Note: Ferb = Robot

Progress

Introduction

In this lab, we continued to expand on the color logic we started in lab 3. During lab 3, we worked on ensuring our robot could detect colors under specific thresholds. These thresholds were then used to allow the robot to detect colored objects, move in the direction of the colored object and track the colored object. Lab 4 builds on this logic. In lab 4, we start off with allowing Ferb to be able to differentiate between red and green cones. This will allow us to build the path that Ferb will navigate. For Autonomous Racing, we decide to implement Option 1 and Option 2. In option 1, Ferb will be navigating through red cones on the right and green cones on the left while chasing a beach ball. The way we went about implementing option 1 was to decide the priority of events. The priority order goes, detection of the red and green cones and then, chasing the beach ball. This was simple to implement initially but it got more difficult as Ferb displayed some strange behaviour when interacting with the cones.

In option 2, Ferb will be weaving between orange or yellow cones with wide spaces between each cone. We will implement this by detecting the cone and then deciding to go left or right around it depending on if Ferb needs to zig or zag respectively. Adding onto this option, we will reuse much of the code to make Ferb complete a figure 8. To accommodate this, we extended the time that Ferb turns for before looking at the next cone.

The hardest part of this lab was once again, dealing with the threshold values and working on having the cones and beach ball appear on the screen. Ferb was very laggy during the lab which did not produce the best view of the colored objects.

Data

Thresholds for the HSV values discussed above were determined live using cv2. In the pictures later in the report the sliders can be seen along with some of the older HSV values we tried. The final HSV values chosen were:

Beach Ball:

- Hue: 0-90
- Saturation: 155-185
- Value: 130-230

Red Cone:

- Hue: 0-99
- Saturation: 34-156
- Value: 133-247

Green Cone:

- Hue: 33-124
- Saturation: 124-172
- Value: 80-122

These values did not stay stagnant though. When changing from working in the morning to working in the afternoon, the values needed to be changed drastically due to the difference in brightness and temperature of the light.

Algorithms

ZigZag/Figure 8: Multiple algorithms and a state machine were used in the ZigZag and Figure 8 portion of this lab. To center the cone in Ferb's vision, we used a proportional controller which would find the error between the cone and the center of the screen, computing a proportional steering that allowed Ferb to correct naturally without stopping to turn. The state machine for this portion is much simpler than the previous lab's state machine (mostly due to the proportional controller that reduces the number of states necessary). It has three states, the first being a search that finds the cone in the beginning or if the cones are ever lost. The second is an approach state that implements the proportional controller, steering Ferb towards the cone. The final state is a turn state that navigates Ferb around the cone based on whether it needs to go around the left or right side.

Bonus

Option 3 (Figure 8)

- During this option, Ferb will make a figure 8 around the red cones. This will build on the logic that was developed in Option 2 and the zig zag bonus.

Create/post-edit a video that shows your robot doing one of the tasks and the CV processing on your screen

- During this bonus action, we filmed Ferb navigating through the red and green cones while chasing a beach ball.

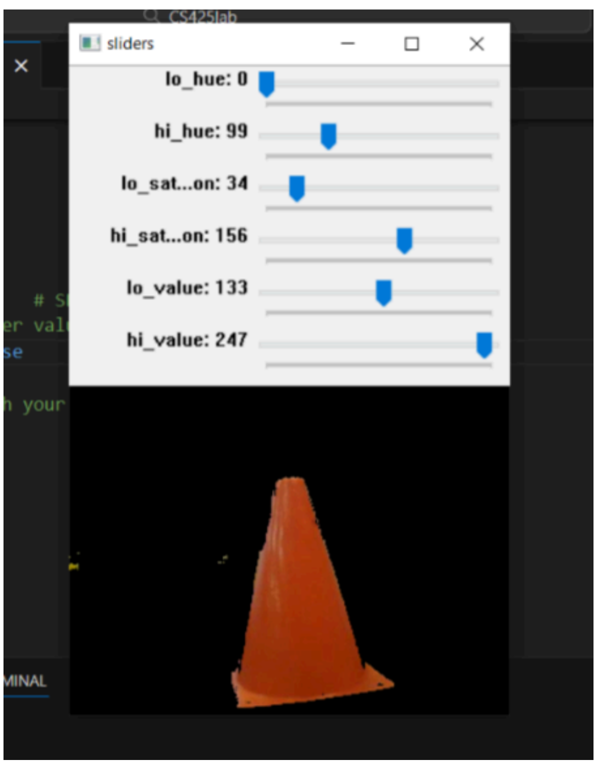
Results and Media

Ferb was able to navigate through cones to follow a beach ball, wind its way through cones, and perform figure 8s. Something surprising was the implementation of a proportional control. It is something the group had some experience with but we didn't consider it for the last lab. It made this lab's implementation much easier than the last. One thing our robot couldn't do that we wish it could is the zig zag course. We just didn't end up having the time to implement it, otherwise it was very doable. Throughout this lab we had to reconsider how we were implementing our state machines, especially with the weaving and figure 8. Originally we looked at making the navigation for this purely computer vision based, but this proved difficult to implement with our current tools leading us to our final solution instead.

