Outreach Robot

Jesse Calzada, Pratikshya Devkota, Sedick Iyamah, Jeswin Mathew, Alexander Windeler.

Senior Design

UTA SIXTY 1959-2019 ENGINEERING

VIRTUAL INNOVATION DAY

Executive Summary

The goal of the Out Reach Robot project is to create a interesting representation of the technology that can be built by a group of undergraduate students in computer science in order to inspire future potential students of computer science. To accomplish this goal after many iterations and different implementations of our project we were able to reconfigure a 3D printer to copy what a participant draws on a provided tablet. The process first starts with the user drawing on a tablet in Inkscape. After the figure is drawn the 2nd step is converting that drawing to G-code so the modified 3d printer will be able to move correctly based on what is drawn. The 3rd step is to modify that G-code with a python script in order to eliminate unnecessary G-code and to insert G-code that adjusts the height of writing utensil. Finally the last and final step is to send the modified G-code to the printer and watch as a machine duplicates the drawing that was provided by the participant.

Background

- The background and purpose behind this project was originally to be used by Dr. Tiernan, a Computer Science professor at UTA in her programs for encouraging computer science engineering for school students. As initially planned, these students need to be able to make their drawings on the tablet and the drawing has to be sent to a robotic arm which mimics these drawings on paper. Our first tool for drawing was a 6-axis SCARA robotic arm. Due to some complications which arose while working on the robotic arm by the Marlin software, our team switched to a new tool for doing the drawings. We started working with the MonoPrice Maker Select 3d printer. This implementation's details will be shown in further sections but the path of the drawing to the final output drawing by the printer is similar to what we had tried with the robotic arm.

Conceptual Design Phase

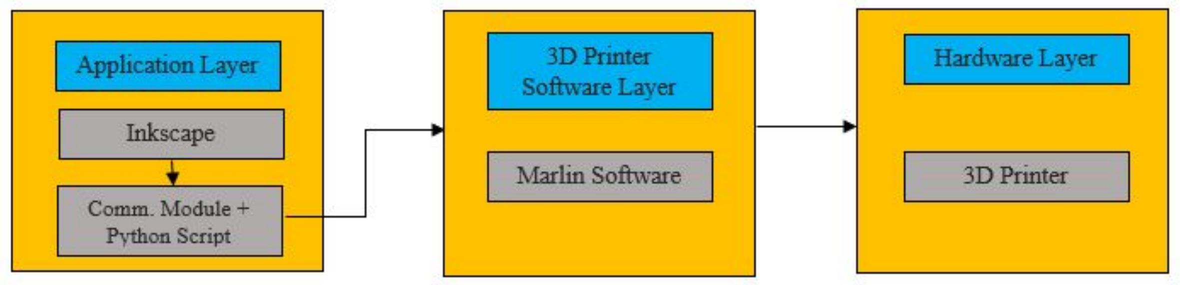
As our original plan and concepts were based on the robotic arm's implementation, so our earlier requirements and constraints were developed around that, such as sending SVG file of the drawings via Bluetooth to arm, the arm making use of inverse kinematics to calculate its position and orientation to do the drawings, budget constraints on tablet etc. Our plan since the beginning was to have the robotic arm draw basic shapes on paper, which we did with fairly good results as our printer did overlapping lines on the drawings along with straight lines with great precision. Eventually some of these requirements carried over when we moved to using a 3D printer, despite the difference in the execution.

	General Requirement List
1	Inkscape or other similar drawing tool like JS Cut will be used to convert SVG to G-code for the drawing to take place.
2	High priority on wiring safety is kept as school students use it. Constraint: only one drawing cycle can be done at a time by the printer, so students have to wait until the drawing is complete to start another.

Detailed Design Phase

- The system is composed of three major hardware and software layers.

