wavelengths, it would also be desirable to have another program that can peak the intensity of the laser light.
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