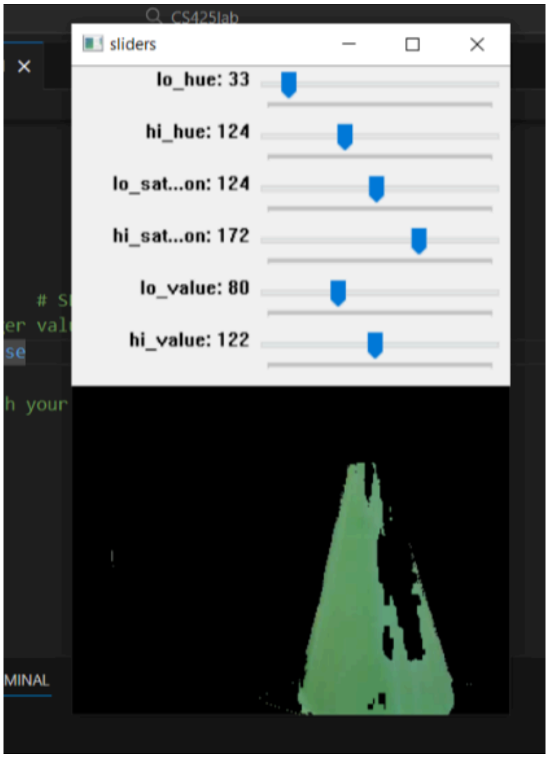
Pictures

Image of Robot

Selfie of group with robot



Ferb segmenting an orange/red cone.



Ferb segmenting a green cone.

Videos

https://youtu.be/gVPH952fF8s

The video has 4 clips in it. The first clip shows Ferb navigating the orange cones in a wide pattern. The second shows what Ferb's vision is while navigating the cones. The third clip shows Ferb in a loop as he does a figure 8 around two cones. The fourth and final clip shows Ferb avoiding cones to chase after the yellow beachball.

Reflection

By the end of the lab, we completed option 1 (follow ball through cones), option 2 (weave through cones), option 3 (complete figure 8s around cones), and a video of Ferb's vision while completing one of the tasks. While the lab ended in success, there were frustrating and difficult areas in this lab. Particularly frustrating was the initial implementations of state machines for all three of the options that we did. None of the initial ideas that we had worked or at least they didn't work well. The other point of frustration in the lab was determining proper general thresholds. With the days getting shorter, the lab was swinging from bright to dark, keeping our thresholds inconsistent. If we use computer vision in our final project, we might look into some way to calibrate the thresholds on demand. We also might look at using proportional control like we did in this lab (or a PID controller). Given extra time we would have looked into making Ferb more consistent through the tasks and making him a bit quicker, maybe through further optimization of the code.

Owen

This lab was frustrating. It took a lot of dead ends before we landed on the solution for each part of our final code. In the end though, our solutions were very satisfying making the suffer a little more worth it.

Srean

I think being able to see what we can use in lab 3 and extend it further to having Ferb doing zig and zag, performing figure 8, and navigating through different colors of cones to chase for the beach ball. I think it is pretty cool because it reminds me a lot of the similar features for the robots going into dangerous fields.

Rowena

This lab included a lot more hitting my head into the wall than I was expecting. I thought we'd have it easy working off of the last lab's code, but that was not necessarily the case. Much time was spent developing work arounds for the shortcomings of our filtering. Although tough, things worked out in the end so I suppose it's okay.

Divya

This was one of the most challenging labs so far. It involved us being able to integrate the lab 3 code with the lab 4 starter code. It was very helpful to keep building off of lab 3's code because it allowed for a clearer understanding of the code implementation and it allowed us to avoid the learning curve that we typically experience with the previous 3 labs. It was also a lot of fun to work through the cone detection while chasing the beach ball.

Code

Attached in the '.zip'. "lab_4.py" is option 1 while "lab_4_zigzag.py" is option 2 and 3; it is toggleable by changing a variable value.