WYSIWYG TXRX

Where You Steer is Where You Go RC Car Transmitter & Receiver

by

Fareed R

Official Submission

Project Title: WYSIWYG TXRX (Where You Steer is Where You Go RC Car Transmitter & Receiver

Hardware: Adafruit M0 Feather RFM69HCW + Sensors etc. along with Raspberry Pi 4 with OV5647 camera

Problem Statement: When driving a RC car with a normal transmitter, the steering response does not align to the perspective of the driver. When the car is facing away from the driver, steering right makes the car go steer right as per the perspective of the driver and the car. However, when the same car is facing towards the driver, steering right will steer the car left according to the perspective of the driver. In short, there is no orientation awareness and feedback to assist steering.

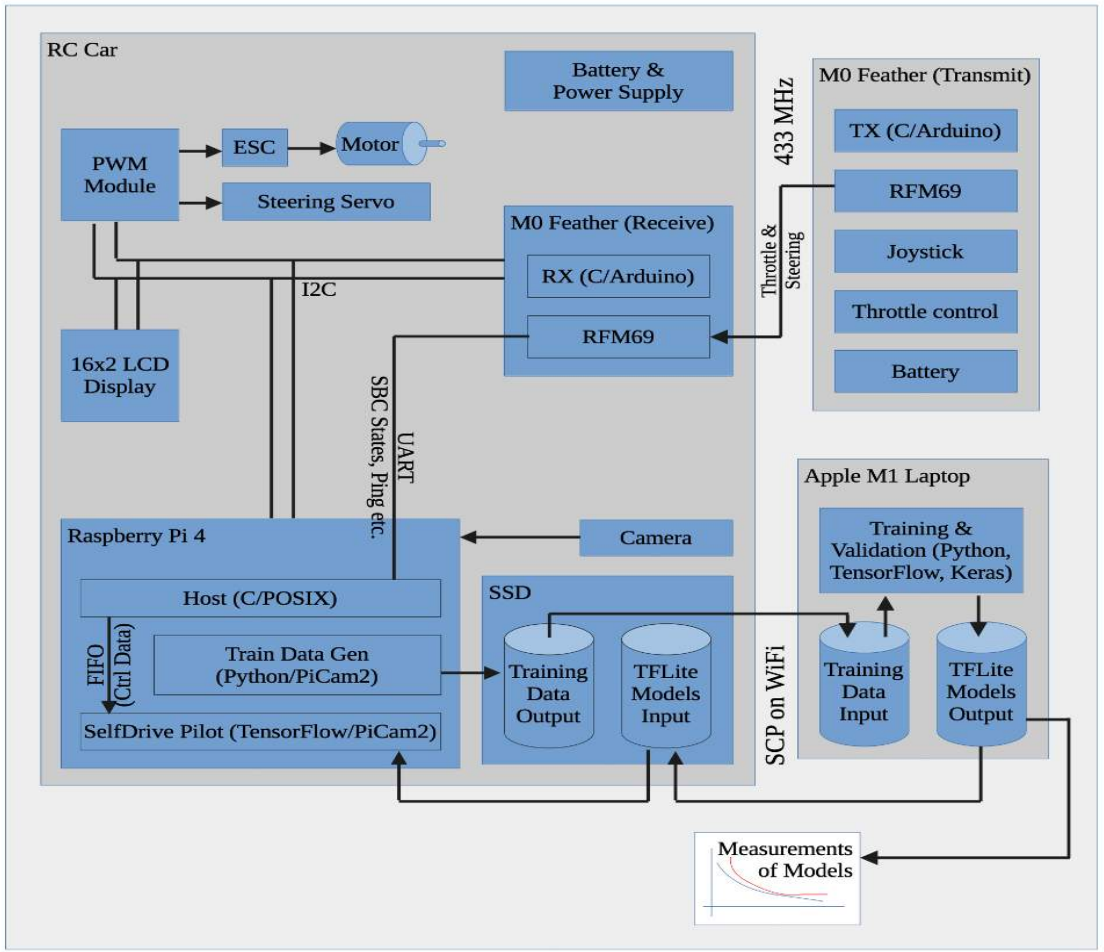
Solution: Using a custom built receiver that utilizes a gyroscope and compass sensor on the car to calculate yaw and then use it as a feedback for steering with a 360 degrees joystick using a custom built transmitter such that the car steers as per the intended direction as per to the perspective of the driver. Other mechanisms are used to align the initial direction. The radios being used in the transmitter and receiver are based on Adafruit M0 Feather RFM69HCW. Transmitter and receiver hardware is built on prototype PCBs. The transmitter has another quirk where the throttle is controlled by a 500gm force sensor. Both X and Y values of the steering joystick will be sent to the receiver and the steering direction will adapt as per the orientation of the car thus providing a unique driving experience to the driver. The driver will see the car go in the direction it is steered.

