15th Jan 2022

Reaching Destination

- From a fixed start point / starting co-ordinate known
    - Angle and distance based on start and end-point
    - Traverse
- From any point in testing region (starting co-ordinate unknown)
    - Method to identify starting co-ordinates
    - Angle and distance based on start and end-point
    - Traverse

Obstacle avoidance

- Depth mapping and segmentation using stereo vision
    - Identify potential obstacles
    - Decision based on size of obstacle
    - Route alteration
    - Maintain history of obstacles
- Mono-vision depth estimation and segmentation
- Ultrasonic Sensor - not robust

Hardware

- Raspberry pi / Jetson Nano
- Camera / Stereo camera setup - [mounted on servo motor (if required)]
- Chassis, Motor, Driver, Power source

Concerns

- How to integrate Reinforcement learning
- Obstacle types
- Testing space
- Use Case

https://keras.io/examples/vision/depth_estimation/
https://docs.opencv.org/4.x/dd/d53/tutorial_py_depthmap.html
https://github.com/isl-org/MiDaS - Monocular depth estimation
https://github.com/isl-org/MiDaS/releases/tag/v2_1
https://github.com/niconielsen32/ComputerVision/blob/master/monocularDepthAI/monocularDepth.py

https://towardsdatascience.com/maze-rl-d035f9ccdc63
https://becominghuman.ai/q-learning-a-maneuver-of-mazes-885137e957e4
https://medium.com/analytics-vidhya/introduction-to-reinforcement-learning-q-learning-by-maze-solving-example-c34039019317

Other options:

Sign language to Speech/Text

- Through computer vision
- Through glove with gesture recognition

https://www.analyticsvidhya.com/blog/2021/06/sign-language-recognition-for-computer-vision-enthusiasts/
https://www.youtube.com/watch?v=8YnyAjkOap8
https://www.youtube.com/watch?v=pDXdlXlaCco

Robotic arm mimic hand movement

https://gmntu.github.io/mobilehand/
https://paperswithcode.com/paper/learning-to-estimate-3d-hand-pose-from-single
https://www.youtube.com/watch?v=94UBrCmn6MY

Reinforcement learning in robotics

18th Jan 2022 - MOTM

Meeting with Sathiesh Kumar

- Identify dimensions of the testing space
- Exploration
- Obstacle Mapping
- Task completion through reinforcement learning

Tasks:
- Get briefed on Reinforcement learning
- Implement Sample Obstacle Mapping simulation

Future Tasks:
- Set up closed testing space
- Hardware implementation of the simulated example

29th Jan 2022 - Update

Look into:
- Methodology for obstacle detection
- Detection of destination
- Testing space and bot specifications
- Q - Table complexity

Learning path:

- https://www.youtube.com/watch?v=nyjbcRQ-uQ8&list=PLZbbT5o_s2xoWNVdDudn51XM8lOuZ_Njv&index=1

- https://github.com/sichkar-valentyn/Reinforcement_Learning_in_Python

3rd Feb 2022 - MOTM

Meeting with Sathiesh Kumar

Updates:
- Briefed on sample RL SARSA implementation
- Used https://github.com/sichkar-valentyn/Reinforcement_Learning_in_Python
- Modified to add obstacles to GUI only when the agent reaches the obstacles

- Obstacle coordinates were provided. This will be replaced by the obstacle detection algorithm

Next Steps:
- Finalize hardware modules to be used
- Groundwork on how to integrate and implement, prepare the codes involved
- Meet in person to test it
- Set up testing space
- Implement bot movement
- Interface stereo camera
- Map testing face
- Implement reinforcement learning

Obstacles - Simple blocks
Testing space - Coordinate based

7th Feb 2022 - Update - Sathiya

Hardware requirements:

- Jetson Nano based bot setup
- Jetson Nano
- L298n / Featherwing motor driver
- Chassis
- Wheels
- Motors
- Stereo vision camera
- Camera mount

15th Feb 2022 - Reference links - Pranav

- Jetson nano bot with l298 driver- https://medium.com/@anandmohan_8991/jetbot-using-l298n-pwm-motor-a6556ed358d6
- Setup for jetbot-https://github.com/NVIDIA-AI-IOT/jetbot/wiki/software-setup
- Deep learning AI bot- explains Jetson repository well- https://www.youtube.com/watch?v=wKMWjIKaU68
- Deep learning projects using Jetson and OpenCV- https://www.youtube.com/watch?v=CRpW9wrRKx4
- Stereo vision implementation using jetson-https://github.com/NVIDIA-AI-IOT/jetson-stereo-depth

Up to 1st Mar 2022 - Update

- Researching processor options
- Raspberry Pi 4
- NVIDIA Jetson Nano
- BeagleBone Black Wi-Fi
- ODroid

- Stereo Camera available- Kinect v1&2

Problems faced:
- Jetson Nano won't turn on
- Kinect power adapter not available

1st Mar 2022:
Embedded lab
Progress:
- Powered Jetson Nano using Barrel connector 5v 4A - had to short J48 pins
- Used micro-usb to SSH - PuTTY serial mode - through COM port, Speed: 115200
- Initialized Jetson Nano
- Tried to interface with Kinect v2
- Faced errors with installing TurboJPEG library
- Limited work available in interfacing Kinect with Jetson Nano. Lot of possibilities for novel implementations

3rd Mar 2022
Embedded lab

Tasks:
- Obstacle detection
- YOLO implementation
- Kinect interfacing, depth map extraction

Progress:
- Continued to attempt to interface Kinect v2, also tried to interface Kinect v1. Unable to interface and fetch streams.
- Looked into alternative options
- Downloaded and flashed Ubuntu 20.04 for Jetson Nano. To test stereo camera interface.
- Camera required to implement YOLO

Links:
https://developer.nvidia.com/embedded/learn/get-started-jetson-nano-devkit#next

- Kinect interface

https://github.com/OpenKinect/libfreenect2/issues/1084
https://forums.developer.nvidia.com/t/kinect-v2-support/72923/4
https://github.com/OpenKinect/libfreenect2/blob/master/README.md#linux
https://robertcrimmins.com/vision.pdf
https://www.jetsonhacks.com/2016/07/11/ms-kinect-v2-nvidia-jetson-tx1/

- On Windows

https://codeyarns.com/tech/2015-11-26-how-to-use-kinect-v2-on-windows.html

- Ubuntu Installation

https://qengineering.eu/install-ubuntu-20.04-on-jetson-nano.html

8th Mar 2022
Embedded Lab

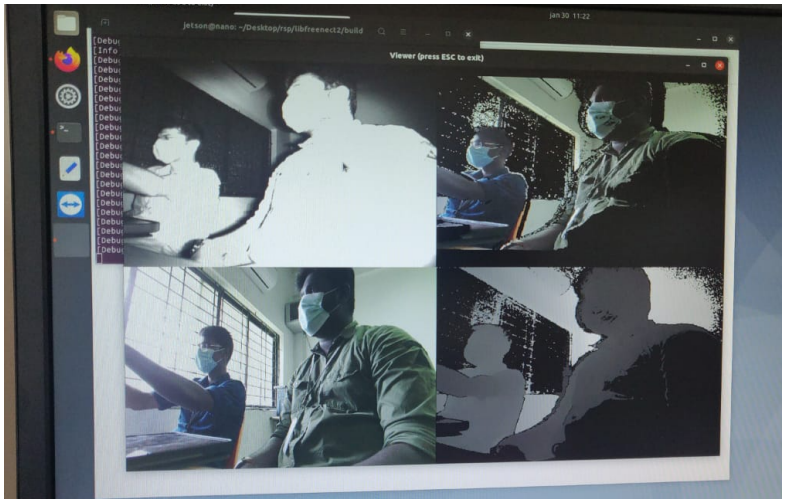
Progress:

- Logged in and Initialized Ubuntu
- Followed instructions to set up required libraries for Kinect v2
- Successfully installed TurboJPEG and other libraries
- Unable to test inference due to unavailability of display

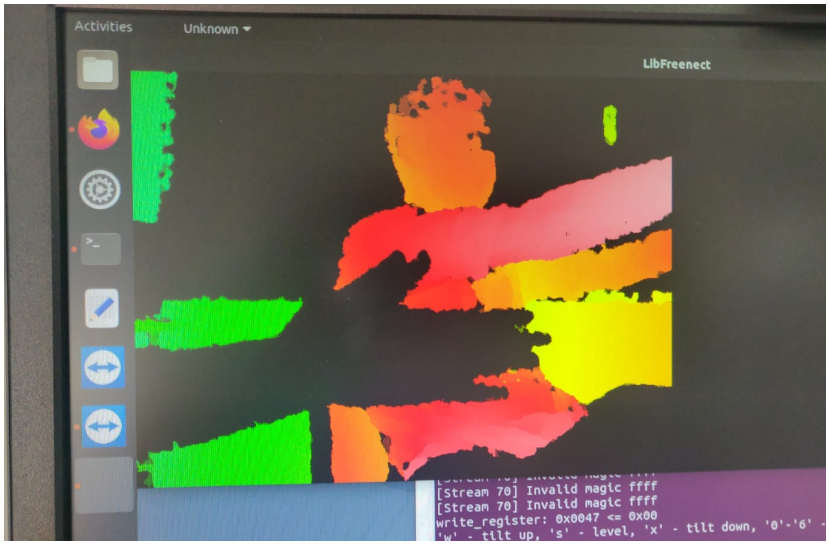
9th Mar 2022
Embedded Lab

Progress:

- Successfully interfaced KinectV2 with Jetson nano
- Tested sample application using ‘./bin/Protonec



- Attempted python wrapper implementation to access frame within python script (kinectv2)
- Tested sample application for Kinect v1 using ‘freenect-glview’



- It gave good results but had visible variations only beyond a range of 30-40 cm. (Objects closer than that were black)
- Setup python wrapper and successfully accessed depth frames from Kinect v1 in OpenCV (python)

Links:

- https://naman5.wordpress.com/2014/06/24/experimenting-with-kinect-using-opencv-python-and-open-kinect-libfreenect/
- http://r9y9.github.io/pylibfreenect2/stable/installation.html
- https://github.com/r9y9/pylibfreenect2

11th Mar 2022

Embedded Lab

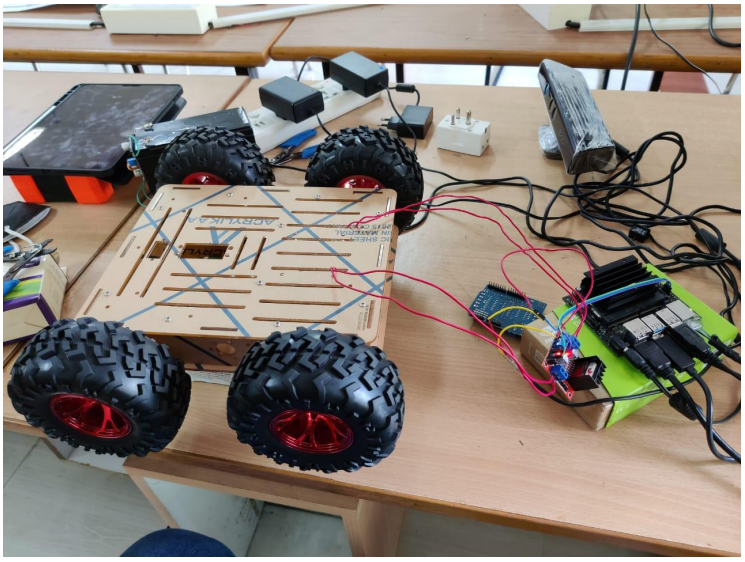
Progress:

- Unable to use pylibfreenect2, facing errors
- Tested demo scripts for python implementation of Kinect v1 interface
- Attempted YOLOv5 object detection by fetching frames from Kinect v1

12th Mar 2022
Embedded Lab

Progress:

- Tested L293D motor driver shield with jetson nano. Unable to interface with motors
- Used L298N motor driver. Successfully interfaced with motors. Used 12V 2A power adapter to power the driver.



- Compared L298N and L293D
- Tested PWM for speed control.

14th Mar 20222
Embedded Lab

Progress:

- Implemented YOLOv5s Object Detection.gm

- Looked into options for power.

15th Mar 2022
Embedded Lab

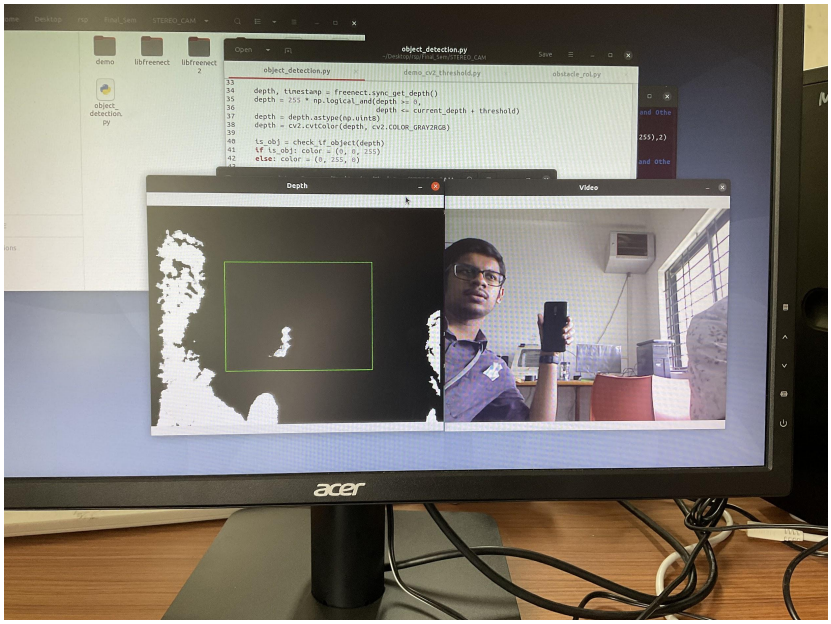
Progress:
- Discussed and determined application and objective
- Discussed power options and portability
- Decided on title:

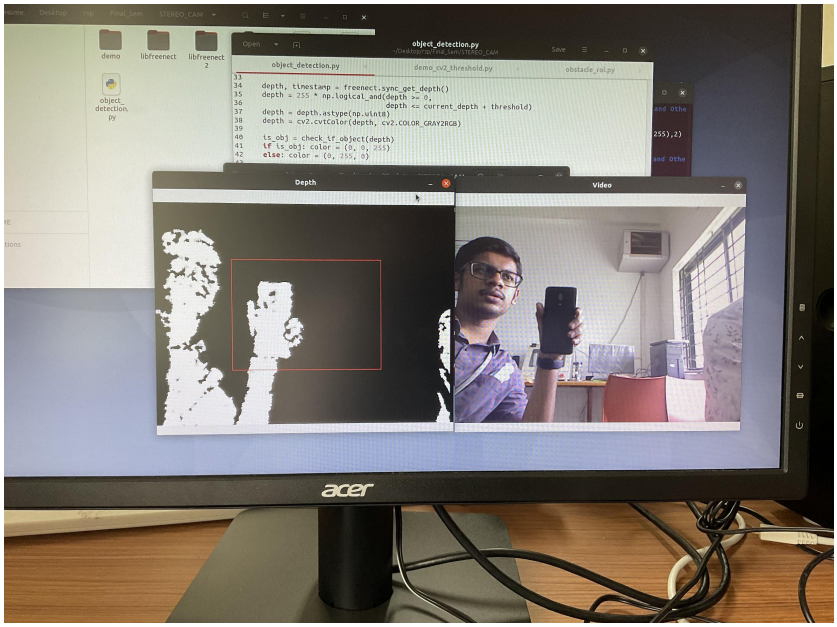
“Reinforcement learning based Automated Path planning in Garden environment - RAPiG”

