Claw Machine Safety Limit System

Capstone Abstract: CSCI1600
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Description/Purpose

The initial project for my group for CSCI1600: Embedded Systems was to create a claw machine of sorts. We designed a system using a series of belts, gears, and motors that was able to pick up designated objects. The claw would be able to move left and right, as well as up and down to grab the objects. My capstone addition to the project was to create a safety system for the motor mechanism. The final product of my capstone would be a set of limit switches that when sensed by our Arduino, would effectively stop movement from occurring in a given direction.

Due to the nature of the DC motors we had initially purchased, there was no way to determine whether or not the system had reached the bounds of the mechanism. Therefore, the motors would overrun the mechanism, breaking the 3D printed parts that we had. If the user were to run the machine in a given direction for too long, it would break some parts, something that we wanted to prevent.

Additionally, our ‘grab’ command was an automatic movement, meaning that the claw mechanism would have to automatically run and stop once it reached the top/bottom of the movement. Our solution was to use a time-based approach, running the motor at half speed for a few seconds, fine tuning it so that it did not overrun the mechanism. There are inconsistencies however: as the battery we have runs out of power, the motors slow down, meaning that the distance traveled in a given amount of time does not remain consistent. Having something to sense upper/lower bounds solves the problem.

Summary of Design Challenges

There are a few design challenges associated with this project:

- Figuring out what kind of sensor should be used to determine the distance traveled was correct.
- Determining how to wire the sensors for use with an Arduino.
- Finding optimal placement of the switches.
- Interpreting the data that was collected, and how it could be used to implement the safety system.

Approach Taken and Challenges Solved

Choosing Sensors:

One of the limitations that I ran into when researching the types of sensors that I could use was finding one that would work with the Arduino, as well as one that would work with the

limited slots that the Arduino had remaining. We already had a multitude of components that were wired into the system, so I had to work with the limited amount of pins available.

One sensor that I had considered was a proximity sensor. This would allow me to sense the distance to the ground where I had to grab. However, I ruled it out as there may be obstacles or other grabbable objects in the play area which would mess up the readings and cause the motors to overrun or stop short, preventing successful grabbing. I also considered a light sensor, which would get covered by something once it reached the lower/upper bound, triggering a low light level, allowing me to stop the motors. Both of these sensors, while viable, would also require a number of pins on the Arduino, which were already in short supply.

I ended up settling on a simple limit switch. When clicked down, the limit switch completes the circuit, and the Arduino is able to read the signal and interpret it. Additionally, the limit switch only requires one pin on the Arduino to have its signal read. I was able to find a number of limit switches that were compact enough to fit on the mechanism and do the task. The aim of this addition is to remain as simple as possible, as having more complex components can be unpredictable and cause failures in the system.

Setting Up the Switches:

Working with my other group members, I determined that the best place to put the switches was in the center of the claw mechanism. That way, the rail would come down and touch the top limit switch, and on the way up, the bottom of the rail would come up and touch the bottom limit switch. Once those switches were pressed, I would know that I've reached the bounds and I would need to stop movement.

There are three poles on each limit switch, each with a purpose:

- COM, which is connected to the signal pin on the Arduino.
- NC, meaning normally closed. This shows a 'HIGH' signal when the switch is open (not pressed).
- NO, meaning normally open. This shows a 'HIGH' signal when the switch is closed (pressed).

