MIAMI UNIVERSITY

Self Driving Car on Miami's Sidewalks

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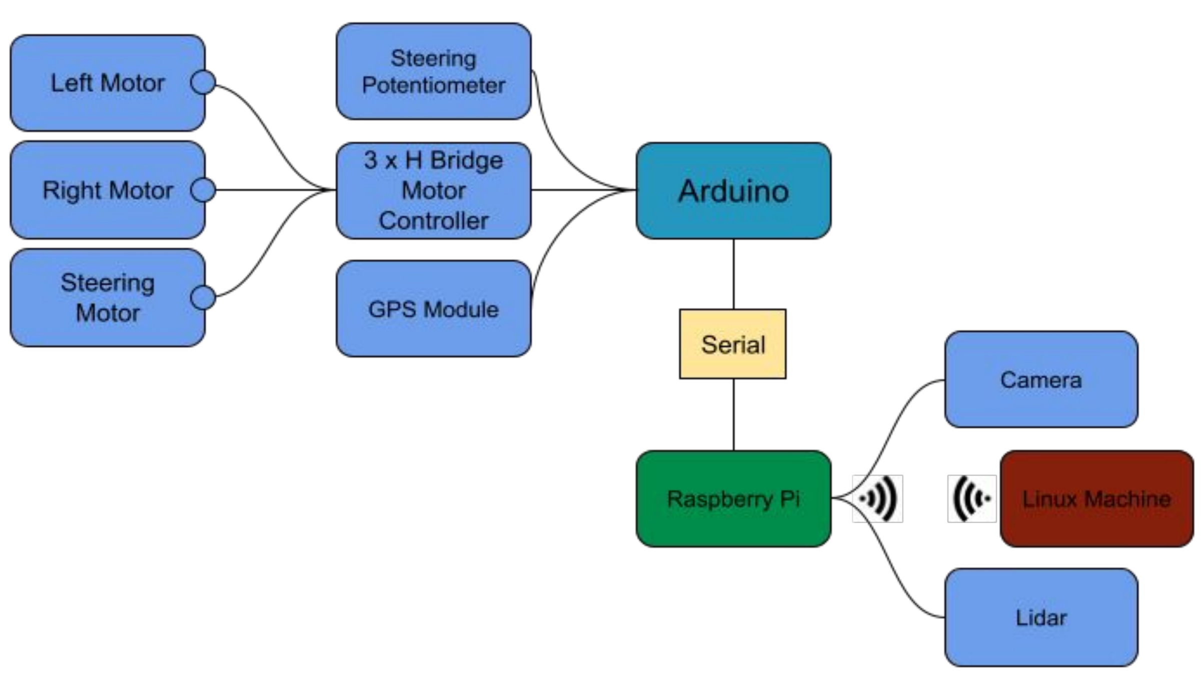
Introduction

In the modern world, technology is transforming every sector of our lives, and engineers are working around the world to automate everything. With these emerging technologies, self-driving cars are one of the most sought-after tools that the average person wants to have. Our capstone, headed by three Computer Engineering students and a Mechanical Engineering student, helped us gain a deep understanding of many of the issues that it takes to reach full autonomous driving. We are continuing last year's project to work towards this autonomous driving sidewalk car. This project provided us with an understanding of proper car mechanics, multi-module embedded systems, advanced computer vision systems, and an overall understanding of how to work as a team to complete this large overtaking project.

Vehicle Overview

Vehicle Components

- GNSS receiver used for satellite positioning and compass navigation.
- 1080p 5MP Camera used for computer vision.
- LDS-01 360 Lidar sensor for object detection.
- 16KΩ potentiometer used for steering control.
- 3 10A Cytron Motor Controller Shields to control 2 rear wheel motors and front steering motor.
- Raspberry Pi 4 used for networking between the robot and the master machine.
- Dell Latitude laptop used as master machine for image processing tasks.
- ROS(Robot Operating System) framework used on Pi and laptop for easier control over communication protocols(RS-232, TCP/IP).



Experimentation

Roadblocks

- Extensive field testing resulted in the need for a larger car battery.
- Original steering potentiometer design resulted in overcorrection and inaccurate readings of steering system being truly 'centered'.
- IP address of Pi changed when going across different access points of Miami's wifi. This broke our static network model.
- Master machine required to migrate to 3 different machines throughout the year due to hardware failures and design decisions.
- Steering motor and gearbox needing to be replaced due to multiple years of use.

Successes

- Remote server network implemented for complex imaging processing tasks.
- Optimized wireless communication between robot and master resulting in little to zero latency.
- Real time sidewalk detection and correction algorithms were implemented.
- ROS framework allowed for image processing to be done on a remote computer to increase computation power.
- Lidar can inform car on the distance of the object, which the Pi processes to get the maximum safe speed.
- Lidar and GPS information was sent to the Pi making the it the central hub for interruptible decision making
- Basic pedestrian detection was accomplished however not implemented into the car.
- Implemented code to get the minimum value reading from -15 to positive 15 degrees using lidar.