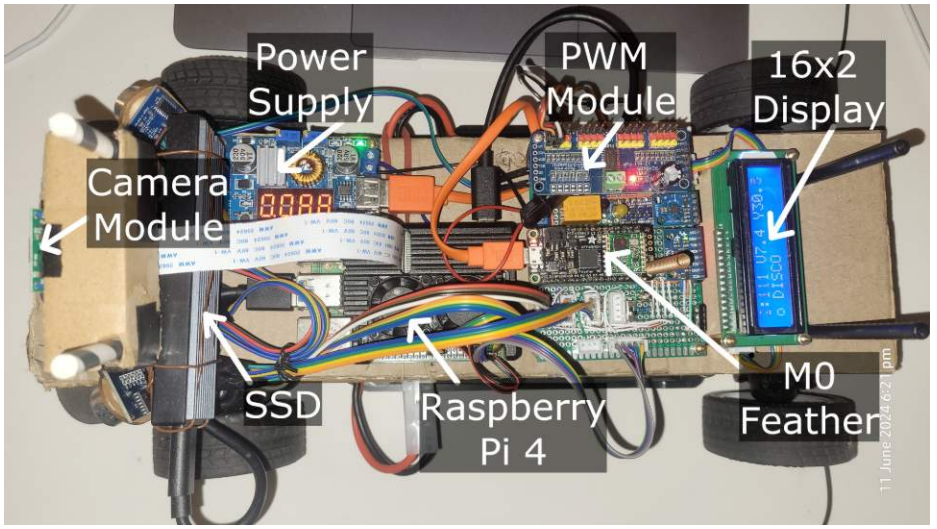
Secondary Goals / Extensions: This mechanism will be used as a base for the training controller of a donkey-car-type (https://www.donkeycar.com/) which will allow for connection of a platform like Raspberry Pi for machine learning experimentation. The Raspberry Pi with a camera will initially be connected as a I2C slave peripheral providing forward collision avoidance data to the Adafruit M0 based receiver as the first stage of assisted driving.

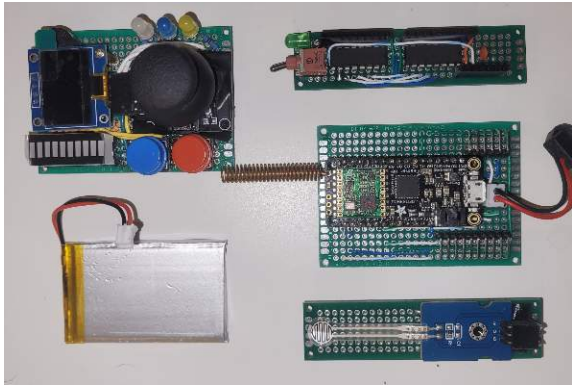
Objectives

- Primary - WYSIWYG TXRX
  - Utilize 2 x Adafruit M0 Feather RFM69HCW + Sensors that fell into my hands
  - Direction aware steering of RC car using custom RX and TX
  - Use gyroscope to calculate heading and use custom 360 degrees joystick to steer as per perspective of driver
- Secondary – Autonomous vehicle experimentation platform
  - Software and robust hardware platform to study autonomous vehicles
  - Study of CNN based neural networks for a self-driving R/C car
  - Image augmentation to improve neural network performance in autonomous vehicles and other experiments
- Project home - https://github.com/fareed1983/racer

High-Level Architecture







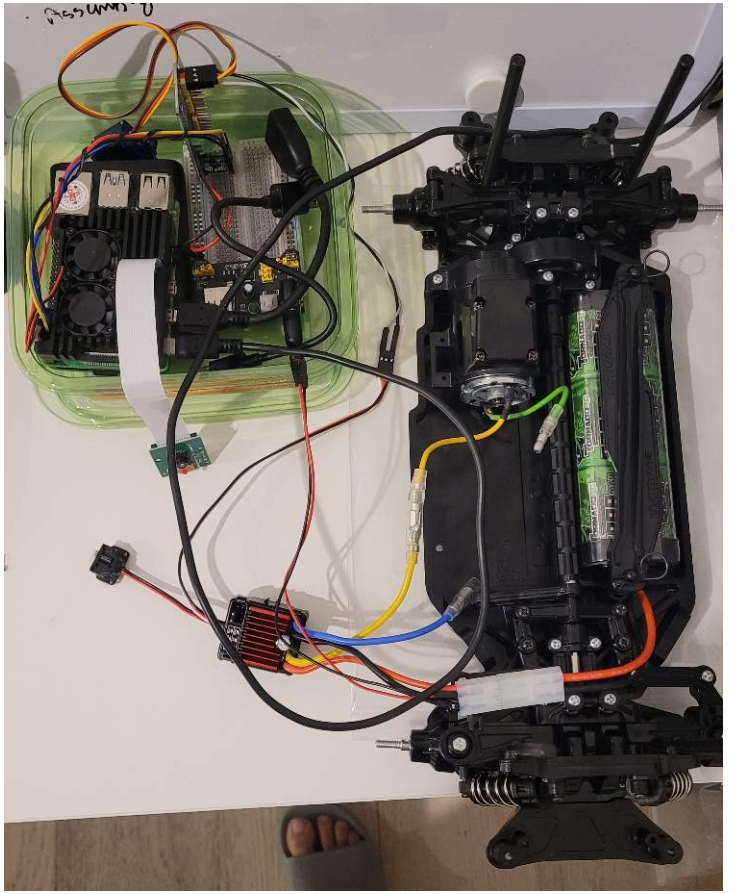
Progress Report

- Core Platform Progress
  - RC model kit assembled
  - TX and RX built on proto PCBs
  - Components mounted on RC car chassis (on cardboard)
  - Tested communication
- WYSIWYG TXRX Progress
  - Mode to control car with directional awareness
  - Concept demonstrated in last meetup