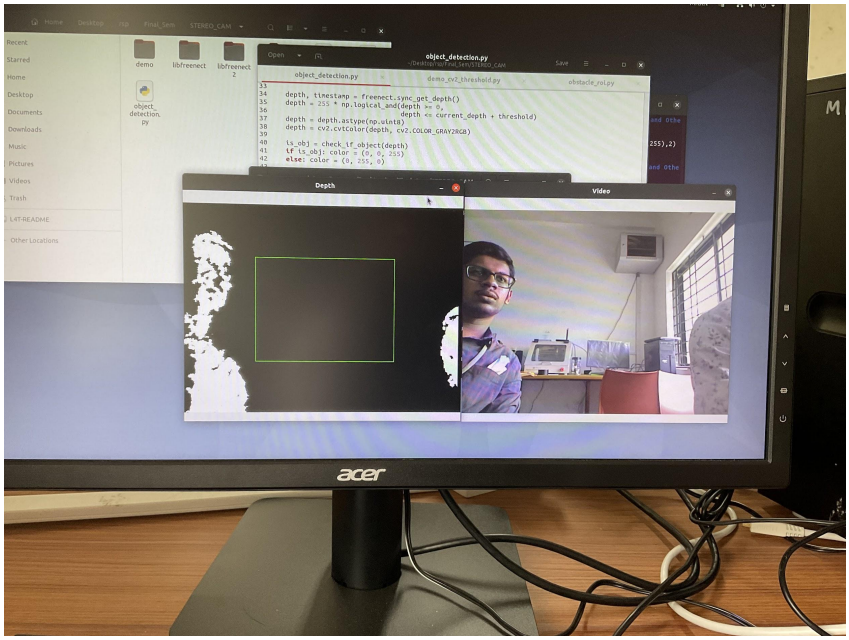
16th Mar 2022
Embedded Lab

Progress:
- Discussed about IR shadow and double image in depth mapping
- Looked into options for thresholding using freenect library

17th Mar 2022
Embedded Lab
Progress:
- Tested Libfreenect demo programs
- Implemented depth threshold to detect objects within a certain depth
- Added Region of Interest
- Added alert when object detected with size greater than a threshold
- L298N 5V output can be used to power Jetson Nano


object_detection.py
Depth
Video
acer


object_detection.py
Depth
Video
acer



18th Mar 2022
Embedded Lab

Purchased components:

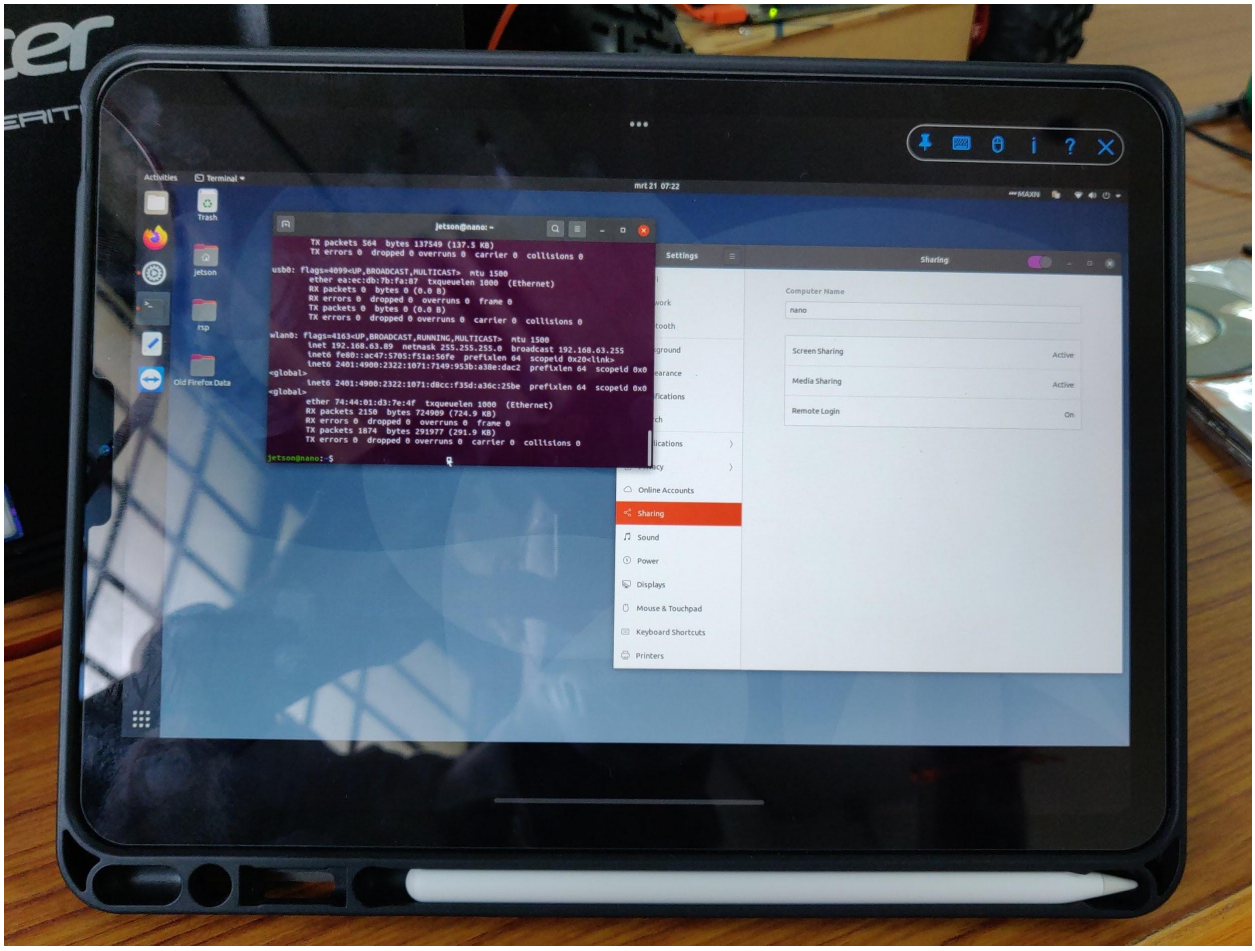
- L298N motor driver
- Screws and Spacers
- Wifi adapter

21th Mar 2022
Embedded lab

Progress:

- Tried to use 5v from L298N to power Jetson Nano through custom barrel connector connection.
- Connected to Wi-Fi using Netgear adapter WNA1000M - did not require any driver installation
- Tried remote access through Wi-Fi
- Accessed SSH from iPad remotely

- Accessed remotely through VNC but would require dummy hdmi connection



22nd Mar 2022

Progress:

- Mounted motor driver
- Tested different ways to power jetson nano

23rd Mar 2022

Progress:

- Powered Jetson nano through power bank
- Made bot portable and moveable
- Remotely accessed and controlled bot
- Set up movement commands for left, right, forward and back.