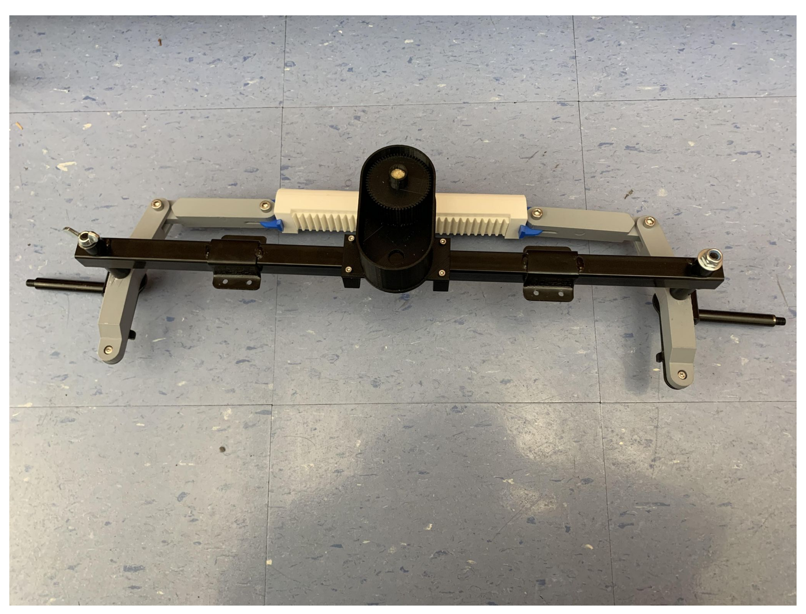
Mechanical Integration

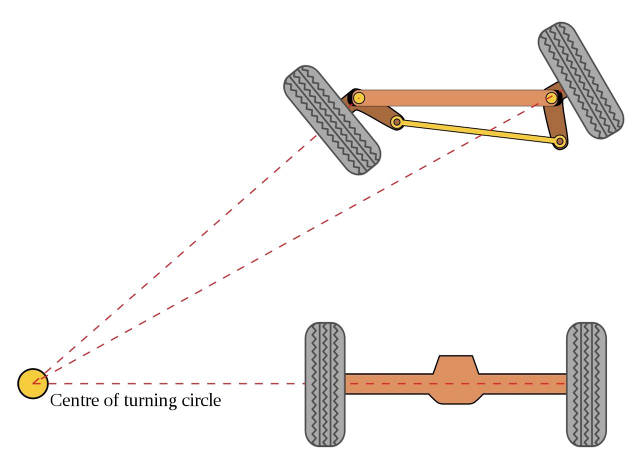
Background

- Ackermann Steering - reduces slippage when turning, not currently implemented on car.
- Rack and Pinion - Utilizes gears to translate rotational motion into linear motion.

Successes

- Steering system modeled and 3D Printed.
- Follows ackermann principles, which will reduce slippage around turns.
- Steering motor repositioned to allow for the new steering system to work properly.