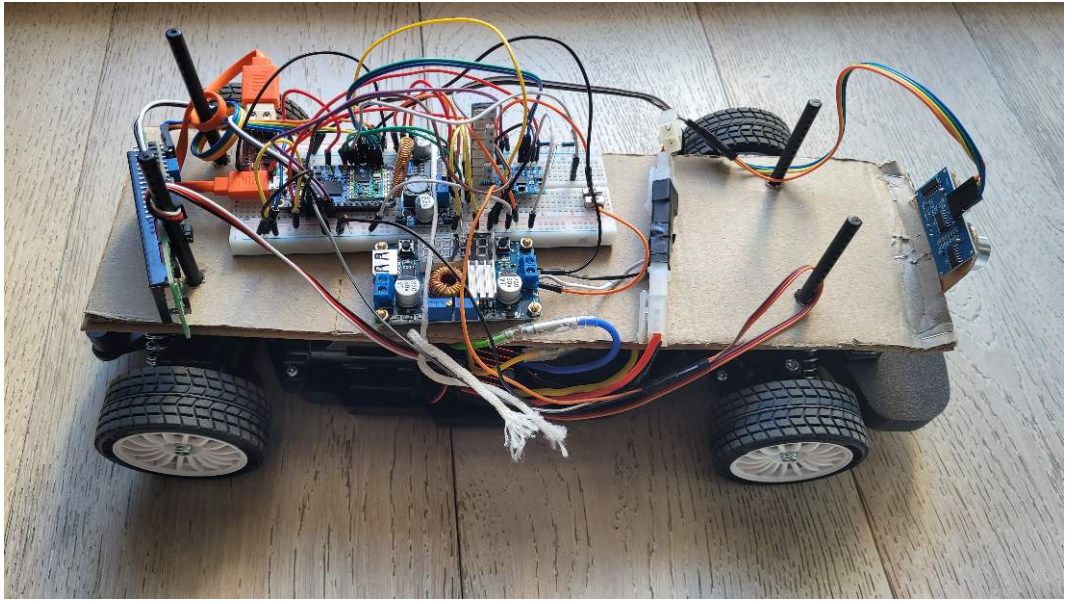
https://github.com/fareed1983/racer

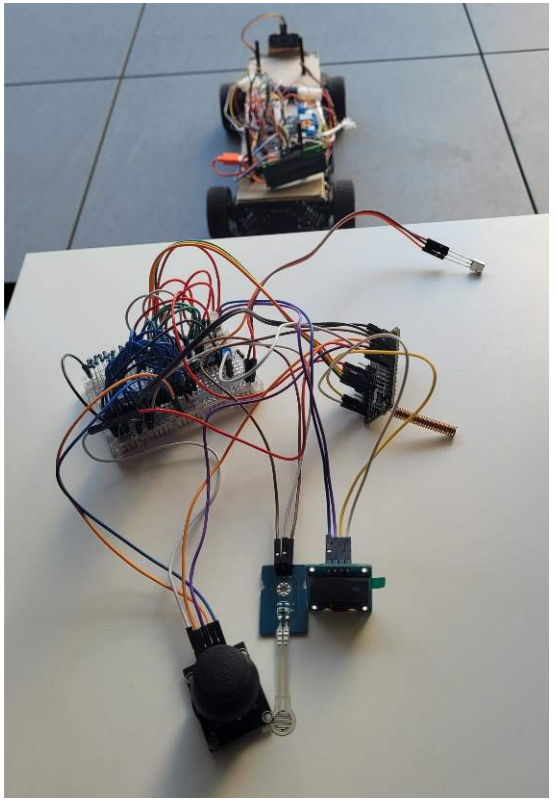
- Autonomous Vehicle Platform Progress
  - Built the Test Track
  - Conducted experiment 1: Image augmentation to improve neural network performance in autonomous vehicles
    - Collected training data
    - Designed a neural network model
    - Trained neural network model
    - Measured network performance quantitively and empirically

