UC San Diego
JACOBS SCHOOL OF ENGINEERING

Autonomous Roadside Mechanic (Team #7)

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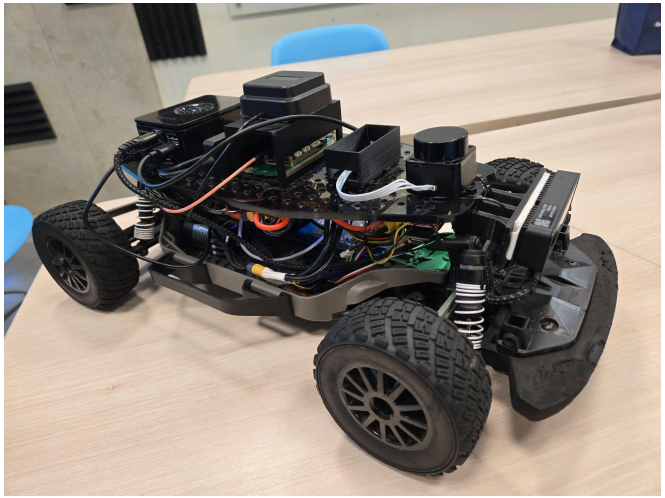
ECE/MAE 148 FA25 Team #7

Project Overview

Overview:

The goal of the "Autonomous Roadside Mechanic" is to identify and navigate a broken down car on the side of the road via hazard lights. The system uses two cameras, one “bird’s eye” camera mounted above the road which identifies there is a broken down vehicle via a blinking hazard light and one OAK-D camera mounted on the car to detect the car itself on the ground. Using ROS2, the “bird’s eye” camera sends a signal to activate the mechanic while the mechanic receives the signal to start driving on the track to navigate to and park behind the broken down car



Must haves:

- Bird’s eye view camera that detects broken down stationary vehicle via hazard lights, sends signal to activate mechanic
- Receive “release” signal from bird’s eye view camera to start driving forward
- Detect back of broken down vehicle with OAK-D camera
- Stop behind the broken down car using LiDAR

Nice to have:

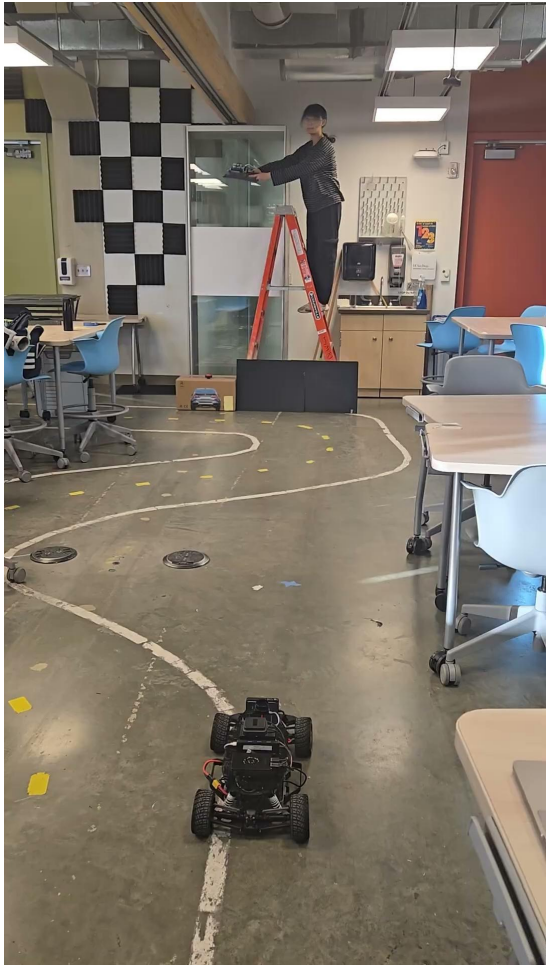
- Avoid other cars/obstacles on the track
- Ability to push the broken down car for a distance (simulating moving the car out of harm's way)
- Change lanes into the emergency lane

Accomplishments

What Have We Done:

- Jetson Nano with ROS2 node (blink detector) for “bird’s eye” camera (Intel RealSense) which detects the blinking red light and send release signal to Pi
- Pi receives signal that a red blinking light has been detected from Jetson Nano (integrated into mechanic node to release robot when blinking light detected)
- Created accurate Roboflow model for detecting the back of cars
  - Mock car with with box, car cutout, and blinking light
- ROS2 node on Pi (camera) uses the OAK-D camera running a Roboflow model to calculate the angle from the center of the camera to the center of the broken down vehicle
- ROS2 node on Pi (mechanic) to control the robot using LiDAR to calculate the distance between the robot and the broken down car
  - Subscribes to blink detector node on Jetson Nano and camera node
  - Car starts driving forward when message is received that red blinking light is detected on “bird’s eye” camera
  - Once the Roboflow model detects the broken down car, angle information from camera node is used to navigate the robot with a PD
  - Car stops when the LiDAR calculates a certain distance from the broken down car

Demonstration



Challenges

What did not work as expected:

- The Jetson Nano has connection issues and would drop out unexpectedly when SSH into the machine
  - Could be solved by obtaining a better external receiver
- The PD control as the robot got closer to the broken down car was not as accurate, error angle is much larger at shorter distances
  - Solved by exponentially scaling the error angle between the car and the robot which increased the angle when the robot was father away
- Robot does not stop directly behind the car ever time with pulling the right worse than the left, initial over-correction was often the issue
  - Could solve with a PID controller instead of PD controller to constrain the over-correction
- Field of view of the Intel Camera not as wide as expected, could not place as high as desired for “bird’s eye view”
  - Solution would be to obtain a wide angle camera

If we had another week…

- Solve the issue of the integration of the lane following and the current system such that the robot lane follows until the car is detected
- Update from a PD to a PID controller for more precise corrections

Lessons Learned:

- Placement and alignment of LiDAR and camera together is extremely important
- LiDAR direction and offset must be taken into account
- VESC connection was not stable all the time
  - VESC must be plugged in first, needs recognized as first ACM device

Gantt Chart Evolution

PROJECT TASK	SUB TASK	START DATE	DUE DATE	DURATION	WEEK 1							WEEK 2							WEEK 3							WEEK 4		
					11/16	11/17	11/18	11/19	11/20	11/21	11/22	11/23	11/24	11/25	11/26	11/27	11/28	11/29	11/30	12/1	12/2	12/3	12/4	12/5	12/6	12/7	12/8	12/9
Preperation	LiDAR research and implementation	11/16/25	11/20/25	4																								
	Develop stand-in model for broken-down vehicle	11/16/25	11/20/25	4																								
Detect and localize a broken vehicle using hazards	Hazard light detection	11/20/25	11/26/25	6																								
	Broken-down vehicle position and distance	11/24/25	12/1/25	7																								
	Test detection	11/30/25	12/2/25	2																								
Navigate to the proper position behind the broken-down vehicle	Emergency lane detection	11/20/25	11/26/25	6																								
	Navigate to the emergency lane	12/4/25	12/6/25	2																								
	Test the parking	12/7/25	12/9/25	2																								
Other	Documentation	11/16/25	12/9/25	23																								

Proposed Gantt Chart

PROJECT TASK	SUB TASK	START DATE	DUE DATE	DURATION	WEEK 1							WEEK 2							WEEK 3							WEEK 4			
					11/16	11/17	11/18	11/19	11/20	11/21	11/22	11/23	11/24	11/25	11/26	11/27	11/28	11/29	11/30	12/1	12/2	12/3	12/4	12/5	12/6	12/7	12/8	12/9	12/10
Preperation	LiDAR research and implementation	11/16/25	11/20/25	4																									
	Develop stand-in model for broken-down vehicle	11/20/25	11/21/25	1																									
Detect and localize a broken vehicle using hazards	Broken down car detection on robot	11/25/25	12/3/25	8																									
	Hazard light detection with "bird's eye view" camera	11/20/25	11/26/25	6																									
	Broken-down vehicle position and distance	12/3/25	12/7/25	4																									
	Test detection	12/4/25	12/8/25	4																									
Navigate to the proper position behind the broken-down vehicle	Emergency lane detection	12/7/25	12/10/25	3																									
	Communication between "bird's eye view" camera and car	12/1/25	12/3/25	2																									
	Navigate behind broken down car	12/4/25	12/6/25	2																									
	Test the parking	12/6/25	12/10/25	4																									
Other	Documentation	12/3/25	12/10/25	7																									

Final Gantt Chart