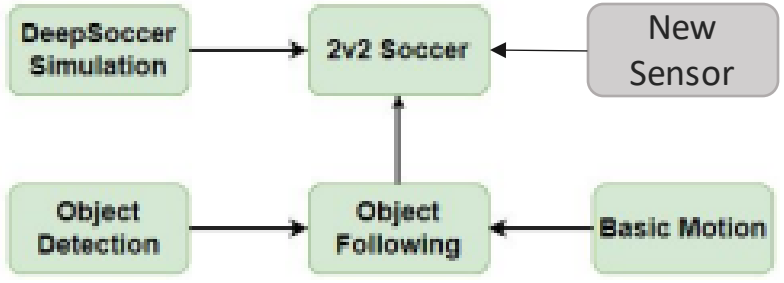
Overview

JetRacer Soccer
Jarod Marshel, Casey Rittenhouse, Arjun Simha, Mason Kang, K Gupta, Julie Ham, Cooper Ritter

Overall Concept:



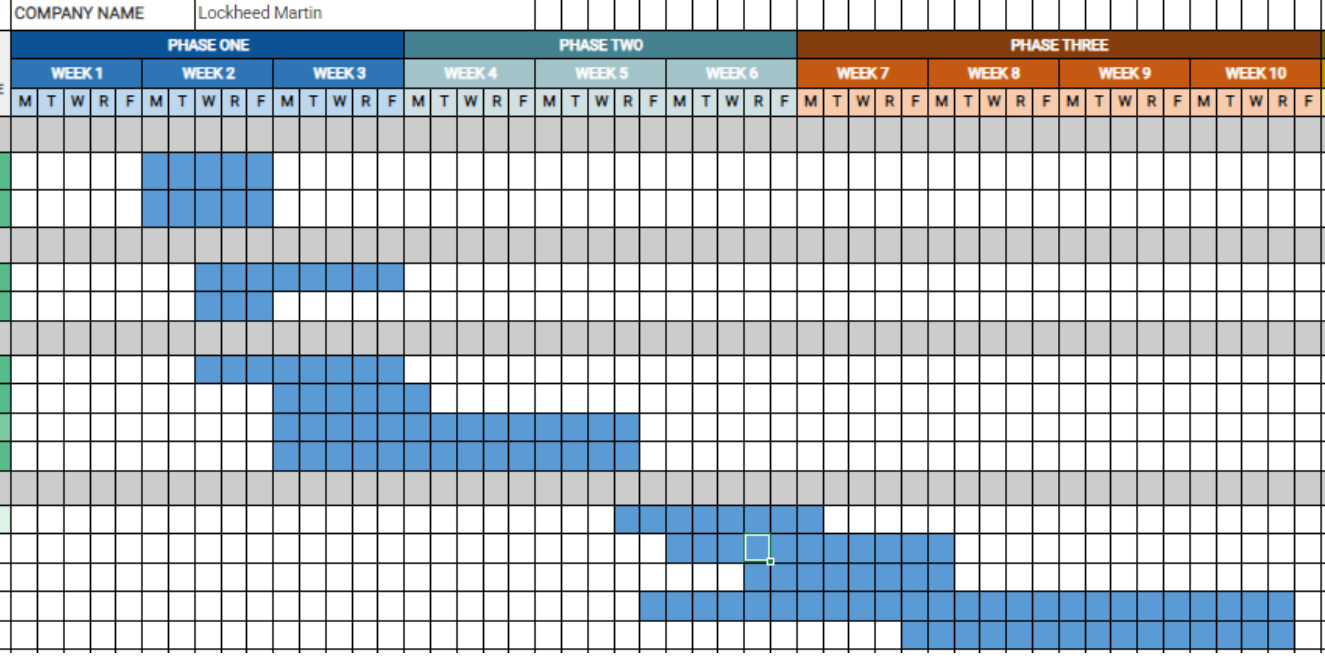
Overall Project Deliverable	Progress
Basic Movement	In progress
Image recognition	Done
New sensor implementation	In progress
Object following/Ball Striking	In progress
Co-op and Versus	Not started
Github with documentation	Not started
Summary and report	Not started