Assembly of the R/C Model Kit

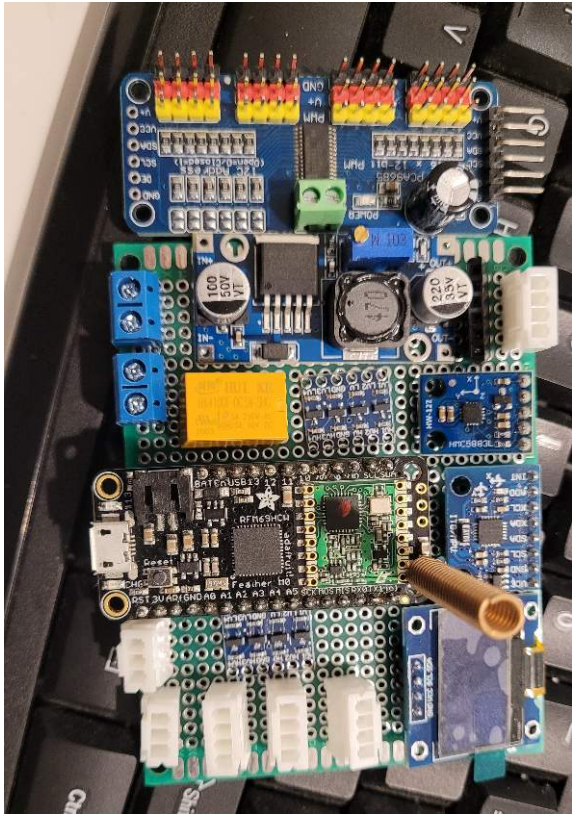


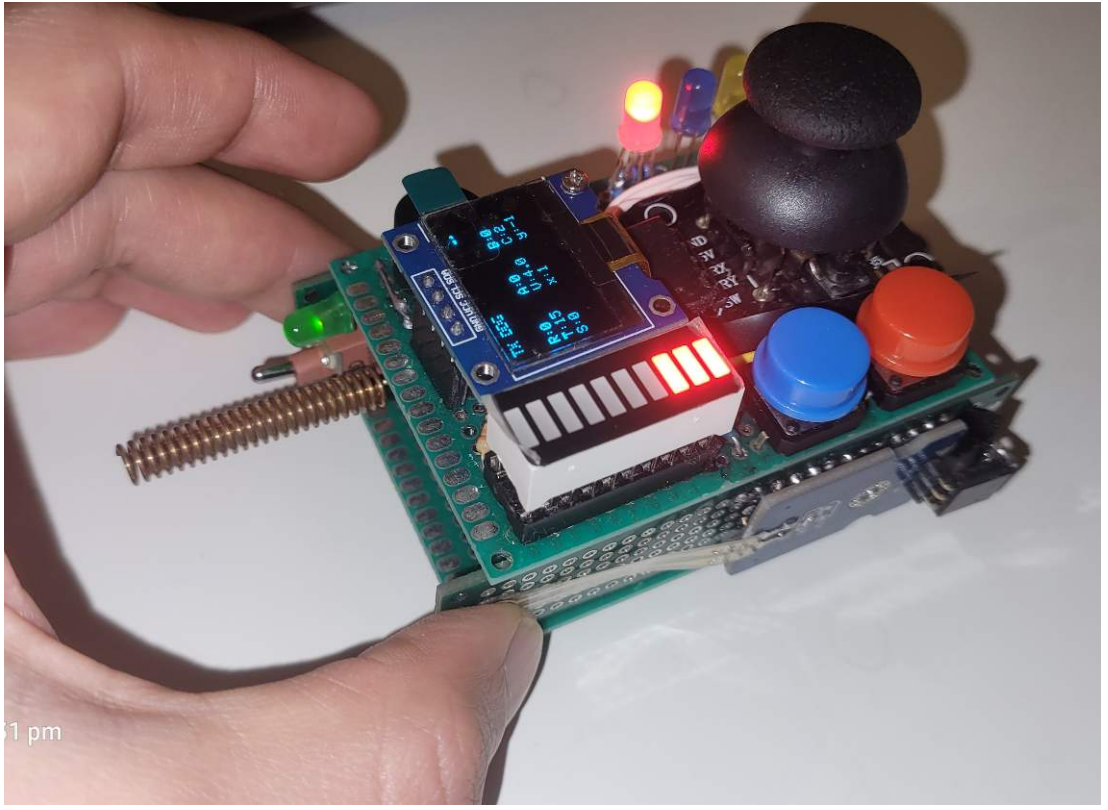
Breadboard Stage



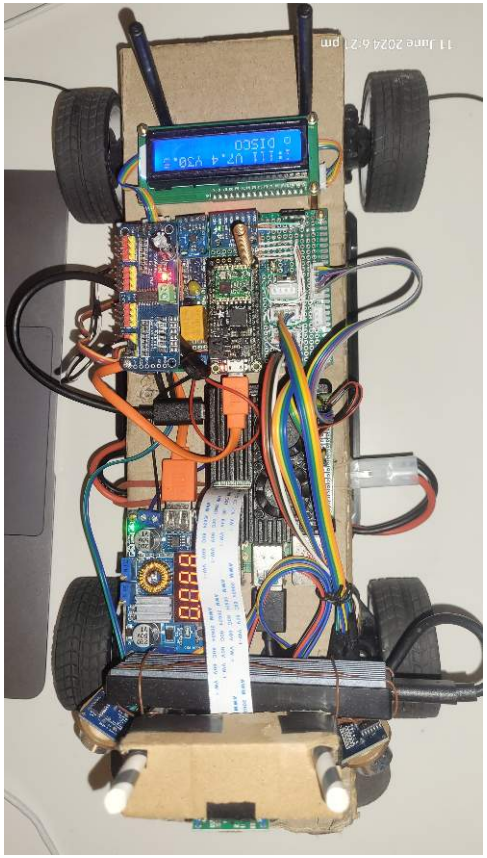