24th Mar 2022

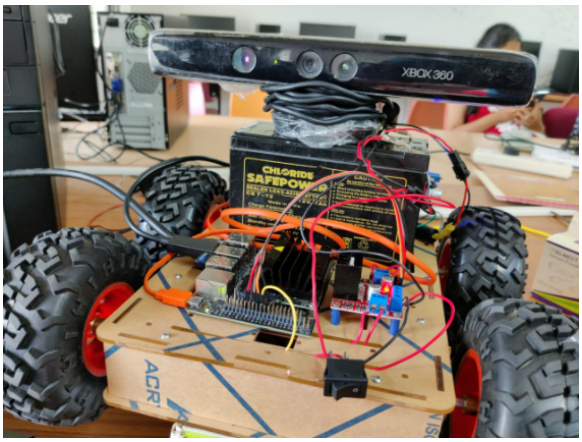
Progress

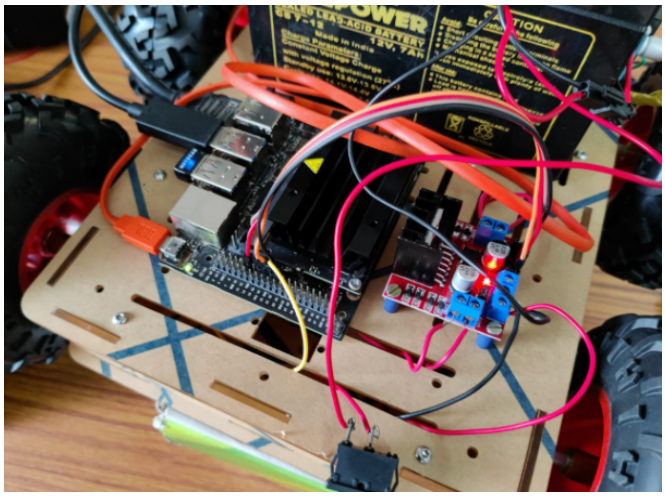
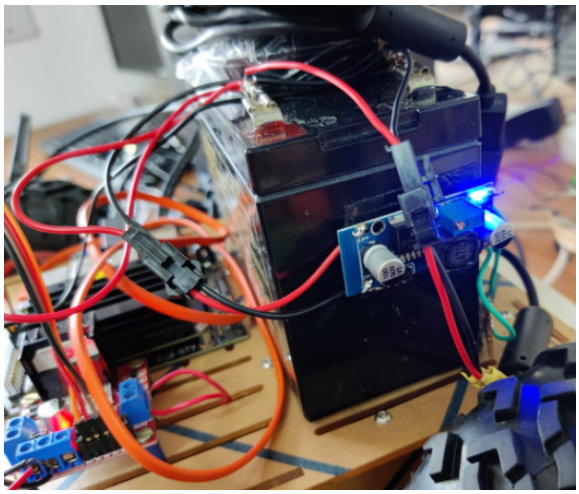
- Mounted Kinect on the bot and tested kinect output through VNC

To buy:
Step down converter - bought LM2596
Screw to mount jetson
Battery caps - bought
Dummy hdmi

25th Mar 2022

- Connected 12v to 5v voltage converter and powered jetson nano with it.
- Set up bot with single 12V7A battery.

28th Mar 2022

Progress:

- Tested software RL SARSA implementation on Jetson

- Tested Dummy HDMI connection - able to VNC remotely without monitor

Zeroth review:

https://1drv.ms/p/s!Ahnb4QXL5YSShkuSK-V-pxlLc3Ko?e=szEKNB

PPT requirements:
Introduction
Motivation
Objective
Literature Survey
Methodology
Current Progress
Next task

Possible questions:
Application
Novelty
Time consumption of RL

To look into:
Stereo camera options
Path planning algorithms
Microcontroller options
Depth at low light, night

5th April 2022

- Tested power supply
- Jetson nano turning off probably due to reduced battery output
- Camera functioning affected by battery, received ‘camera disappeared’ error
- Set up web output for obstacle detection to get inference remotely

6th April 2022

- Decided to test with wired power as battery caused issues
- Set up connections accordingly

7th April 2022

- Tested movement with wired power
- Tested wired power camera interface

- Issues and lagging faced when using vnc

8th April 2022

- Discussed motor options with Veerappan sir, stability improvement, and motor offset issues.

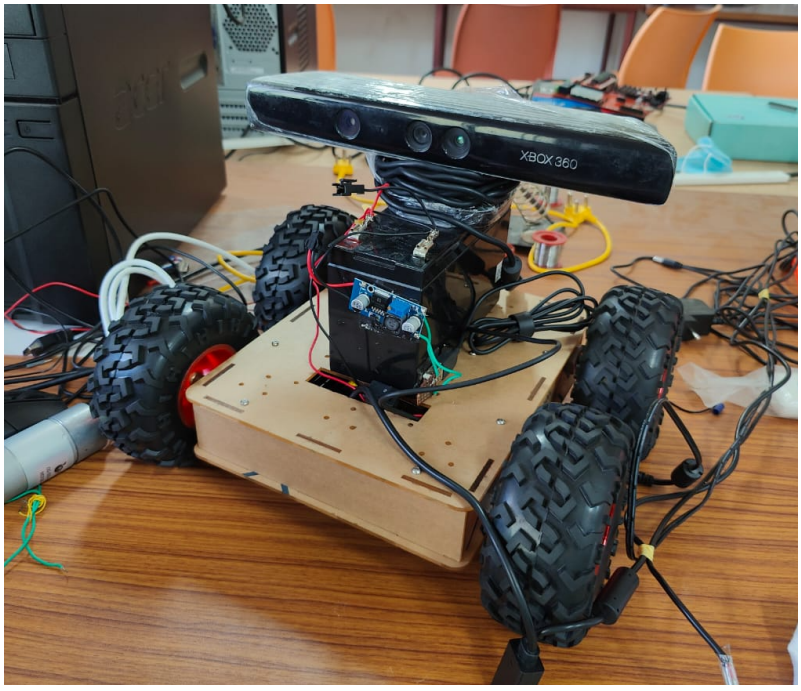
9th April 2022

- Tested speed control of high torque motor using voltage converter.

- Placed jetson nano and motor driver inside body of chassis for even weight distribution. Yet to test.

11th April 2022

- Tested motor interface, kinect interface, movement with jetson nano and motor driver inside body.
- Should work on calibration to identify position within cell



12th April 2022

- Purchased and used HDMI extender, tested movement with components inside body. Moves forward and backward but doesn't make turns. Still not stable. Considering switching to a 5v battery to reduce weight

13th April 2022

- Received li-poly battery - 11.1V 4200mah
- Needs to be charged
- Studied usage

18th April 2022

- Connected web cam with jetson nano and tested mono cam depth estimation with MIDAS model.
- Performance was poor as the results weren't adequate and inference took too long

Stereo camera depth estimation:

- https://github.com/LearnTechWithUs/Stereo-Vision
- https://medium.com/stereopi/opencv-and-depth-map-on-stereopi-tutorial-62cb6792bbed

