CS437: Internet of Things
Lab1 Part1

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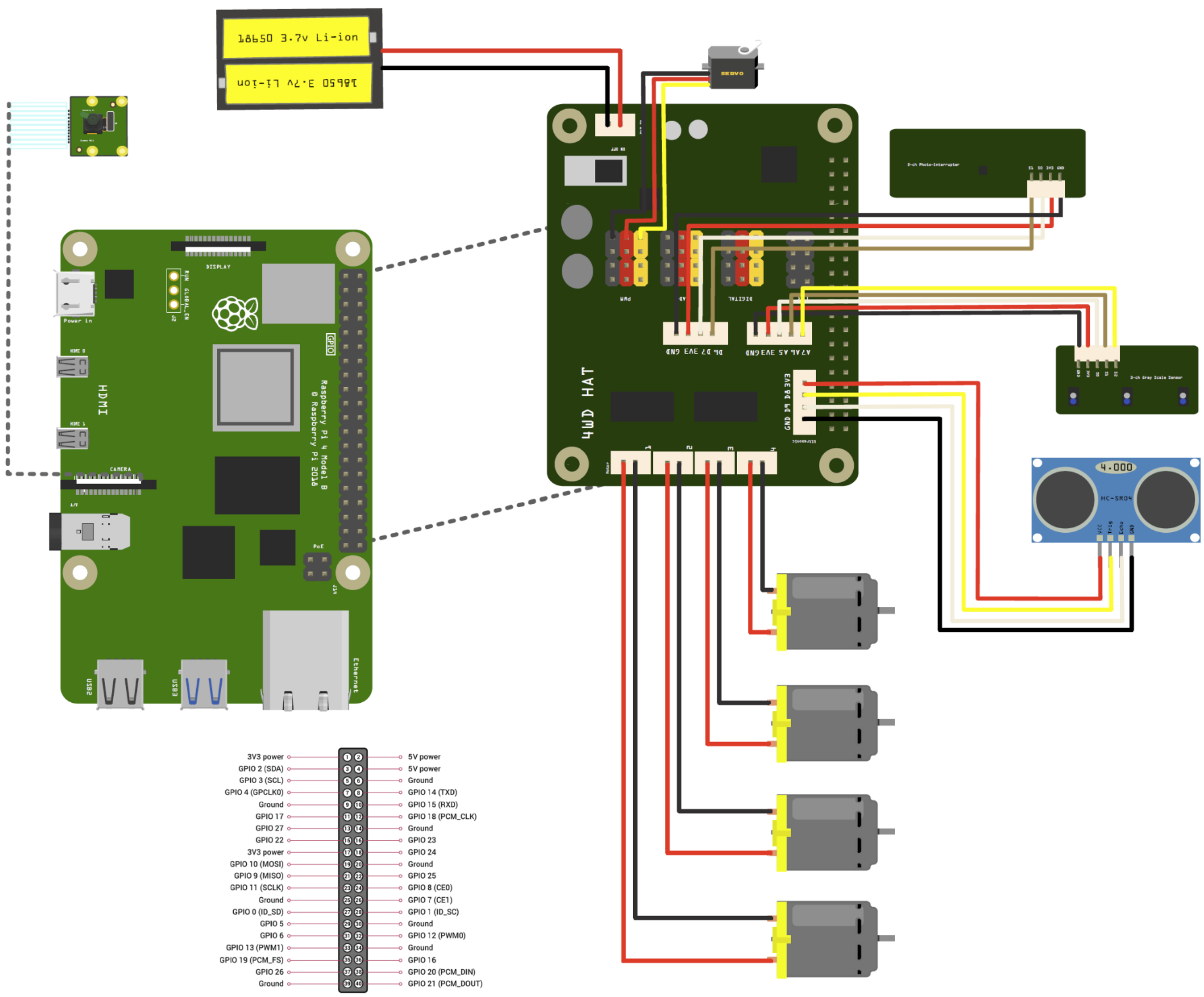
Late days used:
Video Link: shorturl.at/aQRTX

Topology:



Design Considerations

Chassis Assembly:

- Wires were twisted for the ultrasonic sensor to provide good readings as suggested in “Lab 1 Frequently Asked Questions”.
- Raspberry Pi cameras should be plugged in and mounted before assembling the other components on the HAT to avoid having to redo the steps.
- Config file was edited for the wheels to turn correctly and the servo offset was determined by trial and error.
- Documentation by the manufacturer was not comprehensive, but the team was able to trace through the code and understand the implementation.

Naive Mapping:

- Hardware issues present in all but one of our cars. Turning at higher motor speeds resulted in wheels slipping off the axles.
- Initially, we wanted to keep the ultrasonic sensor fixed in the forward position, since we wouldn’t have to consider the servo angle when deciding how to change the car’s heading. However, in this configuration, the car was prone to crashing into nearby objects at the edge of the sensor’s line of sight.
- To enhance the car’s obstacle avoidance capabilities, we wanted to have greater control over its movement. Initially, we had to tweak values depending on the surface we tested the car on. To automate this process, we wrote calibration scripts to determine properties like the car’s turn rate on a given surface. We used this data to inform adjustments to the car’s movement in autonomous mode.
- 15 parameters that control the mapping and the movement of the car were stored in a config json, which simplified the calibration process necessary to run smoothly on different surfaces. The config json also enabled the autonomous calibration scripts that make fine adjustments in those parameters to increase the overall obstacle avoidance accuracy.

```
{"foward_speed" : 0.5, "back_speed" : 0.5, "back_time" : 0.2, "turn_speed" : 0.25,
"turn_time" : 0.3, "turn_pause_time" : 0.25, "min_ultrasonic_dist" : 15,
"ultrasonic_scan_interval" : 0.1, "ultrasonic_sweep_angle_start" : -90,
"ultrasonic_sweep_angle_end" : 90, "ultrasonic_sweep_inc" : 10,
"ultrasonic_moving_sweep_count_limit" : 3, "ultrasonic_moving_sweep_angle_start" :
-50, "ultrasonic_moving_sweep_angle_end" : 50, "ultrasonic_moving_sweep_angle_inc"
: 25}
```

Naive Self-driving:

- To avoid obstacles, we wanted the car to travel in a direction where the obstacles were furthest away. Initially, we used a simple averaging system that chose to turn left or right, but we later refined this to average data over segments of 30 degrees throughout the ultrasound sensor's scan period.

- Initially, when we allowed the car to keep moving when encountering an obstacle, it had the tendency to snag itself on corners. Since it takes time for the ultrasonic sensor to complete a sweep, it's possible that the sensor could have missed smaller obstacles while facing away. To resolve this issue, we chose to stop the car and do a full sweep before deciding its next heading.

Name	**Contribution**
Max Tuecke	Chassis assembly, algorithm ideation, obstacle course setup, demo video
Nishant Sheikh	Chassis assembly, algorithm ideation, document design considerations
Molly Yang	Chassis assembly, algorithm ideation, topology