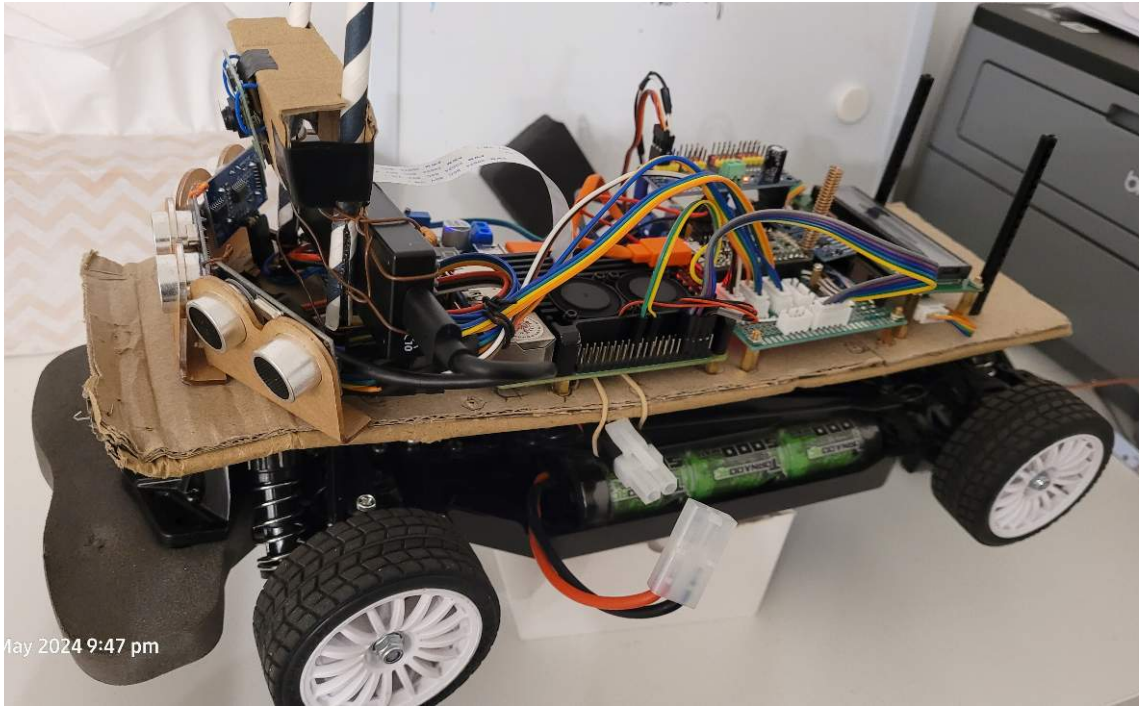
Building the TX and RX





Components Mounted





Building the Test Track

Collecting training data

