Individual Lab Report #3

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Wholesome Robotics (Team E)

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Individual Progress

In the past two weeks I have worked on a number of tasks, of different types, related to our project.

I worked as the lead on the Second Printed Circuit Board Assignment. I designed a schematic for a thermostat to control the robot's cooling system. The robot has two separate compartments for electronics each with two fans, so we will make two thermostats, each controlling the two fans in its compartment.

The circuits used are a thermistor on a voltage divider and a potentiometer on a voltage divider compared via a Schmitt Trigger. The Schmitt Trigger allows for the setting of a distinct high and low transition points, namely a controlable hysteresis so that the fan remains on until the temperature below the low point, but won't turn on again until the temperature rises above the high point. This prevents rapid switching if the temperature were to osscilate closely around a single setpoint.

The output from the trigger then passes through an enable port (a two port connector, where if the two leads are connected, the circuit is enabled) and to a pair of transistors, each controlling one fan. Both fans have flyback diodes for protection from back emf. The two fans are also connected to an override port (a two port connector, where if the two leads are connected, the fans will run regardless of the thermostat state). Since all the components and logic operate at 24V and relatively minimal current (around 240mA at the most) no special power specifications were required.

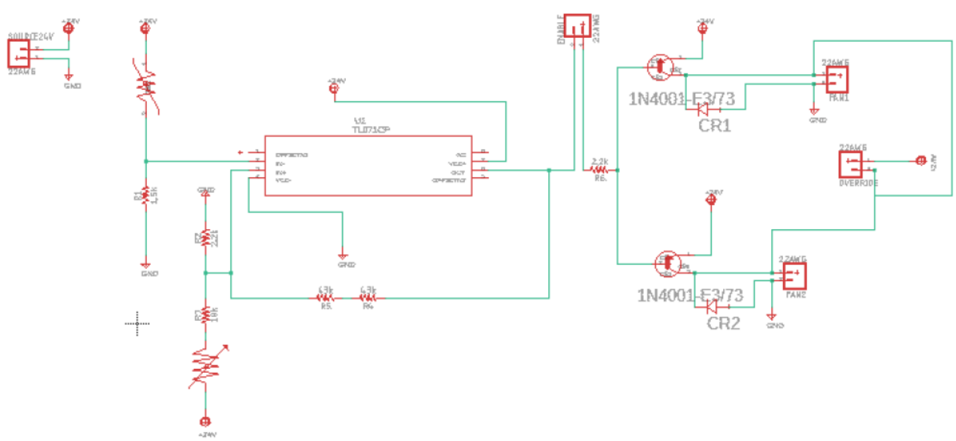

Figure 1 Schematic for Cooling System Thermostats

I also fabricated the cultivator (end effector) prototype for the robot's weeding mechanism. I used the drawings I had previously generated and a 2in diameter 6061 stock for the main piece. First I turned the piece on the lathe, cleaning up the edges and faces and then cutting the shoulder down to ½ in so that it can fit inside a standard cordless drill chuck. Next I mounted the part to the mill with an indexing rotary mount. This allows for easy changing between 15° rotations, ideal for creating bolt circles and other circular patterns. I then found the parts center, and used the digital read out to center-drill, drill, and tap the 19 holes with #10-32 threads at 70% thread width. The holes are placed in a spiral design so that in one direction we will get more ground interaction (the dirt will be pushed into the center) and therefore better cultivation, in the other direction we will have less interaction (dirt will be pushed away) and therefore less force required. We will try both directions of rotation and see which is more effective.

Unfortunately, the machine shop did not have any bottoming taps, so I had to clean out the threads myself using a #10-32 screw. Then I screwed in the zinc-plated threaded rods that will function as the cultivator's teeth. In the design these are ground down to sharp points, however I have not yet done this step in order to preserve the zinc coating. If the cultivator works without the grinding, the coating will prevent corrosion on the teeth, extending the part's life. Otherwise, I will try grinding the teeth before moving on to other designs.