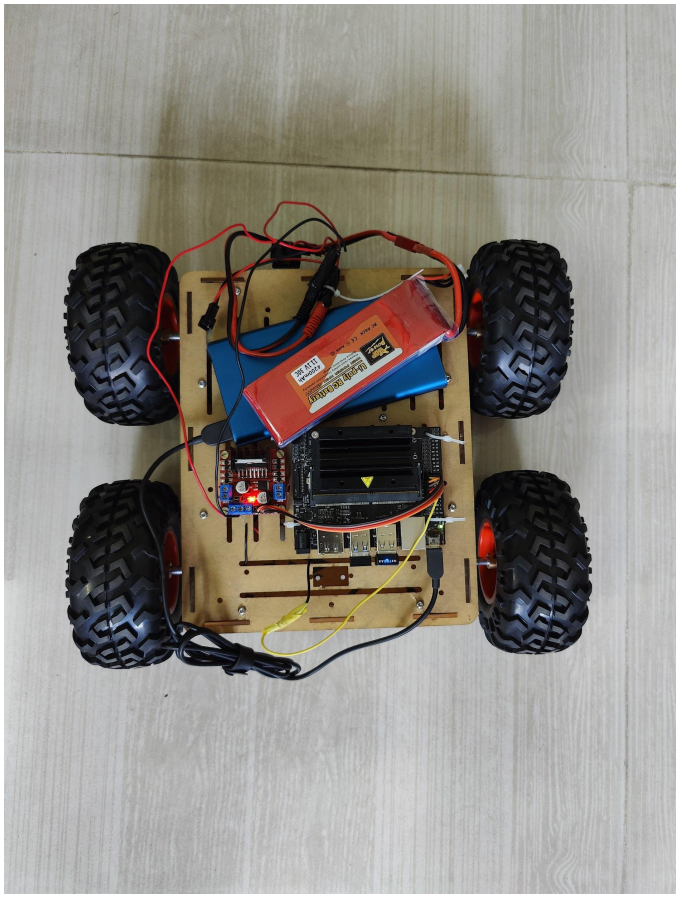
19th April 2022

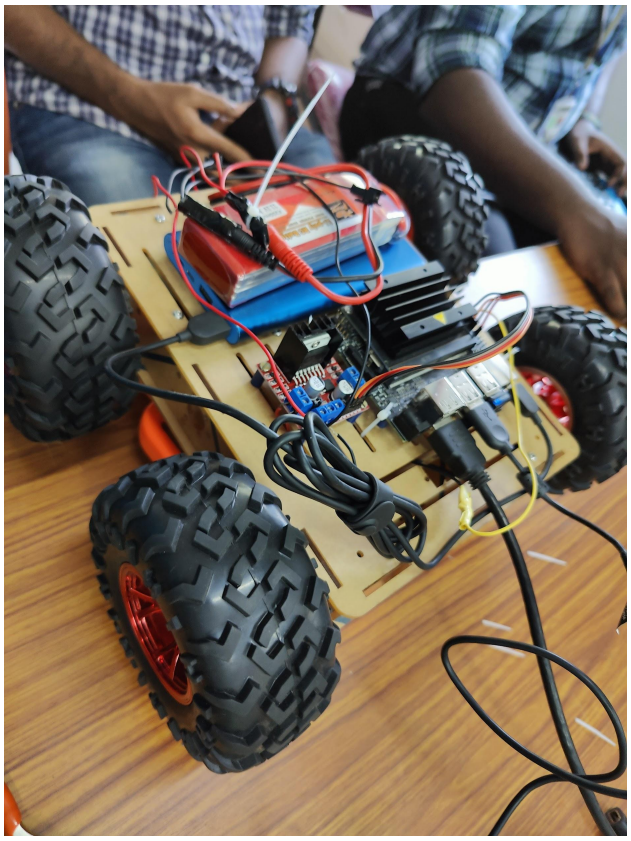
- Received lithium battery charger, charged battery to 11.1 volt
- Considering use of dual webcam setup for manual depth estimation.

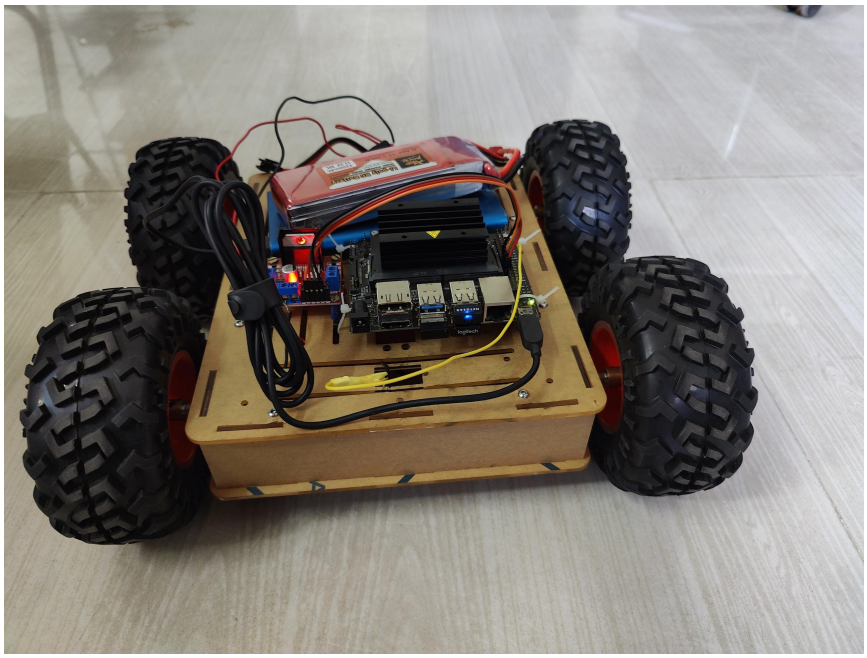
22nd April 2022

- Checked and finalised power supply options
- Power bank for Jetson Nano, 11.1 V Li-Poly battery for Motors.
- Should set up two web cameras for stereo depth estimation
- Mounted Jetson Nano and motor driver back on top.

- To study: RL algos, Path planning algos, Methodology of related works
- To do: Set up line following, Set up stereo camera depth estimation







https://drive.google.com/file/d/1EThKJmT1KSYH0xfKOSUueuqVyN_bmUlB/view?usp=sharing

25th April 2022

- Purchased HY S301 IR array sensor
- The sensor always gives high output.
- Facing issues with GPIO input on Jetson Nano - channel is invalid error
- Stereo camera program won't run on Jetson Nano

26th April 2022

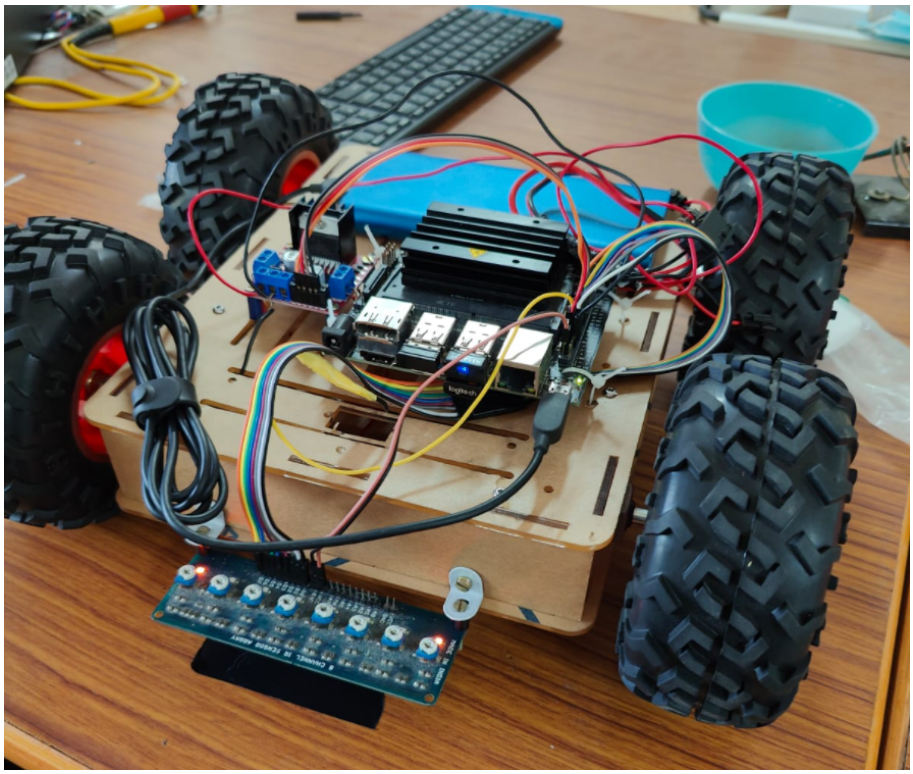
- Tested alternative IR array sensor
- Obtained proper GPIO input of IR sensors

