SURF 2017 Second Interim Report

Project Title: CIBER2 Automated Optical Focus Calibration System

Submitted by: Animesh Mangu, University of California Los Angeles (UCLA)
Mentor: Jamie Bock
Co-Mentor: Phil Korngut

Completed Work Progress + Technical Specifications:

Over the past month I completed the second half of my automated scanning program. Many of the features took much longer than anticipated because of debugging and small logic errors across the "dataGather" function. Additionally, I realized that some of the position data sets which were being produced by my code were inconsistent in their format given different coarse and fine step ranges. Multiple values were being repeated in the lists, meaning that the relay switch would be opened even if the Moonlite stepping motor did not change position. Once I fixed this error, I moved on to my plot simulator function. The scanner position values were generated by a function which would create two lists: a positive and a negative list. The motor would move to the inputted range from an inputted best focus position, and then proceed to step back with a combination of course and fine steps from the positive list. After this it would calculate the max value in the opposite direction, move to that position, and step back to the best focus position using values from the negative list. To create a Position vs Time plot of all steps and displacements, I implemented a simple algorithm to convert the positive and negative lists. The algorithm would simply combine both lists and create a spread of the values over the inputted integration time sorted into a list of x-coordinates and y-coordinates.

Another feature implemented into the code was a relay switch. This addition was necessary to allow my code to communicate with the CIBER2 data acquisition system. Previously, a simple string output was substituted into the function where a TTL pulse was to be sent. A relay was purchased which would be switched on at the start of the distance between two steps, and switched off at the end. Once a connection was established with the relay, I wrote a function which would change the current state of the specified relay number to the opposite state.

When the relay was switched on, a pulse from a 5V power source would be sent to the experiment electronics to set an exposure. To indicate the status of the relay, an LED is connected within the circuit. To implement the relay into the circuit, I drew up a simple circuit diagram which would take a 5V DC power supply as input, and would output into a cable. My program connected with the relay via a USB port provided on the device itself. We drilled holes in a plastic enclosure that was purchased to mount the breadboard and relay device. 3 holes were created to allow the input / output wires (USB, 5V power supply, coax), and an additional 8 smaller holes to mount the circuit elements. Photographs of this assembly process are shown in Figure 1.

Progress + Observations:

From the first week, a ton of progress has been made in the development of the automated focusing system. During the first few weeks, I spent time implementing the algorithms for the scanning program with a simple GUI. The past couple of weeks I've spent time creating the simulated plots, designing

and building the relay circuit, and developing a live-plotting system during the scan. I learned how to solder well and tin wires, as well as properly use heat shrinks to insulate the connections. Additionally, I purchased a plastic enclosure to mount the relay device and breadboard onto and drilled holes into the box to accommodate incoming and outgoing wires.

Shown below is a before / after depiction of my progress in the relay circuit, as well as screenshots of the automated focus program GUI, version 1:

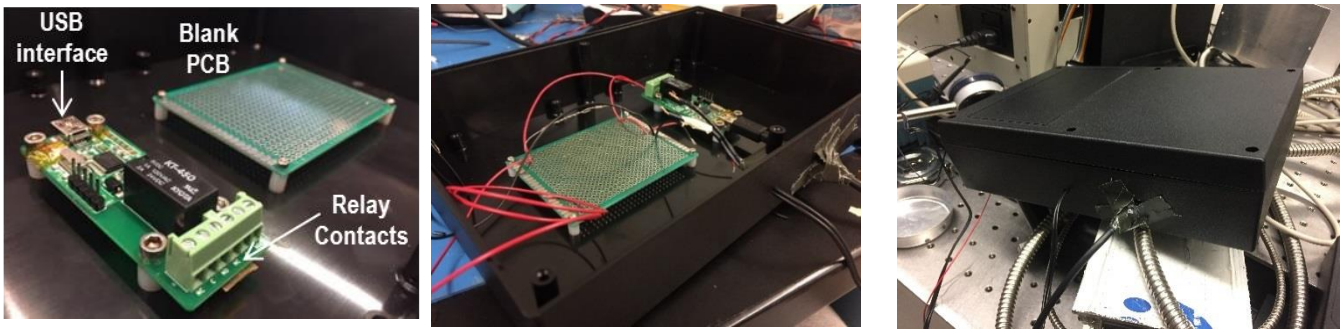


Figure 1: Relay Circuit during assembly Steps 1, 2, and 3

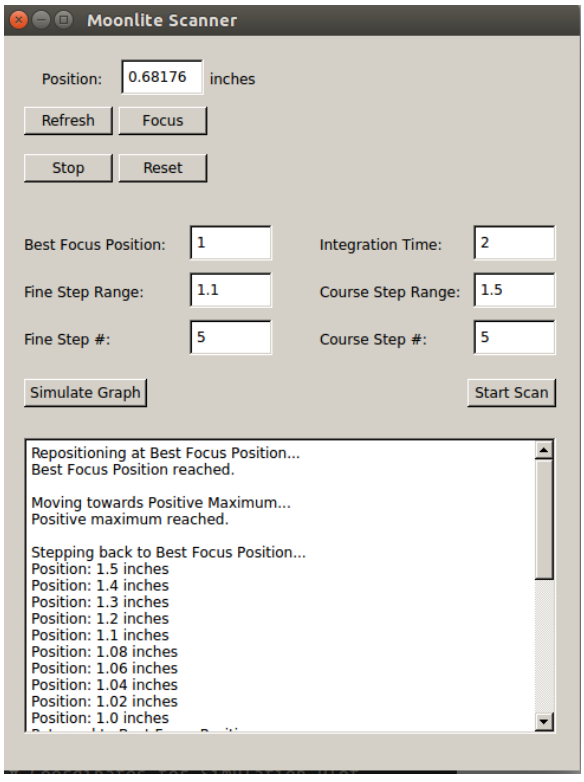
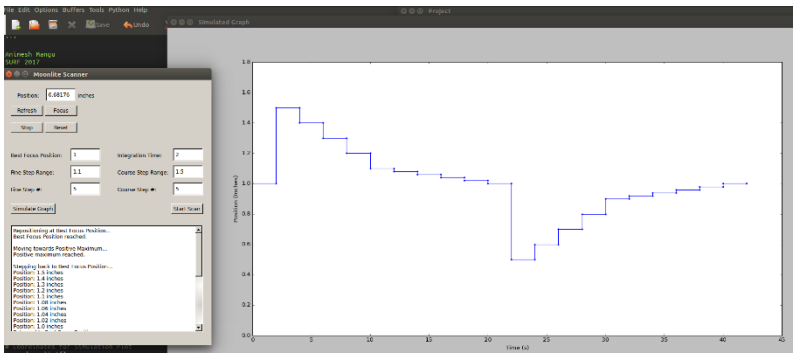


Figure 2: Screenshots of the Automated Optical Focus Calibration System, Version 1



Problems + Research Goals:

I never ran into any real problems during the development of the automated scanning programs. Most of the issues that I encountered were miniature errors in the logic of the code or relay circuitry.

For example, I was having trouble figuring out why my simulation plot (Fig 3) kept displaying overlapped values from previous scans despite my clearing each plot. Eventually, I realized that it was because the algorithm I was using to generate the x-coordinates and y-coordinates was appending to 2 separate lists. Therefore, even though each scan was independent, the list still had values from previous cycles in the data. I solved the problem by simply clearing all the generated lists on the way to create each coordinate array at the beginning of the function. This way, every time the function was called, every data structure being utilized to plot the coordinates was fully reset.

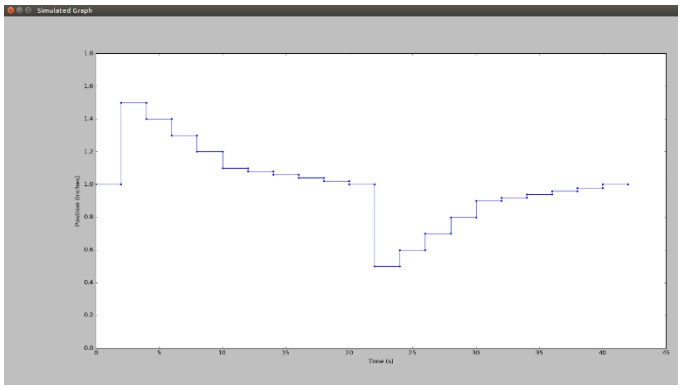


Figure 3: Simulation plot

In terms of physically constructing the relay circuit, I had barely soldered before in my life, since most of the breadboards I had used were basic ones where most of the holes were prewired together. Because of this, much of the circuitry took a little longer than expected and minor mistakes were made such as forgetting to insulate the wire connections with heat shrinks. Another one of the small hurdles I encountered during the development of relay circuit was simply incorrect wiring. It was a pretty silly mistake, as I wired the relay into the circuit without any effect on breaking the circuit. Essentially, my initial circuit design completed negated the presence of the relay. With the assistance of my mentor, I had to un-solder some of the wires and reset the wiring across the breadboard to fix the issue.

I developed the program on my Linux system and hope to completely transfer a robust version of the application onto the Windows system used in the lab. While the scanning functionality is essentially completed, my main goal is to complete the data analysis module of the program by the end of the summer.

References:

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