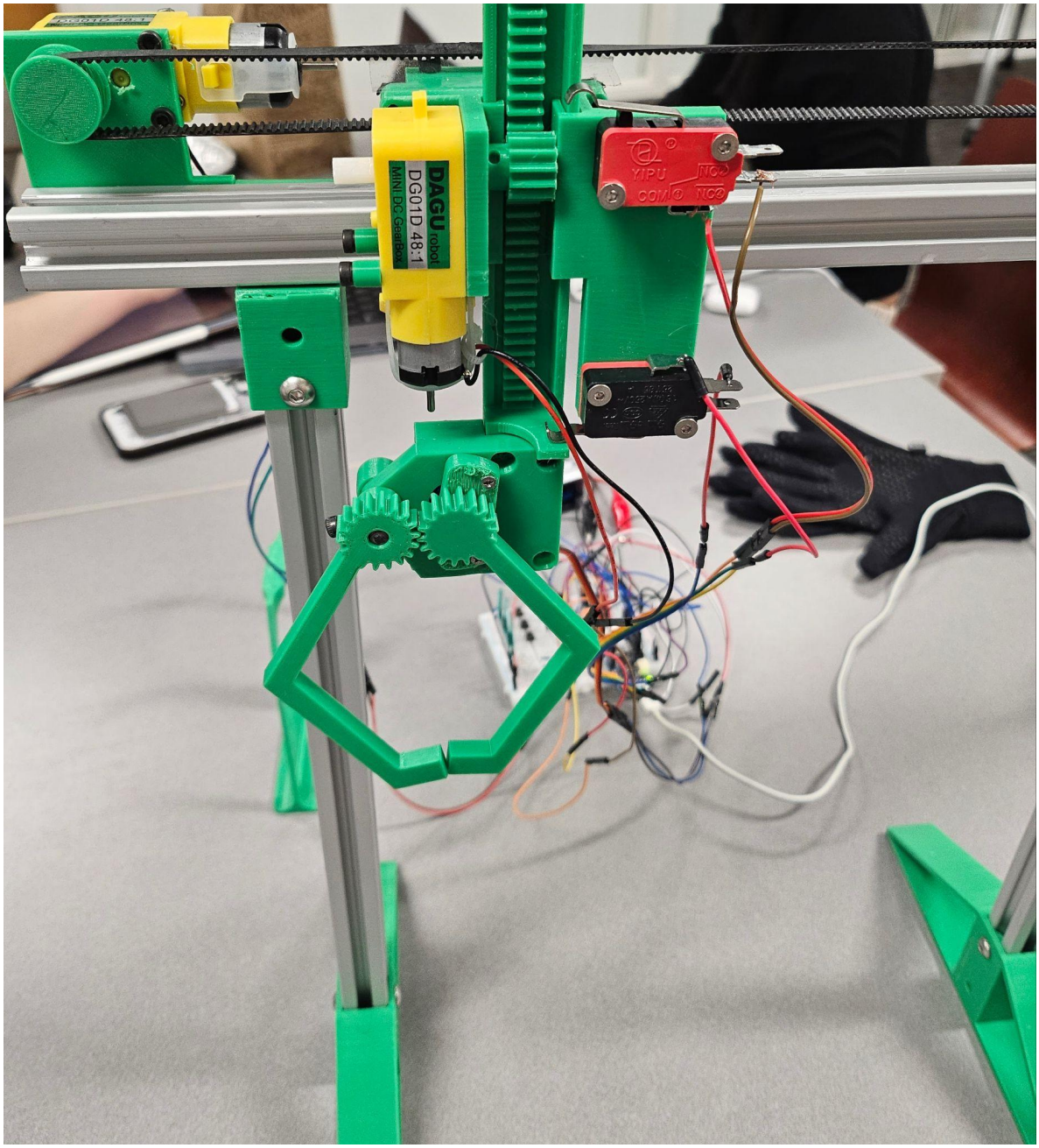
Knowing that I only need to detect when the switch is closed, I wired the COM pin to a signal pin on the Arduino, and a NO pin to ground. That way, when the switch is pressed I can see the signal change and perform our operations.

Getting Everything to Work in Code:

In terms of making the limit switches work the way that I wanted them to, I ran some initial testing to make sure that the switches were working properly. Every time I clicked a switch, I had it print a note that it was triggered. Using that information from the pins, I was able to implement some functionality that would stop the motor. I would run the up/down motor at a given speed. While that was happening, I would loop continuously and read the pin status attached to the limit switch, and once the pin was triggered, I'd stop motor movement. This was incorporated into the FSM that we had as a variable, and was updated when needed.

There were not any huge issues with creating the safety system. It prevented the system from overrunning the motors and destroying the mechanism, and gave the claw mechanism an clear upper and lower bound to stop at.

Pictures of Mechanism:



You can see the limit switches on the right side of the claw mechanism. They are red and black. The bottom switch is currently pressed, which is preventing the motor (yellow) from continuing to run upwards. The top switch is currently not pressed, allowing downwards movement.