Motion Automation for a Rainfall Simulator

Nick Landrigan, Fatema Habib, Prabhakar Bholah, Kaz Otedoh
Second Year Faculty of Sustainable Design Engineering Team
University of Prince Edward Island

Introduction

- Certain soil types absorb water better than others. There are certain factors such as porosity and permeability which impact the rate of absorption of different samples.
- PEI Analytical Laboratories provides chemical and microbiological analysis for soil and compost samples. The current system (Fig. 1.) requires consistent human interaction for the duration of the testing. Each test lasts for 5 minutes with the soil samples placed underneath the rainfall simulator.
- The objectives of this project are to design a solution which limits human interaction with the soil testing, while generating smooth and random motion for the rainfall simulator.

Fig.1. Current rainfall simulator set-up

Materials and Methods

- Disassembly of an old book trimmer used at the Robertson Library in UPEI (Fig. 2).
- Concluding on which components of the book trimmer are likely to be adopted for building. Making use of these parts are what make the X-Y Plotter more sustainable.
- Machining and resizing various components intended for reassembly.

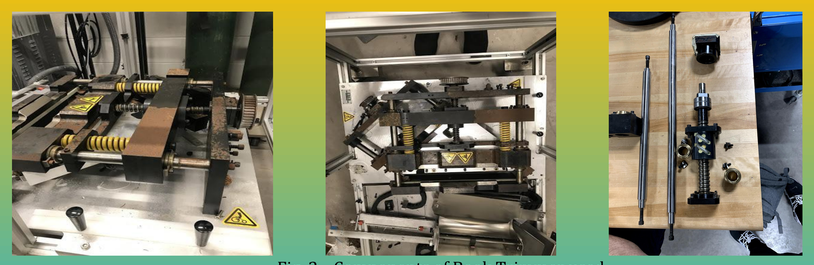

Fig. 2. Components of Book Trimmer used

- In-depth research on the most suitable stepper motor used, including an updated source code on the Arduino software that powers the motor drivers.
- The motor driver holds a total of 7.5V when in use and the most efficient power supply we purchased has ample range for extended hours.

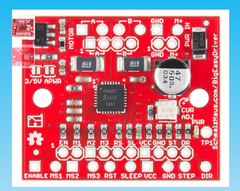

Fig. 3. BE Motor Driver

Fig. 4. Stepper Motor

Fig. 5. Adjustable Power Supply

- The Arduino board has been coded to control a series of stepper motors that are designed to move simultaneously on both the X and Y axes. The program would run for 5 minutes.
- The code used for the calculation of positions were tested with different variables and used in multiple programs.
- Two test procedures were recorded to provide feedback on each start/stop position relayed from the motors. The first two sets of data were tested using 20 positions and in the last two data sets, a program is used to create scatter plots with varying positions 20 to 40 (Fig. 6-9).

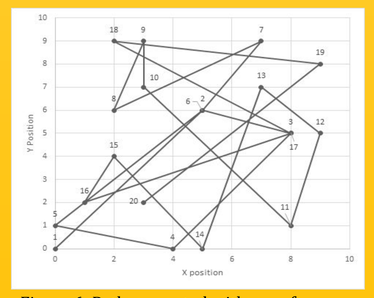

Figure 6: Path generated with use of Program 2.

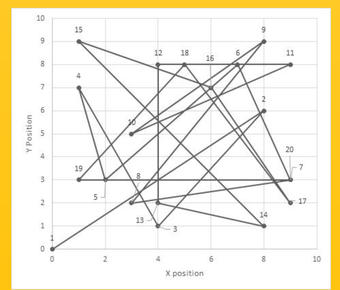

Figure 7: Path generated with use of Program 3.

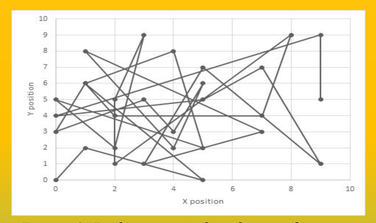

Figure 8: Path generated with use of program 7.

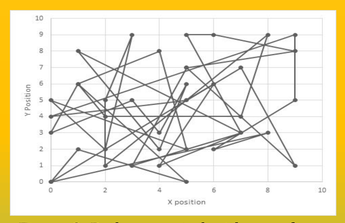

Figure 9: Path generated with use of program 7. 40 Positions.

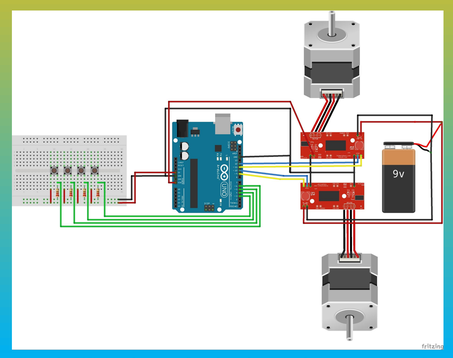

Fig. 10. Wiring layout for the electrical components of the X-Y Plotter. In the actual circuit the 9V batter would be replaced with the Drok adjustable power supply.

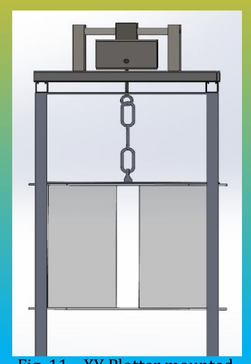

Fig. 11. XY Plotter mounted on current rainfall simulation.

- Buttons were implemented into the programming to allow for different programs to be run based off of the needs of the clients. Adjustments included speed and path.

Results and Discussion

- Each test carried out stopped after 5 minutes.
- All four programs used for analysis were implemented in the X-Y plotter to provide a variety of paths.
- Conversion factors were used to convert positions to steps the motors needed to make to ensure that the X-Y plotter remains within the fixed region. Limit switches would act as a backup system.
- The initial, upgraded and final CAD simulation of the X-Y plotter consists of a linear rail system, end caps, lead screws, mounting carriages as well as connecting and footing plates (Fig 12).
- The original components of the book trimmer consisted of heavy metal components which have now been substituted for lightweight material which include aluminum and steel.

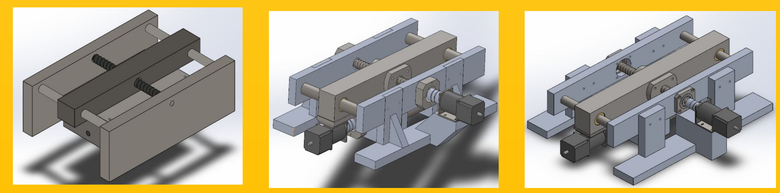

Fig. 12. Development of X-Y Plotter design.

- The X-Y Plotter is to be mounted above the unit that holds the water reservoirs and the existing joint connection is implemented onto its mechanism. CAD representation is provided (Fig. 11).

Conclusions

The X-Y Plotter can:

- Generate smooth and random motion.
- Carry a load of 200 lbs
- Be easily installed on existing enclosure
- Be built under $500

Recommendations

In order for the X-Y Plotter to be implemented into everyday use, the electrical components would need to be upgraded to withstand the work load. PLCs or other industrial controllers would be best, along with more advanced motor drivers and soldered connections. An emergency stop would also be required to cut power easily.

Acknowledgements

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