27th April 2022

- Continued to test stereo camera and ir array for line following

28th April 2022

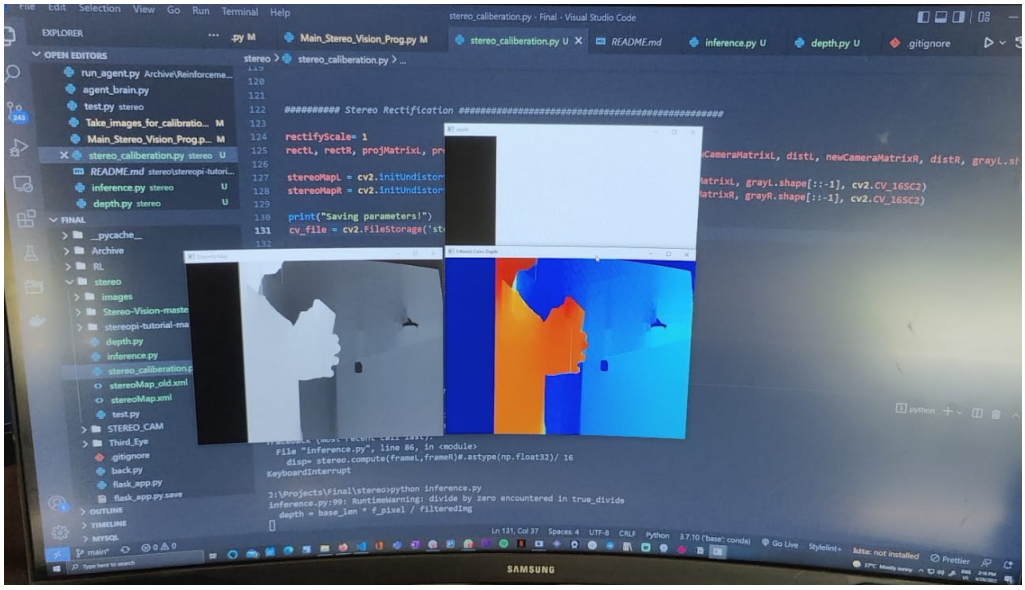
- Mounter IR array
- Coded line following
- Modified battery placement
- Tested line following
- Bot follows line but intersections and sharp turns are missed due to speed. Should try down converter to reduce speed



https://drive.google.com/file/d/1WVT8aHVKEHuaGcgMqv0tDrP_hiMYYd5j/view?usp=sharing

29th April 2022

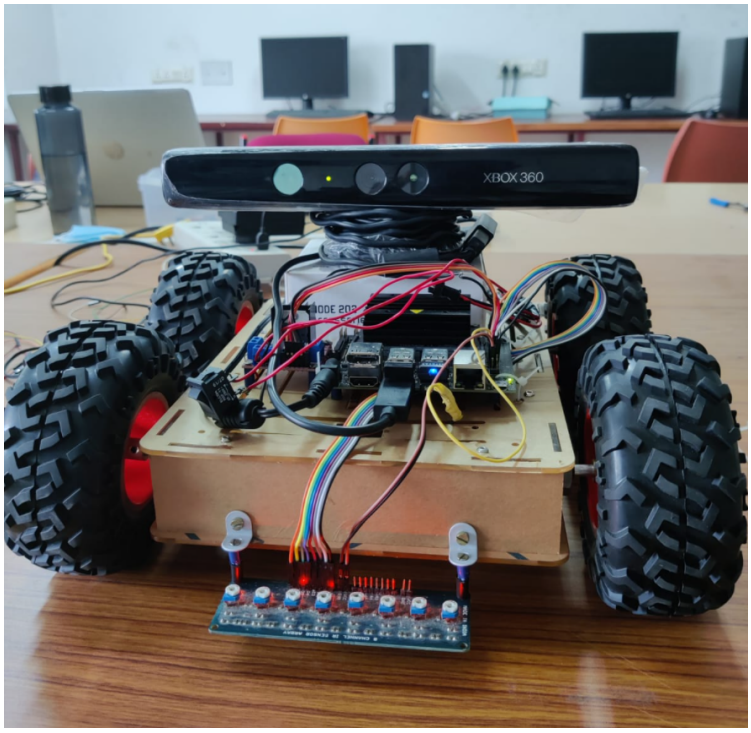
- Tested multiple codes for calibration and inference of stereo camera
- Results are not satisfying
- Should test with more calibration images and also test possibility of using kinect camera itself

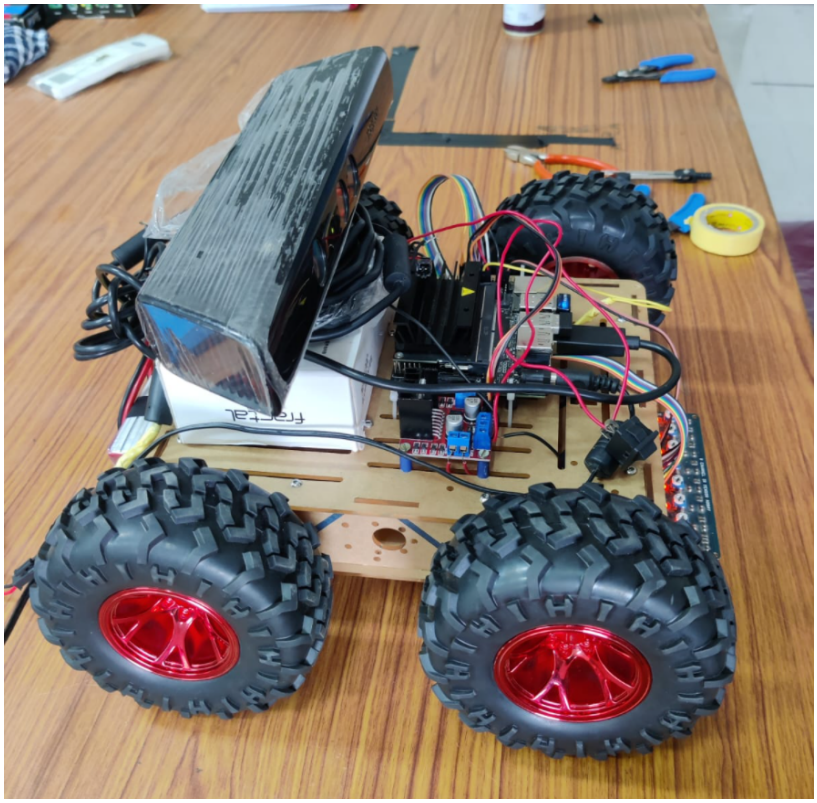


https://docs.opencv.org/4.x/d3/d14/tutorial_ximgproc_disparity_filtering.html
https://learnopencv.com/depth-perception-using-stereo-camera-python-c/