Training the neural network

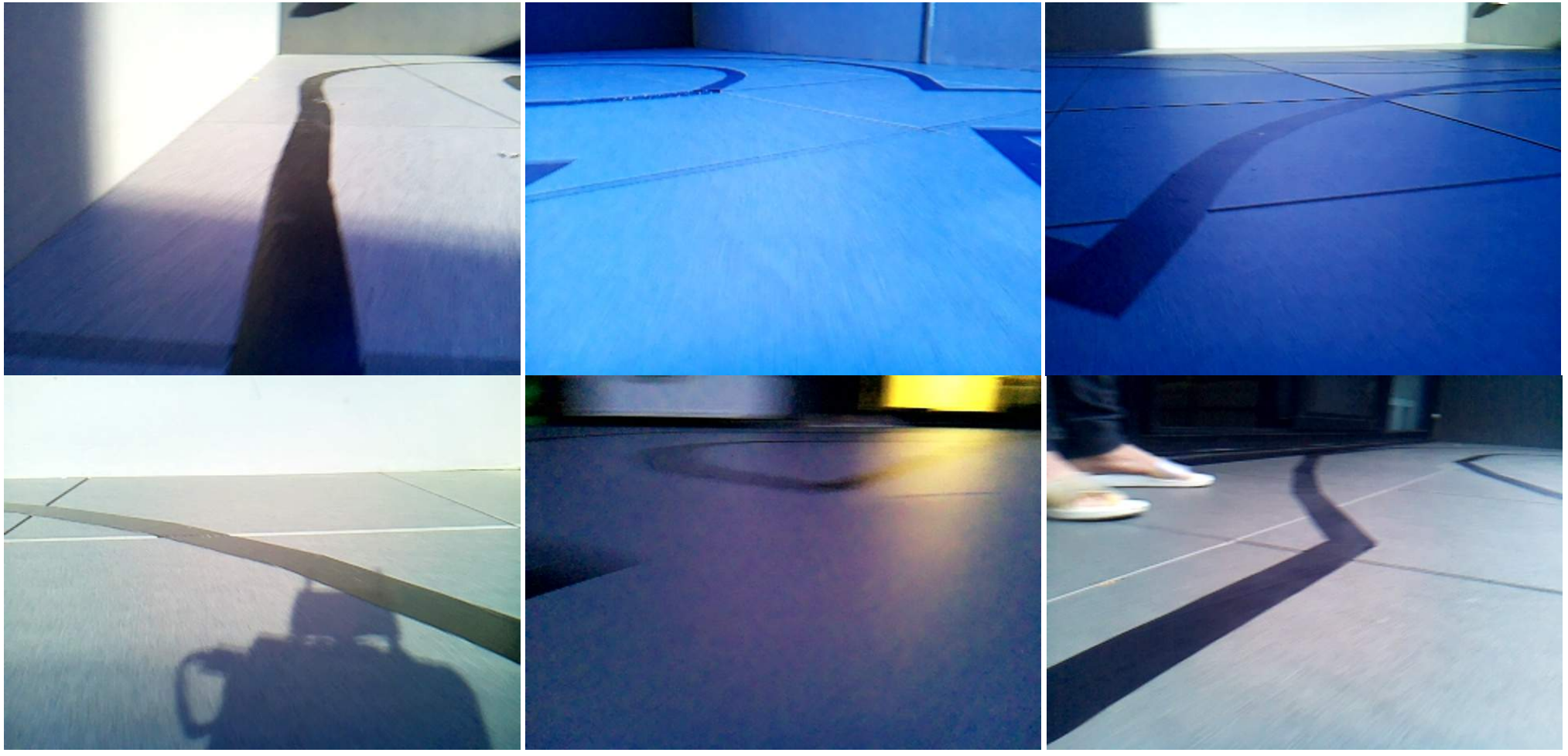
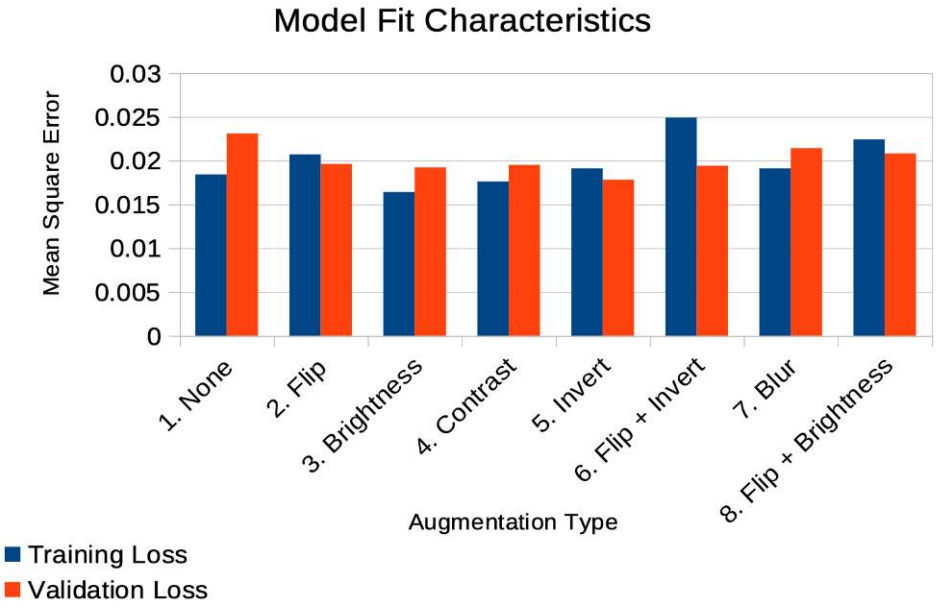
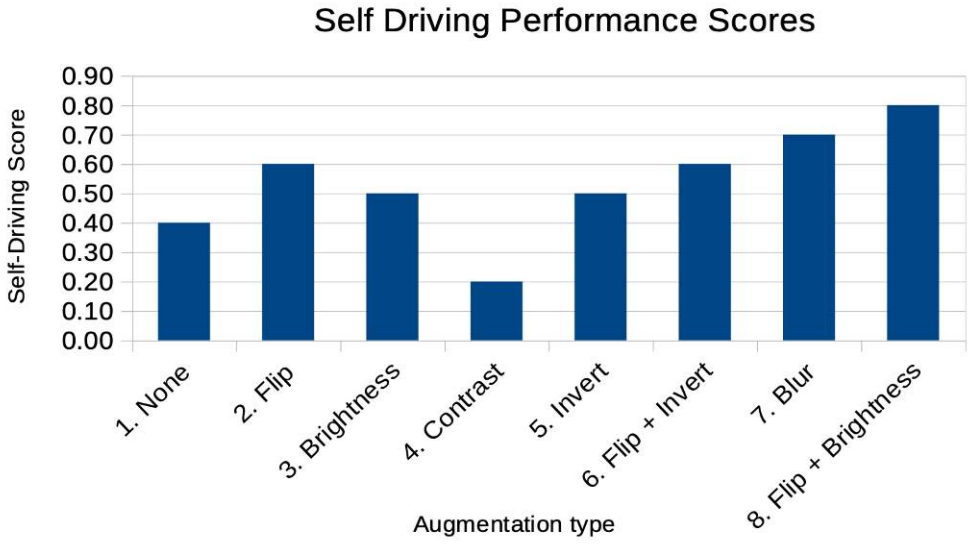