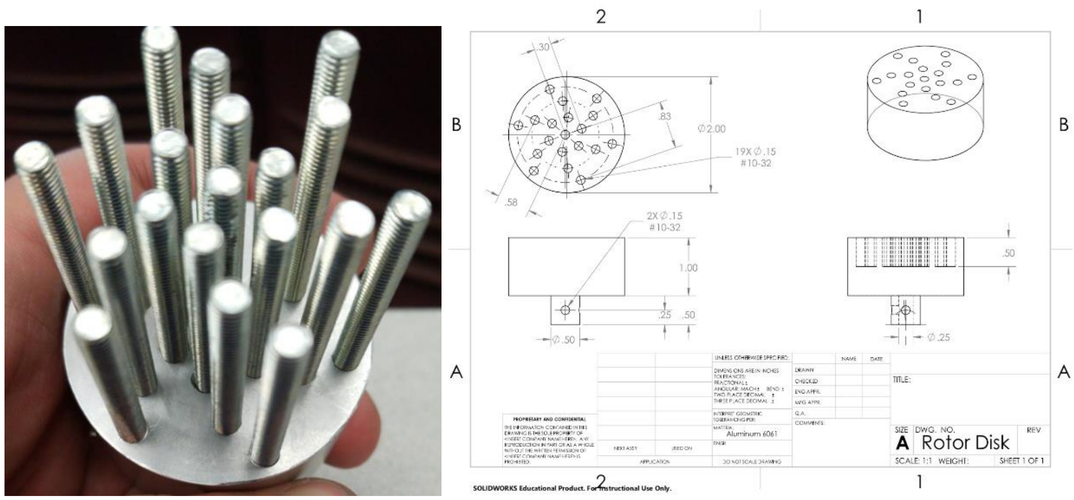

Figure 2 (left) Prototyped Cultivator (right) Design Drawing

I am currently working on finding places to test the cultivator such as Phipps, or filling a planter with weeds and performing the experiment in the highbay.

Finally, I mounted our Velodyne Lidar to the robotanist for testing in the upcoming week. This was not trivial because of the different types of mounting used by the puck and our robot. We want to use an adjustable mount so that we can experiment our SLAM algorithm's effectiveness for different mounting angles. However, the tilt mount that we have was not directly compatible with either the Lidar or the robot's T-slots. To solve this I used some simple tricks that will help for the time being, and that can be replaced in the future by a custom built mount. For example, I mounted the tilt mount onto a different mount already present on the robotanist and compatible with the T-slots. I also prevented the lidar from spinning with a screw that fits into one of the lidar's packing recesses and not into a designed mounting point. Among other issues, this causes the lidar to be slightly rotated from forward-facing, a problem which can be fixed relatively easily in softawre. These are issues that will be adressed more fully in the future, but for now the design is sufficient to begin our testing next week.

I also was the point person for purchasing and receiving supplies and parts.

Challenges

A major challenge we had in the past two weeks was scheduling. We are behind schedule on the assembly of the robot, and we are inundated with other tasks, many of which are dependent on the completed robots. We underestimated the amount of man hours required to update the designs and to then fabricate it. We are looking into possibilities for speeding up the process such as sending out more parts for fabrication or getting help from other members of George Kantor’s lab.

Teamwork

Aman has finalized the designs for the robot that are to be sent out for fabrication.

Aaditya has been working on the SLAM algorithms and integrating the Velodyne Puck.

Dung Han has been working on the perception algorithm for recognizing holes in the plants’ leaves.

John has been working on the particle filter for the navigation subsystem.

Together we have worked on a number of integration tasks, such as testing the motor controllers, setting up our Zotac and NUCs. We also worked together on our assignments for the business course, and the various project course assignments.

Future Plans

Wholesome Robotics

In the coming weeks my plan is to research and begin assembling the robot’s electrical system. This is comprised of multiple voltage regulators, fuses and connectors, assembled on “terminal blocks” I plan to build first a benchtop circuit then shift to the robot’s battery so that we can power all of the robot components in a portable way.