2nd May 2022

- Measured dimensions of plate to be mounted on top of bot as stage
- Tested speed control of motor by voltage control using DC DC converter
- Bot still over shoots at intersections
- Tested Kinect on Lipo battery 11.1V





5th May 2022

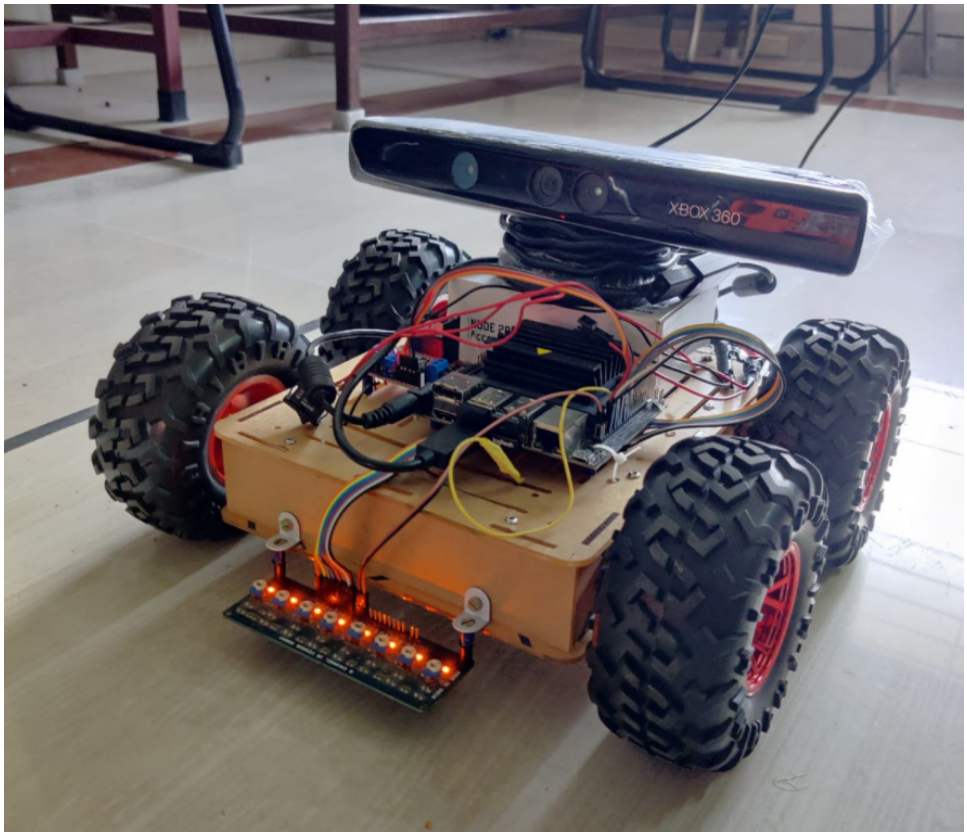
- Tried lane detection

- Tried to turn by detecting line crossing

https://drive.google.com/file/d/1BiFB7v-zMCT8uyBZ5y8GZ6Q1ZNyCZvq1/view?usp=sharing

6th May 2022

- Tuned obstacle detection to detect obstacle in immediate next cell
- Performed Linear test and recorded demo
- Programmed the bot to move linearly and map spaces ahead as empty or obstacle



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https://drive.google.com/file/d/1StmhIehbwoAjzSirtmoUHxlx8y9eFO4S/view?usp=sharing

9th May 2022

- Added line following to linear test

11th May 2022

- Tried to calibrate turns using lines
-

https://drive.google.com/file/d/1DfzKRoSeRlQKQ2OJnQzELBTM1MdcXWmY/view?usp=sharing

12th May 2022

- Continued to test turning using timing
- Started PPT for first review

13th May 2022

- Started looking into implementation of RL

16th May 2022

- Mounted stage for kinect
- MPU 6050 interfaced with jetson nano and obtained raw data as output
- Connected 100RPM 12V motors on all four wheels.

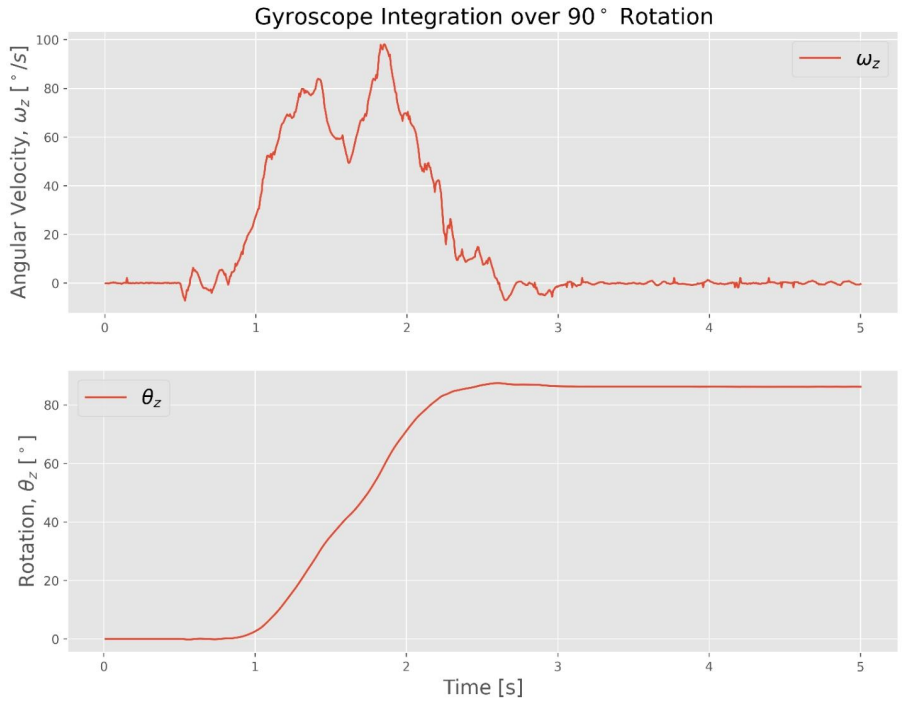
https://automaticaddison.com/visualize-imu-data-using-the-mpu6050-ros-and-jetson-nano/

https://makersportal-com.cdn.ampproject.org/v/s/makersportal.com/blog/calibration-of-an-inertial-measurement-unit-imu-with-raspberry-pi-part-ii?amp_gsa=1&amp_js_v=a9&format=amp&usqp=mq331AQKKAFQArABIIACAw%3D%3D#amp_tf=From%20%251%24s&aoh=16529509377396&referrer=https%3A%2F%2Fwww.google.com&ampshare=https%3A%2F%2Fmakersportal.com%2Fblog%2Fcalibration-of-an-inertial-measurement-unit-imu-with-raspberry-pi-part-ii

17th May 2022 - First review

18th May 2022

- Calibrated and converted raw data input of MPU6050
- Integrated gyro output (Angular velocity) to get Angular displacement along z-axis which is suitable to identify bot turning.



https://github.com/makerportal/mpu92-calibration/tree/main

19th May 2022

- Used angular displacement destination to accurately turn left and right
- Set up calibrated movement code to test movement in all directions

23rd May 2022

- Looked into RL algorithm modification
- Added calculation of turn required for any action in a given state

