Final Project

ECE/ME 439 Robotics

Thomas Hansen

Yifeng He

Peter Hornung

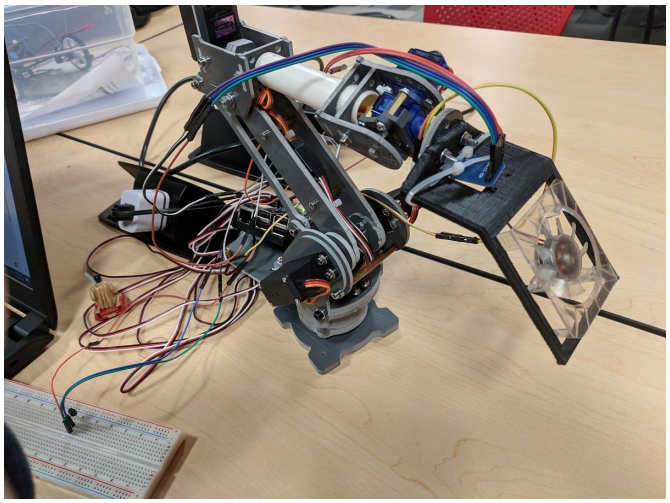
Introduction

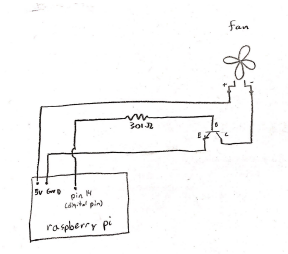
Our project is to build a system that can find a cup, read its temperature. If it's too hot, a fan turns on to cool it until it reaches the desired temperature. We achieved this by attaching a thermal IR sensor and fan to a mount on the end of the arm, which is used to locate the drink by finding an abnormally hot spot on the table, and track its temperature as the fan cools the drink. Once the drink is cooled to an acceptable temperature the fan will turn off the and the arm will return to the resting position. The path algorithm is built from a modified version of the robot inverse kinematics writing file, following a predetermined path generated from an svg file.

We chose this project since we wanted to be able to develop an understanding of multiple different aspects of the robot. We wanted to use the arm in a new way to draw a path, but we also wanted to know how to implement an I2C based sensors as well as use a digitalwrite pin into the robot. We decided on this drink cooler robot since it serves a necessary function while allowing us to learn about different aspects of the robot.

Design

Our robot is built up of a couple different parts. It is the robot arm as used in class, but with a 3D-printed mount holding a fan at 45 degrees and a IR thermal sensor level. The IR sensor sits next to the fan pointing down so it may read the temperature of whatever is below it. The cup additionally must be placed in a pre-designated area relative to the robot arm for it to be able to find it and measure the cups liquid temperature using the IR sensor.

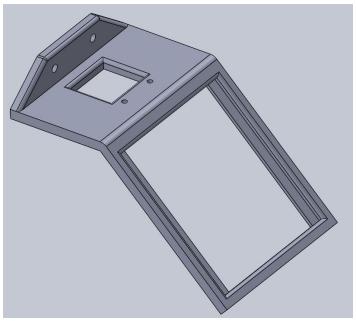




The simplest of part on the robot is the fan used to cool the drink, which we operate using a digital pin on the raspberry pi. The digital pin runs through a resistor and turns on an NPN transistor, powering the fan from the more powerful 5V pin which can't be turned on or off. We connected the pins on the raspberry pi to a seperate file named "fanController" using a ported python version of the wiringPi library.

Next is the IR temperature sensor which is connected to the arduino board as well. It's connected using the I2C protocol, and we based it off of the adafruit industry provided code. After instantiating the IR sensor, we are able to read the temperature using the python method sensor.readObjectTempC(), which returns the temperature in degrees celsius which we can use in the python file or share in a topic if we used ROS.

The final major part of the project is the robot arm itself, which is powered by the provided raspberry pi board, with a shield to control the motors and an arduino uno board on top (branded as a alaMode_v3 board). The arm that moves around is a 6-axis arm, with a base rotation of approximately 190 degrees and two major arm portions which are able to move around and reach out. Here we used a python file to read in an SVG file to find the desired path, which traces around the designated area until it find the up using the IR sensor. Once it finds the cup, the robot decides if the temperature it too warm. If it is, it turns on the fan and periodically re-checks the cups temperature. Once the temperature has lowered to an appropriate level, the robot turns off the fan and return to its original position to signal that it has finished cooling the liquid.



The temperature sensor and fan are both held together by a mount at the end of the robots arm, which we 3D printed piece. The fan had clips on it still from when it was in a GPU, so we were able to size the holder so the fan would pop in without additional

adhesives. The fan additionally sat at a -45 degree angle, so that it could more accurately target the cup when cooling. There was additionally another tapered hole for the IR sensor, and we held it in place using zip ties which we poked through the two holes built into the sensor.

Results

Overall the robot performed as we had hoped. The largest challenge we faced when attempting to build the robot was issues with the temperature sensor, which after speaking with Josh about the matter he told us it appeared to be broken, which we confirmed by testing some of the points on the board with a multimeter. To josh's instruction, we build an array of fake temperature points and build all the additional functionality around the robot, so the fans, arm, and logic all work properly using predetermined temperature values.

We also found that the fan we were using wasn't as strong as we had hoped. We pulled the fan off of an old GPU and had to work around some of these limitations, such as adding a transistor into the circuit so we could pull power from the stronger but non-variable 5V source on the board. The fan cooling will definitely work, however it may take a while to cool the cup.

Discuss

We learned more about the python code behind the arm operation, and delved deeper into Raspberry pi to make fan work through code. In addition, we also learned how to use transistor and resistor to supply 5v power for fan. We also started learning about how to code the IR thermal sensor, either through arduino or through python, but the thermal sensor we ordered showed up broken. The most valuable lesson learned was to order multiple of a sensor if there is not enough time to order another one.

There is significant room for future work on our project. The next major step would be to order another temperature sensor that actually works. Once that is working, we would replace the generated placeholder thermal data with the correct thermal measurement code. Once we are collecting the thermal data, we could optimize the cup locating method by experimenting with data averaging to hit the center of the mug with the fan. Then we would find a new, slightly more

powerful fan that would be able to cool. A stretch goal could be adding ultrasonic rangefinders to find the height of the mug and make sure the arm does not knock over the mug.