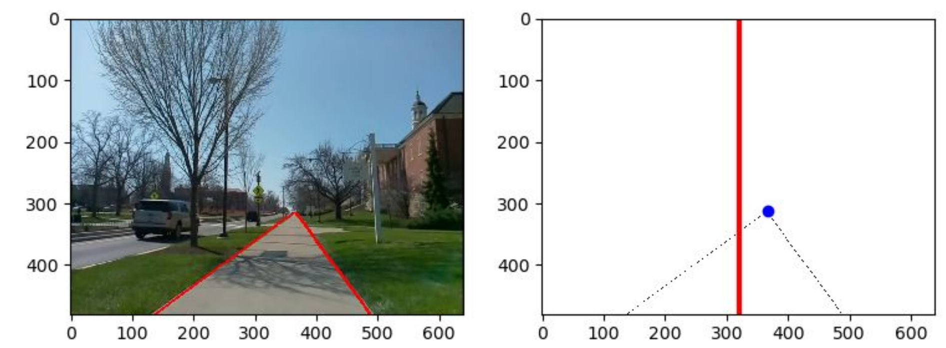




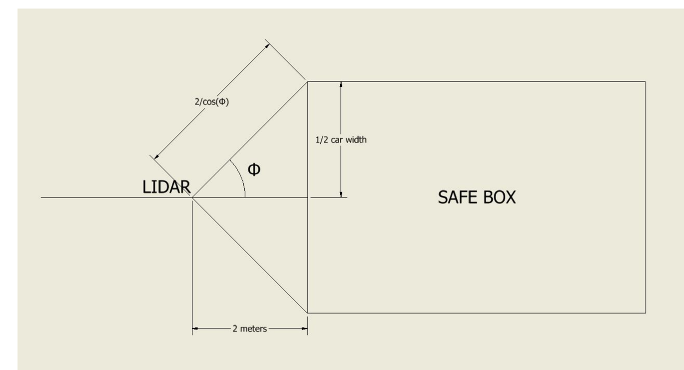
Results

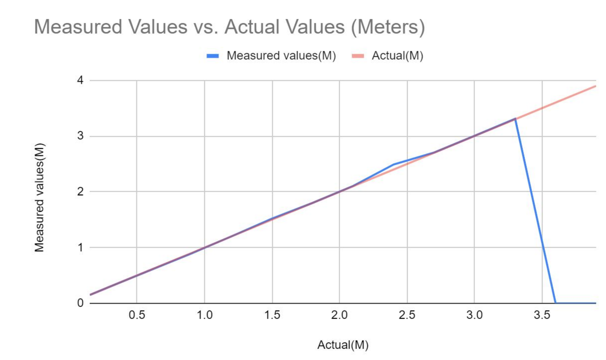
Sidewalk Detection Algorithm

Vanishing Point



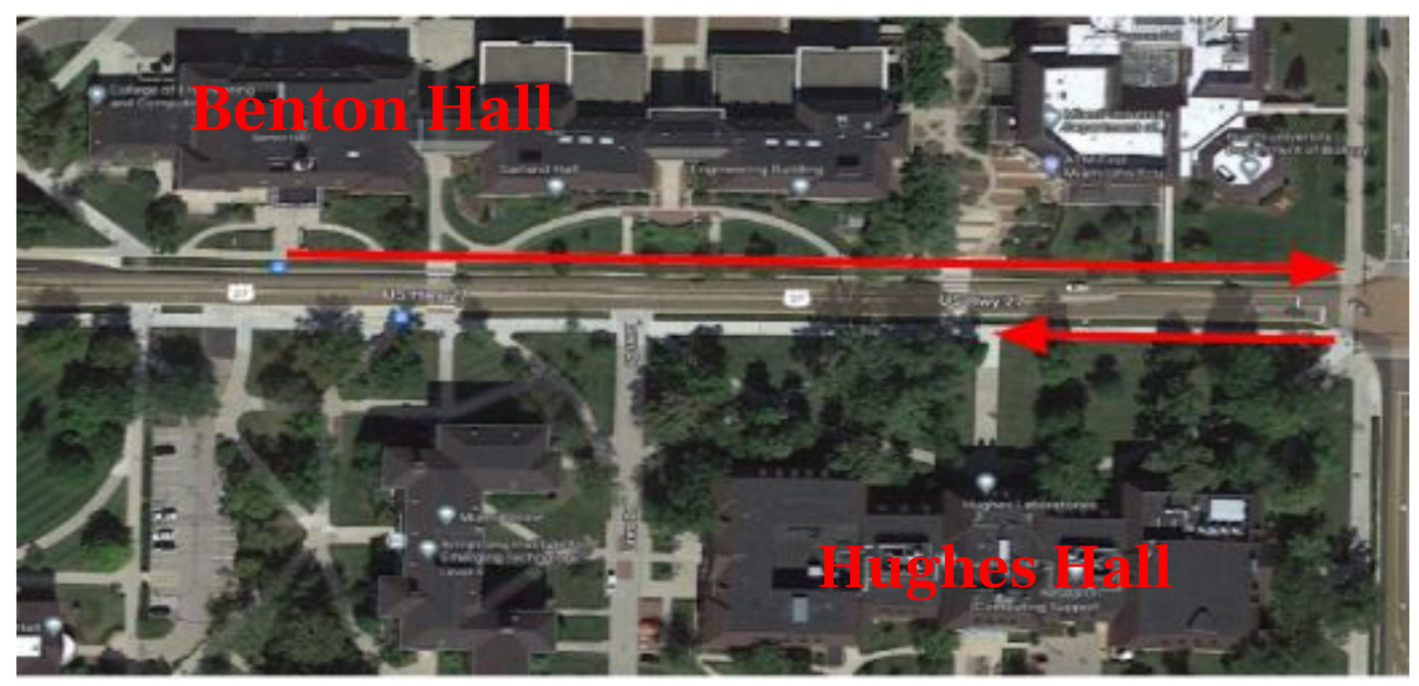
Lidar 30 degree FOV and Range





Future Improvement

- Improve sidewalk detection around intersections to improve reliability.
- Implement a stronger pedestrian detection algorithm using image processing to use alongside the lidar.
- Implement a crosswalk and stop light detection algorithm in order to safely cross street.
- Implement both lidar & computer vision sensing to do sidewalk detection & pedestrian following together.
- Purchasing higher resolution camera and faster master machine for more intensive image processing.



SCAN ME

Take a look at our code!