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Raspberry Pi Car Following Object

Dec 8, 2022

Semester Project: Part 5 Final Report

Dataset: The database we collected involved over 20 pictures of a tennis ball that we put in various kinds of distances, angles, and lighting conditions. We also supplemented this with 40 more pictures of tennis balls from a Kaggle dataset of tennis balls we found online. That link is attached here. Although our application of this data is meant to be done live and not with training and test data splits, the dataset we used was useful in helping us figure out the parameters we would have to tweak for our AI model. By identifying the best hyperparameters of our circular hough transform algorithm, we can best select the right accumulator resolution and threshold to use as well as the min and max radius of the ball that's being detected. Our edge detection algorithm will then be more robust and with a better range of HSV values. When we finally tested our car live, the tennis ball was very accurately detected as a result of this preprocessing method.

Classification Accuracy: The classification accuracy of our algorithm maintained strong detection of the ball which was measured in the last phase to be at .945 accuracy. This continued to be stable for our testing scenario but as mentioned previously, it's hard to say how consistent it can be when the ball is being detected live while it's moving around. We can see from the attached video in the drive (check README doc) that the detection of the ball is nearly exact so it suffices to say that the classification accuracy was still likely around .94.

Improvements: I think finding the perfect frame and buffer rate can play a part in detecting the ball and real time and making decisions about steering. Sometimes the car hesitates when deciding to change direction or detect the car. We managed to fix the weight distribution problem as well as the problem with the faulty wiring after much deliberation. We also fixed the problem with the wheels not being able to start without a push. We have become professional electricians. The only thing that we wished we could have been able to do is find a way to not have to have the car tethered to the power source. We had to keep it tethered to an outlet but it was enough to show the proof of it working. Another error we noticed when testing our application for the final time was that sometimes the Circular Hough Transform algorithm identified multiple circles around the tennis ball which could be fixed by the threshold of area that it needs to detect. In some cases, this is necessary lag when operating in a lighting that tends to be yellow. These multiple circles don't appear too often but can confuse the robot and cause it to momentarily freeze. Luckily, it didn't affect the performance of our car too much and it was hardly noticeable.

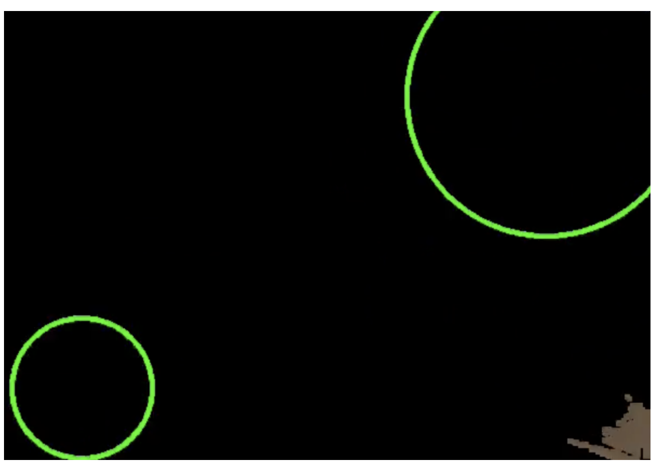

Figure A: Circular Hough Disaster

Team assignments: For this final wrap-up week, Alvin worked on getting the car to operate from an electrical and physical perspective. He fixed the mechanical and wiring issues that were preventing the car from operating or obeying the code. Luke fixed a lot of the detection and frame rates of the Pi's camera which by tweaking the resolution and buffer rate, he was able to get the car to stall less and respond proactively to the ball's location based on a minimum area threshold of detection. We both worked on the final video presentation and report.