Project is On Schedule

Gantt Chart/Schedule

PROJECT TITLE: JetRacer Soccer League | COMPANY NAME: Lockheed Martin

WBS NUMBER	TASK TITLE	START DATE	DUE DATE	PCT OF TASK COMPLETE
1	**Project Conception and Initiation**			
1.1	Project Background and Context	1/8/24	1/19/24	100%
1.1.1	Project Objectives and Deliverables	1/8/24	1/19/24	100%
2	**Project Definition and Planning**			
2.1	Scope and Goal Setting	1/10/24	1/27/24	100%
2.2	Budget	1/10/24	1/20/24	100%
3	**PHASE 1**			
3.1	Research JetRacer	1/10/24	1/27/24	100%
3.2	Initial Hardware	1/15/24	1/31/24	100%
3.3	Basic Motion	1/15/24	1/31/24	80%
3.4	Image Recognition	1/15/24	1/31/24	100%
4	**PHASE 2**			
4.1	Sensor Trade Study	2/1/24	2/12/24	20%
4.2	Object Following	2/5/24	2/19/24	0%
4.3	Preliminary Design Review	2/9/24	2/19/24	0%
4.4	Soccer Play	2/1/24	3/7/24	0%
4.5	New Sensor Implementation	2/16/24	3/7/24	0%



Short-Term

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Previous Meeting Action Items:

Item	Description	Owner	Target Date	Status
1	Car CAD Models	Cooper	Feb 12	Done
2	Unity soccer simulation training	Mason	Jan 31	Done
3	Get all cars working with basic movement	Everyone	Feb 9	In progress
4	Redo hardware attachment to cars	Everyone	Feb 12	Done
5	Demonstrate image processing	Everyone	Jan 31	Done
6	Integrate ROS onto cars	Everyone	Feb 12	In progress
7				

Biweekly Action Items:

Item	Description	Owner	Target Date	Status
1	System integration	Everyone	Feb 29	Not started
2	Preliminary Design Review	Everyone	Feb 19	Not started
3	Object following	Everyone	Feb 12	In progress
4	Build field for cars	Everyone	Feb 19	Not started
5	Implement SLAM into LIDAR systems	Everyone	Feb 12	In progress

Significant Roadblocks/ Non-developing Items:

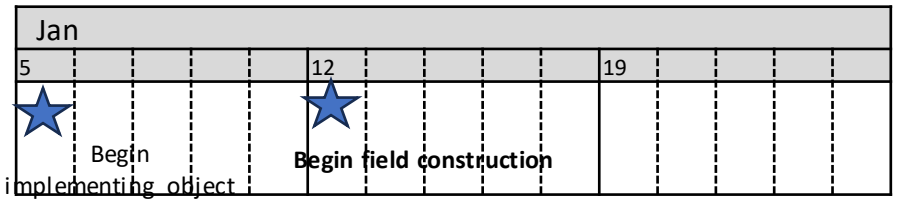
- Currently have 3 working cars (4th car may need to replace motor)

Budget:

Total Proposed	Plan to Date	Used to Date	Used Vs Plan
$3500 USD	$0 USD	$0 USD	+/-$0 USD

Request for teaching staff:

Short Term Schedule:

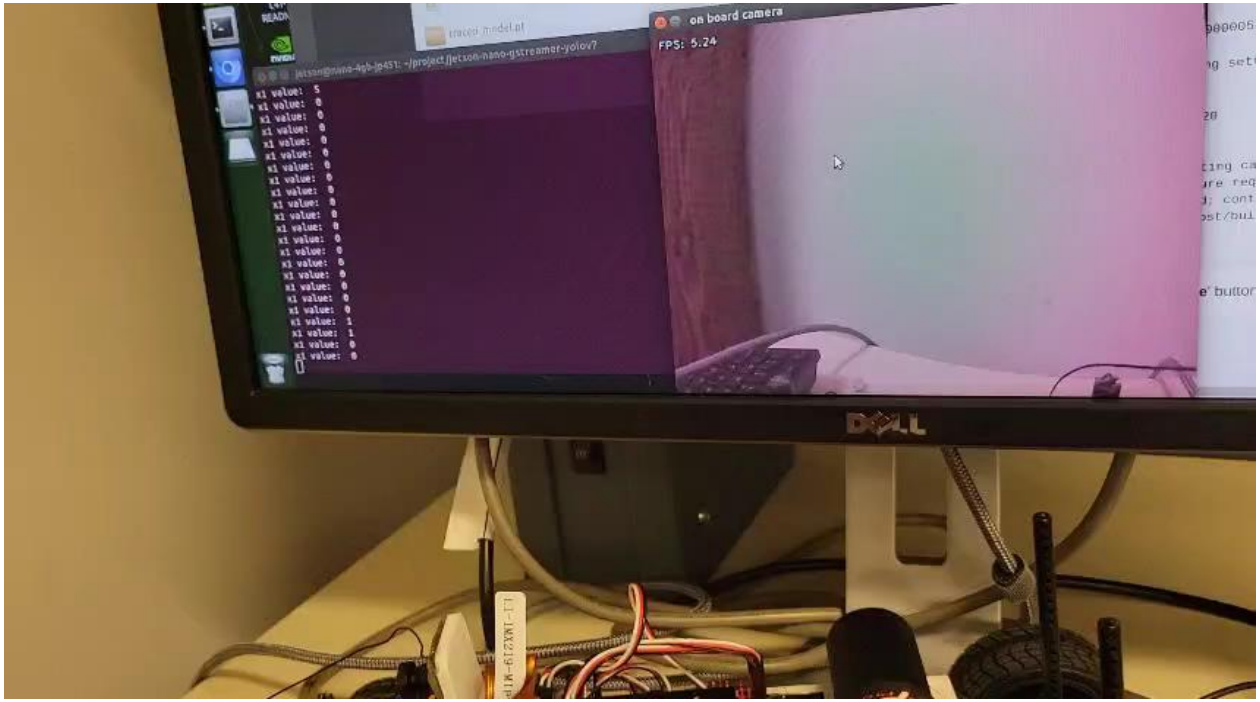


Detail

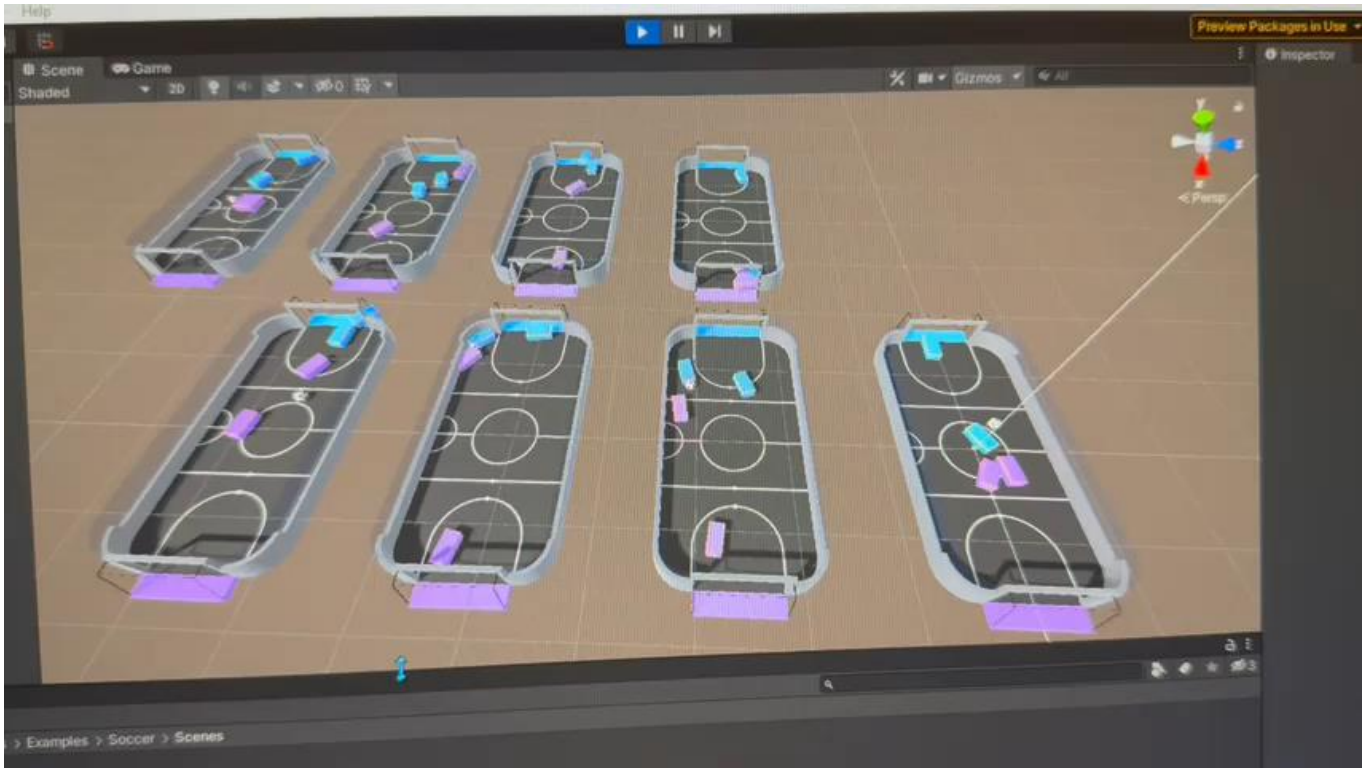
Progress:

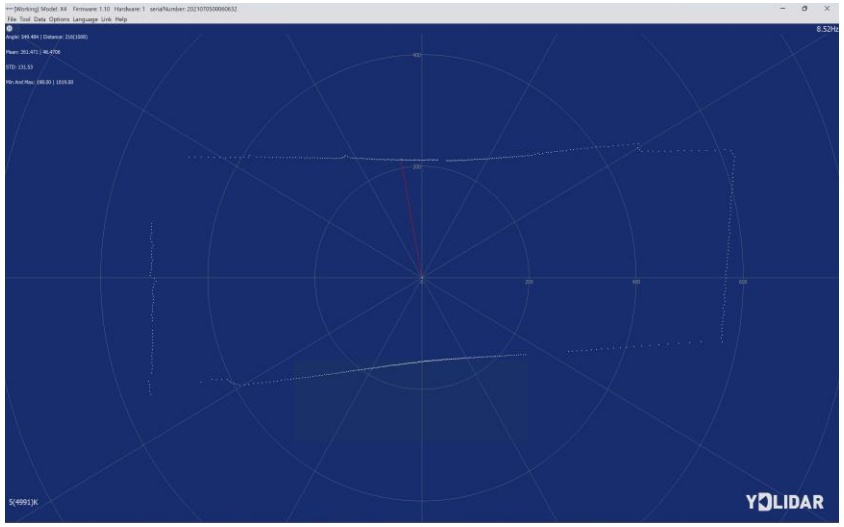
- Setup LIDAR packages (drivers and hector SLAM) on Jetson Nano
- Learned capabilities of LIDAR: tested for crosstalk, created point cloud visualization, tested mapping capabilities
- Made ROS navigation package
- Setup VNC
- Modelled and printed brackets for mounting components
- Worked on CV algorithm: YOLOv7 object detection runs