Image augmentation experiment conclusions





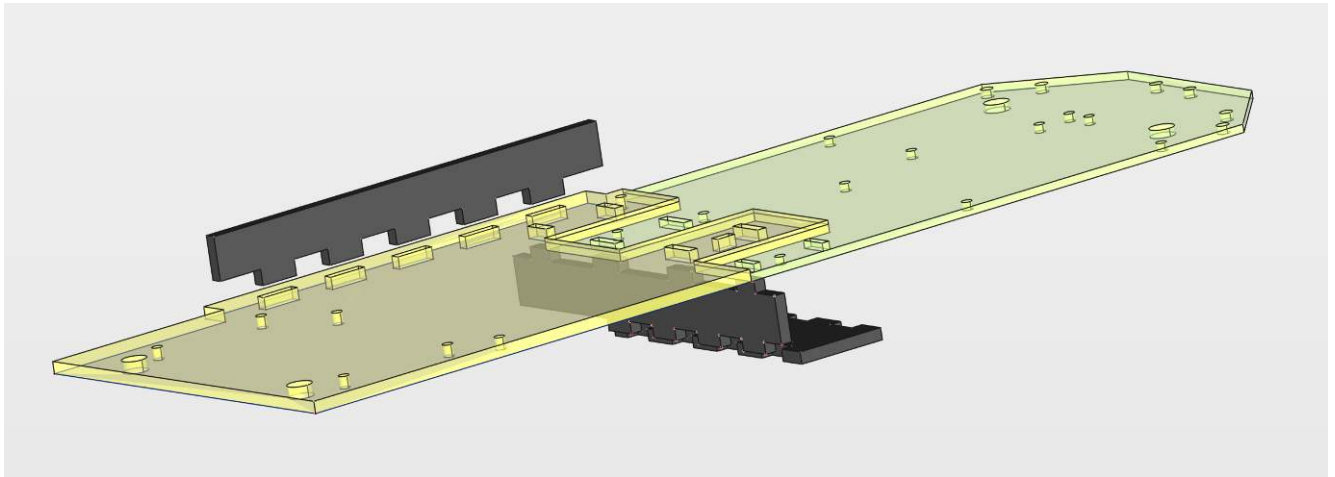
Challenges as on August 2024

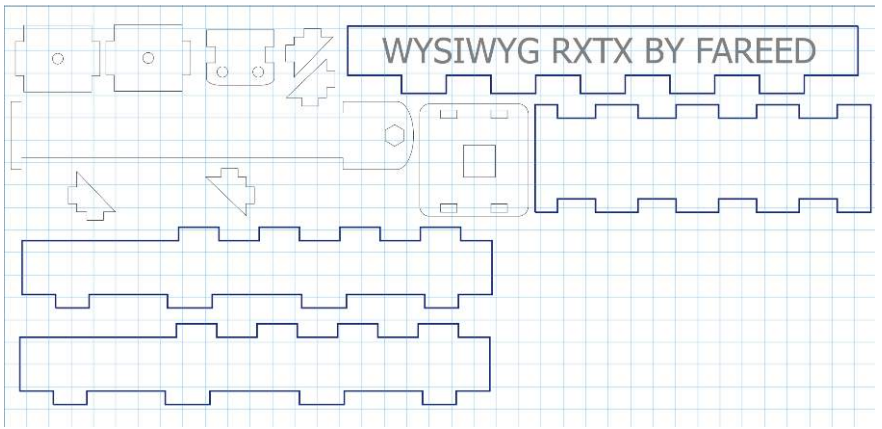
- Communication problems on UART
- Software incomplete
- Heading calculation has drift
- Magnetometer too close to servo power supply
- Mounted on cardboard
- No enclosure for TX
- Not very pretty

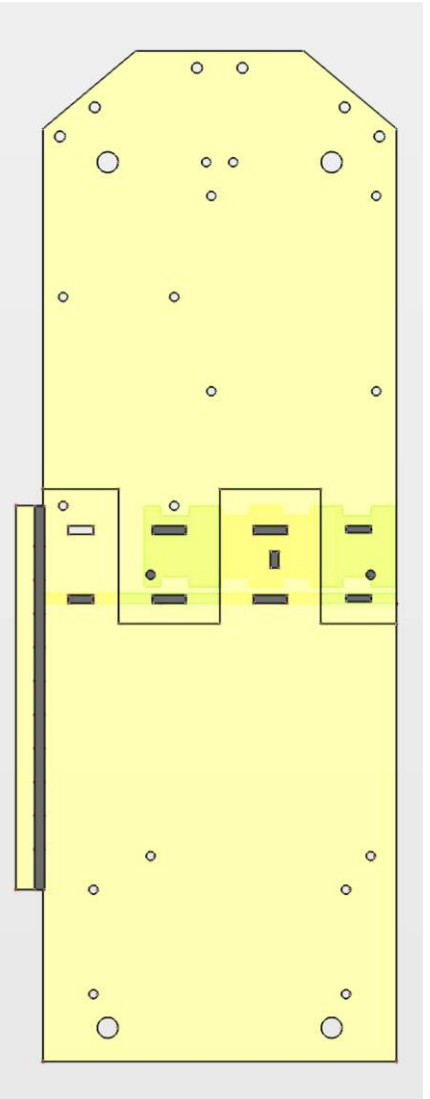
Progress Since

- CAD design (laser cut plywood at Makerspaces)
  - Downloaded and modified Raspberry Pi camera stand
  - Designed base in FreeCAD for smaller (free sample) pieces of plywood with some interlocks
- Angle calibration reset
- Paper on “Image augmentation to improve neural network performance in autonomous vehicles”