24th May 2022

- Looked into upcoming conferences

25th May 2022

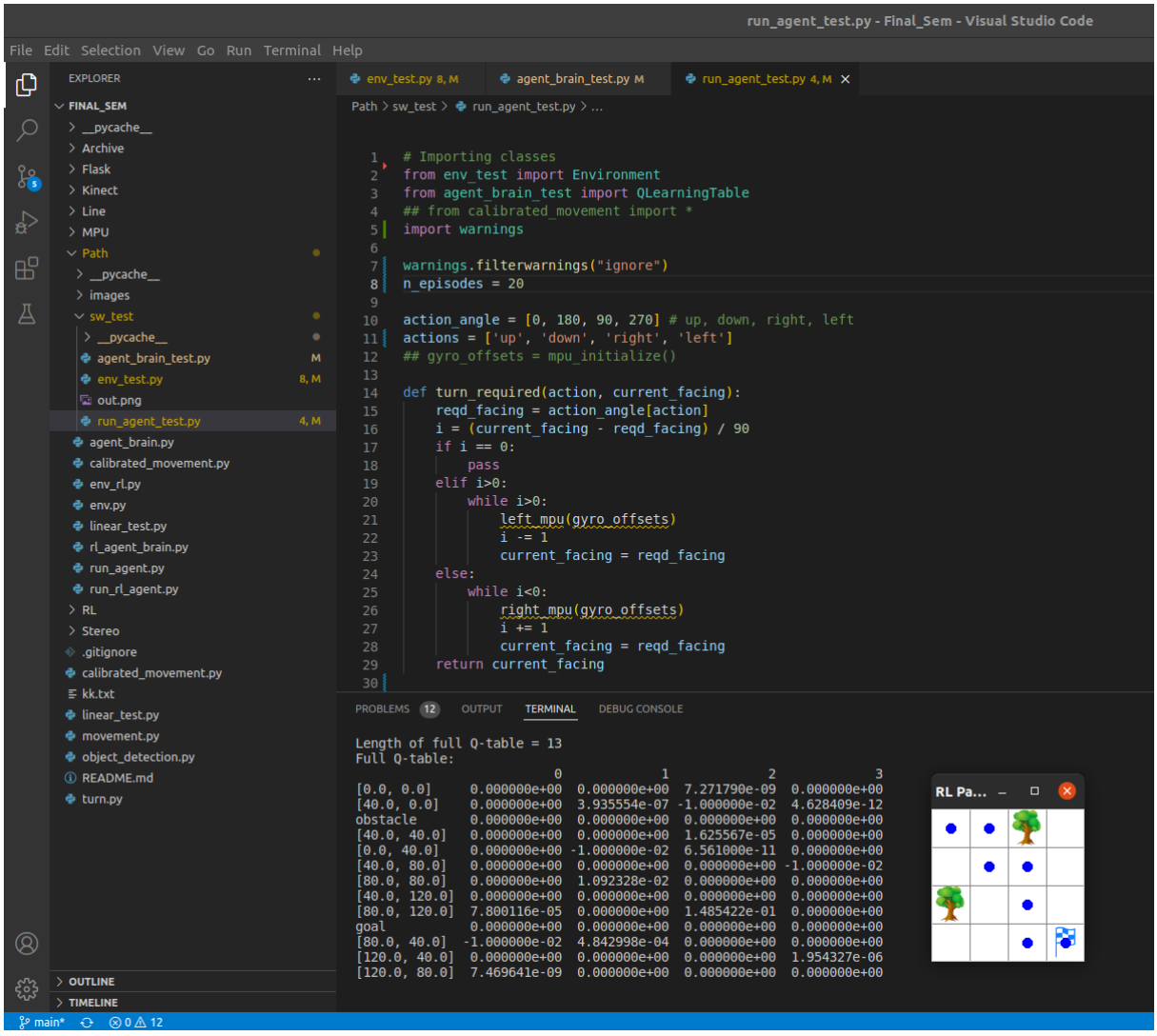
- Modified RL algo to account for obstacles ahead of movement. Facing errors, should try again.

26th May 2022

- Altered RL algo and tested simulation.

27th May 2022

- Removed unnecessary turns for invalid locations
- Fixed invalid movement out of boundary
- Removed warnings
- Simulation works well
- To check - invalid movement, same location updation, processing, final and complete q-table.
- Getting errors in turning using gyro sensor, unable to test in hardware.



30th May 2022

- Fixed gyro sensor turning errors
- Tested modification of software test to run on hardware. Bot runs but doesn't detect or populate obstacles
- Worked on conference paper

31st May 2022

- Fixed obstacle detection inclusion in hardware using depth
- Modified code to test hardware implementation on table top (connected to monitor)
- Ran 10 episode test in 3x3 sample environment on table top

3rd June 2022 - Second review

9th June 2022

- Optimised turn thresholds and timing for forward movement

- Unable to account for lateral shift in turns

10th June 2022

- Tried to perform hardware test in testing space
- Difficulty due to requirement of display for action determination

12th June 2022

- Set up web app for passing information regarding action chosen in each step

13th June 2022

- Performed 2D space mapping in testing space successfully
- Ran 10 episodes on 3x3 space and recorded demo
- 

- 

Videos:
https://drive.google.com/drive/folders/1o6_GF0UxDqjnkAbrD25ymSs3vJMn-_K_?usp=sharing

-

Done:

Upto 18/3/2022

- Tested RL SARSA implementation in PC
- Modified program to add obstacles to map only when detected by agent
- Tested Midas model for mono cam depth mapping
- Researched microcontroller options, components required
- Installed Ubuntu 20.04 in Jetson Nano
- Initialized Jetson Nano and interfaced with Kinect v1, v2
- Tested and used python wrapper for Kinect v1 interface
- Motor driver options
- Set up movement using L298N motor driver

- Object detection using YOLO v5s
- Explored freenect library usage
- Depth thresholding of depth map
- Added ROI
- Detection of object based on percentage of pixels

Upto 12/5/2022

- Connected WiFi adapter - Netgear WNA1000M
- Set up remote access through SSH and VNC
- Mounted motor driver
- Made bot portable
- Set up remote access
- Remotely controlled 4 directional movement
- Placed Jetson nano and motor driver inside the body of the bot
- Studied options for power supply and alternatives
- Tested mono camera depth estimation
- Set up web output for obstacle detection for remote inference
- Switched to and tested wired power for Jetson and Kinect
- Tested and looked into different options for weight distribution to make the bot stable and move accurately
- Swtiched to Li-Po battery
- Mounted IR array and implemented line following
- Tested Stereo Camera depth estimation performance
- Tried various options for accurate turning of bot
- Performed Linear test - mapped obstacle in a linear space

- RL algorithm testing
- Distance calibration
- Testing space setup
- Mapping
- Make bot stable
- Calibration of movement

Problems faced :

Upto 18/3/2022

- Midas model inference requires heavy computation and is not very accurate.
- Couldn’t install libfreenect & libfreenect 2 in jetson nano official sd image.
- Couldn’t set up python wrapper for Kinect v2(decided to go with v1 considering size and complexity.
- Power arrangement for portability.

Upto 12/5/2022

- Unable to power jetson nano through 5v output of L298N motor driver. Turns on and then off in about 5-10 seconds
- Bot movement irregular due to weight and loose shaft
- Unable to VNC remotely without display connected. Need to purchase a Dummy HDMI connection
- Jetson nano and Kinect camera not functioning properly when used in battery mode.
- Stability of bot and calibration is an issue
- Bot doesn’t turn due to the weight of the 12V lead acid battery
- Jetson Nano turns off when using Kinect camera when powered by power bank
- Bot turning is irregular