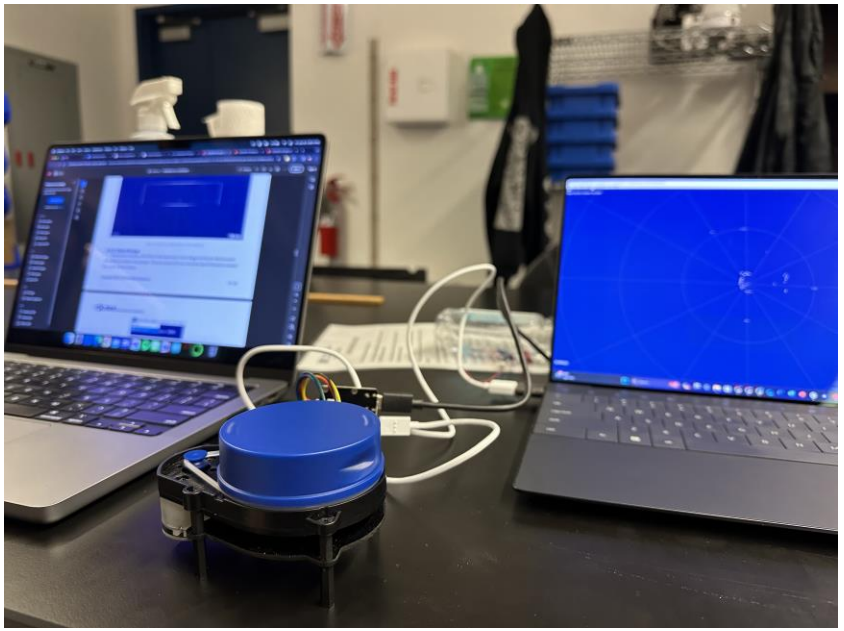
Detail

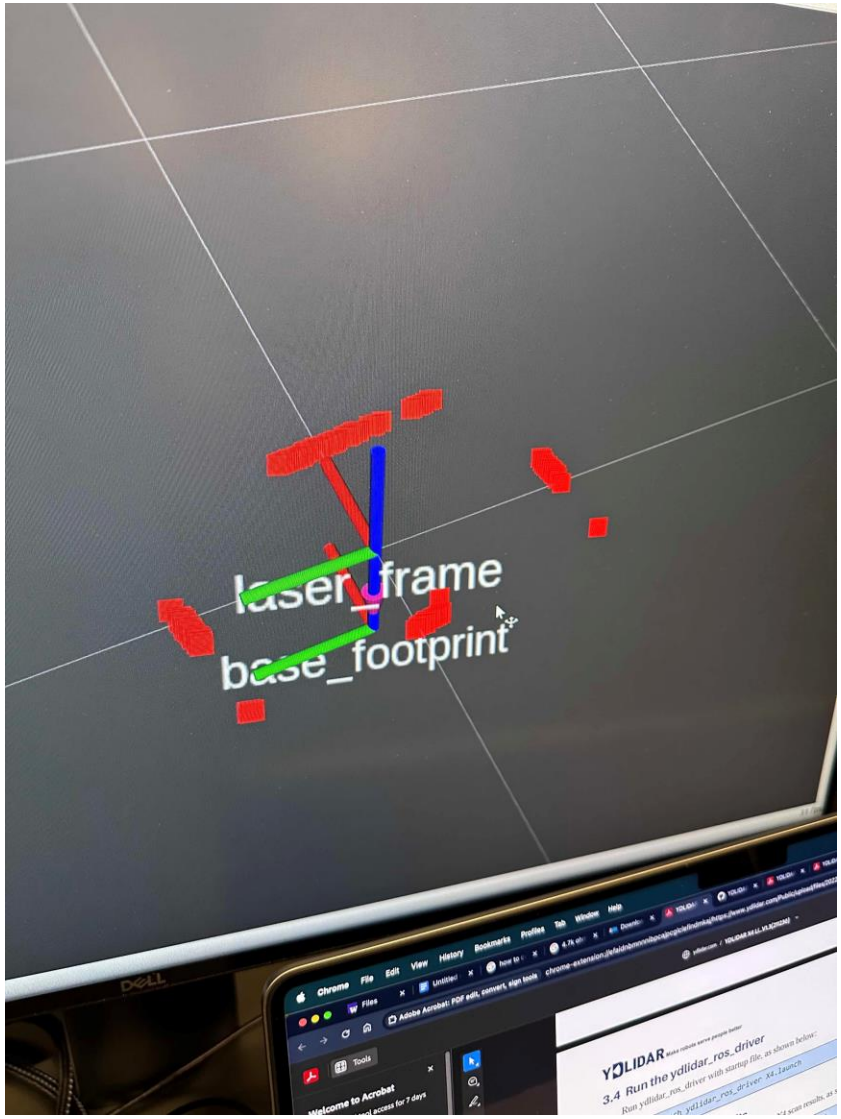


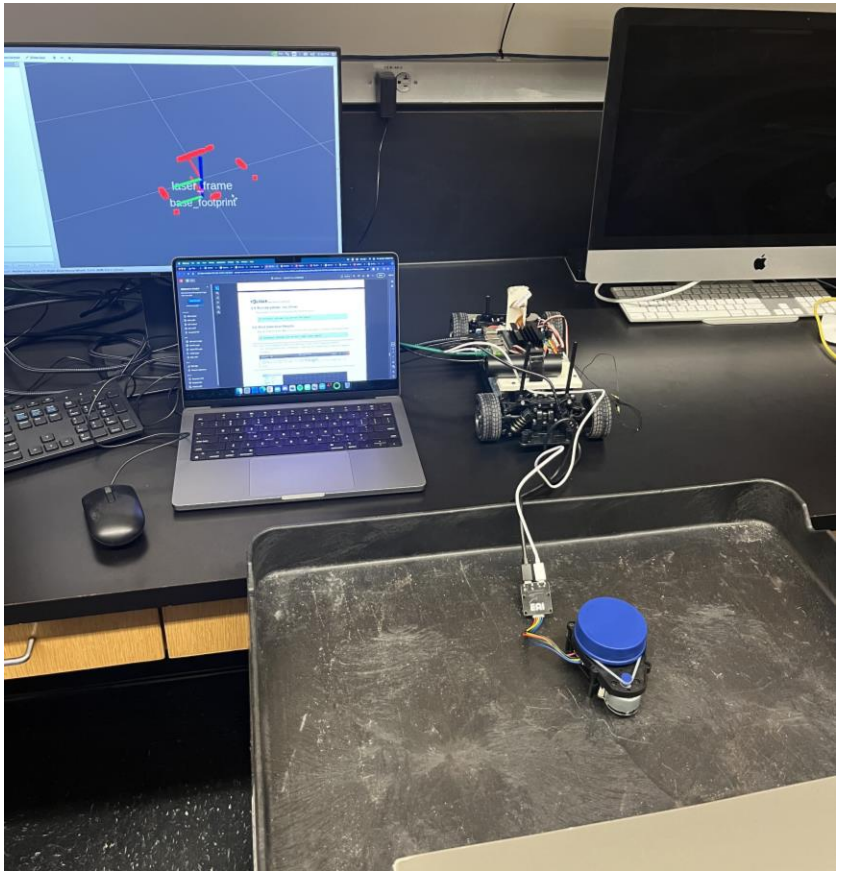
Detail


Help
Scene
Game
Shaded
2D
Gizmos
Persp
Inspector
Preview Packages in Use