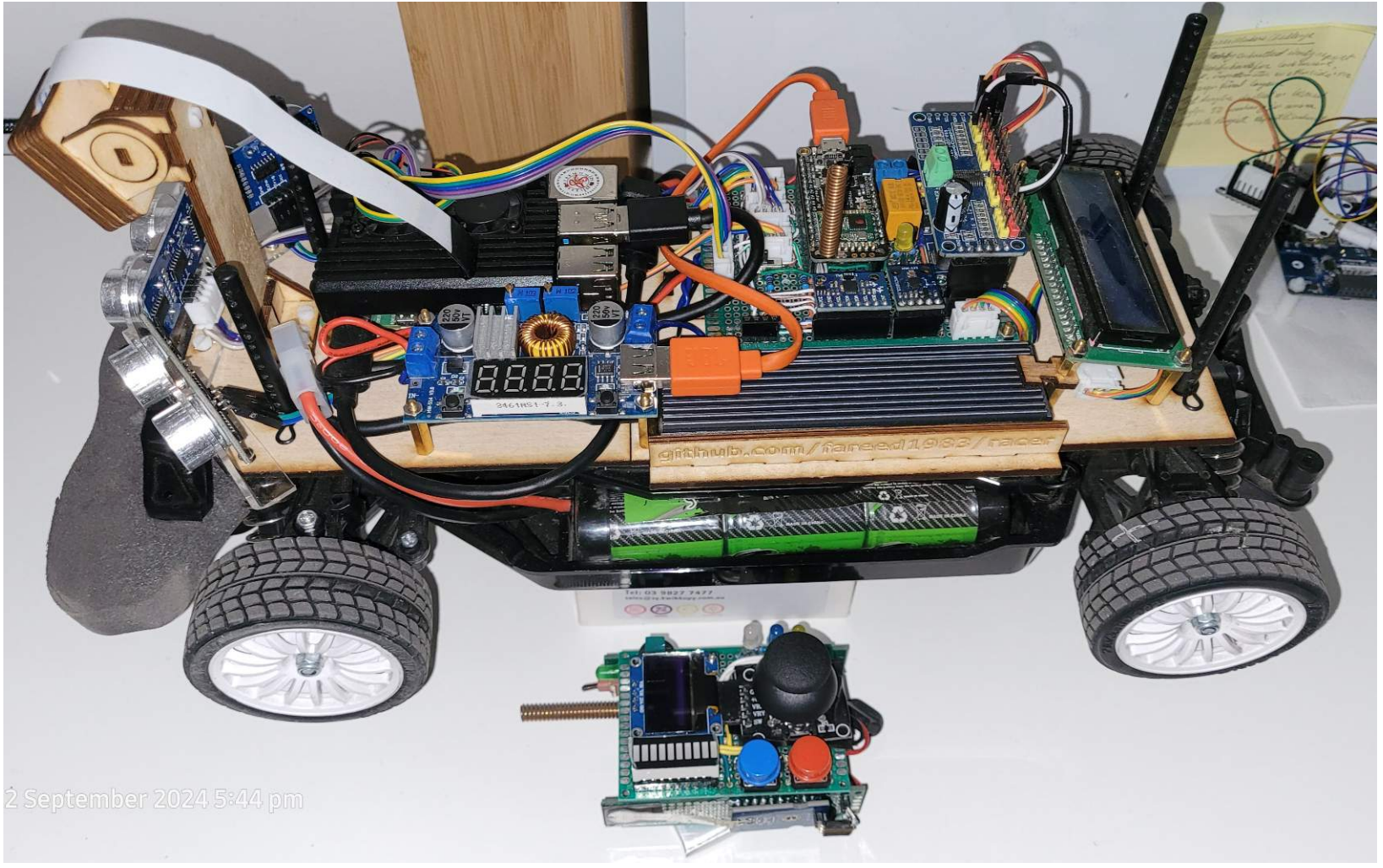
CAD Work







Current State



New Learnings on Project

- Adafruit Feather M0 RFM69 Packet Radio
- RadioHead library for encrypted ReliableDatagram
- Gyroscope, accelerometer, force sensor
- MultiMaster I2C, I2C slave on Raspberry Pi
- TensorFlow, Keras, Python OpenCV, Raspberry Pi camera libraries
- Neural networks – CNN model design, training
- Image augmentation - research papers
- Python IPCs (named pipes)
- FreeCAD for/and laser cutting
- Soldering techniques
- RC cars, ESC, servo, chassis, differential etc.

Source Code, Presentation & Paper

http://github.com/fareed1983/racer