1. **Application Layer.** This layer contains all of the software used by the tablet/computer. It contains the two subsystems, the Inkscape application, and the communication module and Python script.
   a. Inkscape is a drawing application that takes a user input in the form of a drawing. It than has the option of saving the drawing as a Scalable Vector Graphic (SVG) file which can then be converted into G-code
   b. The Python script was created to modify our G-code, such as adding extra steps to raise and lower the arm at the beginning and end of the drawing, and the communication module to send our code to our robotic arm.
2. **Print Software Layer**. This layer contains our Marlin Software which drives the robotic arm.
   a. The Marlin software is the software which controls our robotic printer. It takes an input in the form of G-code from our communications module and uses those instructions to move the printer
3. **Hardware Layer**. This layer is the 3D printer itself.
   a. The our robotic printer is a modified 3D printer. The nozzle and material feed were removed and replaced with a gripper to hold a dry erase marker. The printer moves according to the instructions from the Marlin software. The height of the marker is adjusted from the modifications added using the Python script so that the printer can lower down to begin drawing and raise back up when done.

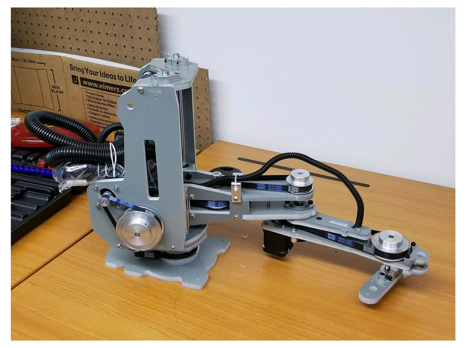
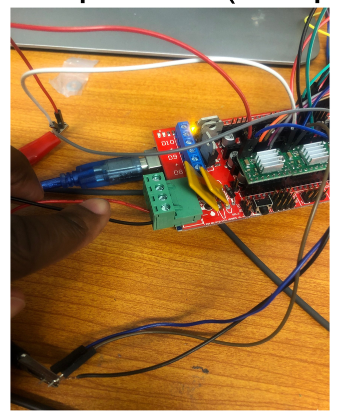


Prototype & Test

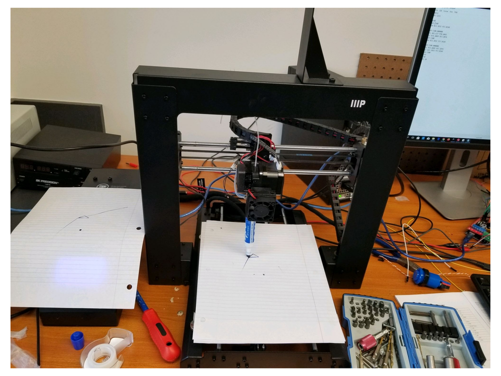
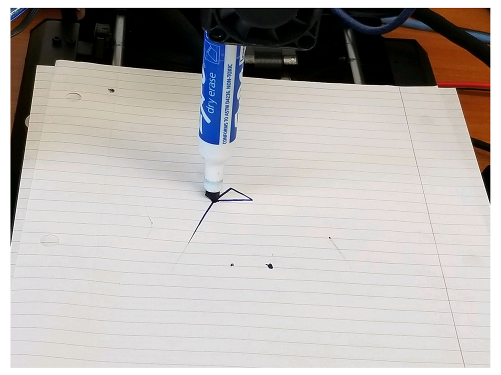
During the life of our project, we had two prototype designs. Our first and earliest design used a robotic arm. After realizing that this prototype would be unsuccessful through various test, we moved on to using a 3D printer as a substitute for the robotic arm.

Note: Both designs required us to tape a marker to the arm/printer. (We planned on making a harness later)

1) Robot Arm Prototype

2) 3D Printer Prototype

Conclusions

- This project was targeted to get school students interested in computer science. Although we switched to 3D printer it will still match the goal which was set. The device is as portable as it would be using a robotic arm. As this is a hardware project we had complication because of this current situation and we couldn't work on our project as much as we wanted to. However, we as a team learned a lot through this project, as it involved a lot of research. We had to switch to different approach to find the best methods to implement. More than half of us being a software major was one of the complication but getting help from our teams who are computer engineering major made our project go smoothly.
- In the future we are planning to develop an application for a communication between the tablet and the 3D printer. We will also research more on how we can do the drawings in real time.
- We are very thankful for Dr. Conly who helped us greatly on this project and the CSE department for all the funding needed for our project.

References

1. Liu, S., and Bobrow, J. E., "An Analysis of a Pneumatic Servo System and Its Application to a Computer-Controlled Robot," *ASME Journal of Dynamic Systems, Measurement, and Control*, 1988, Vol 110 pp 228-235.