Examples > Soccer > Scenes


8.52Hz
YDLIDAR




laser_frame
base_footprint
YDLIDAR
3.4 Run the ydlidar_ros_driver


laser_frame
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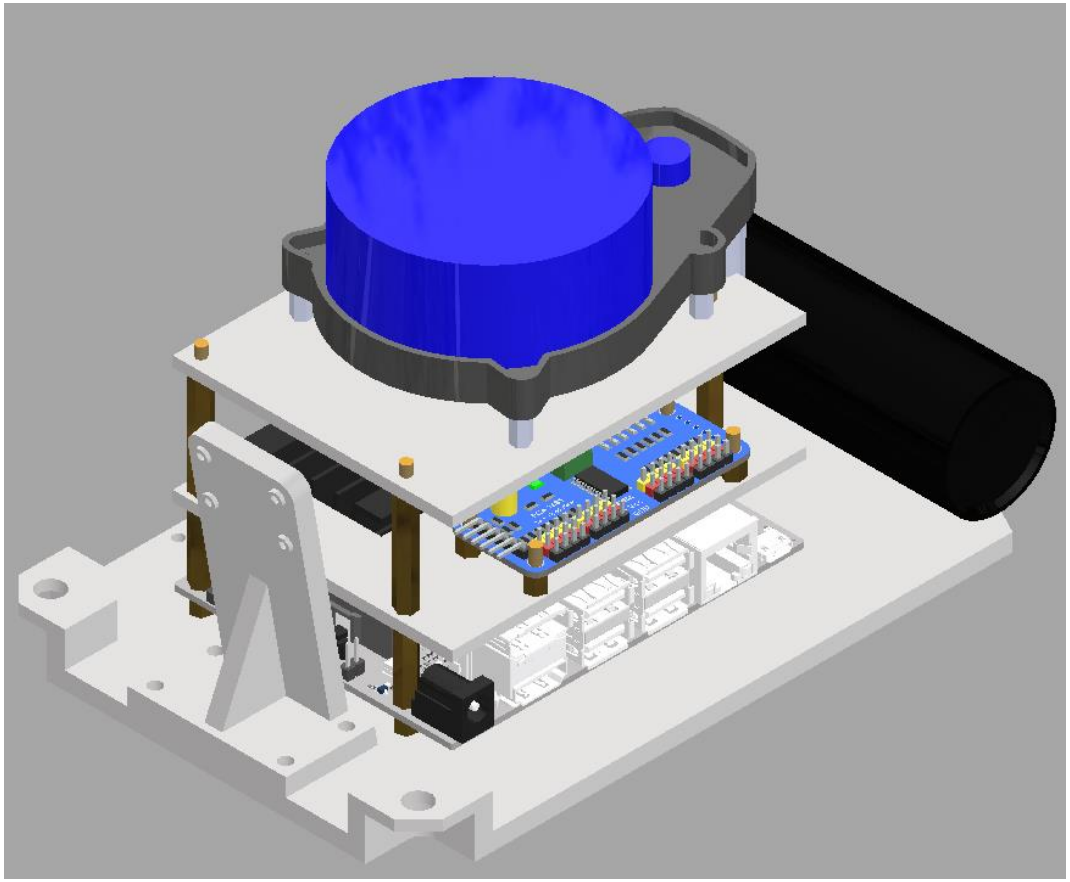
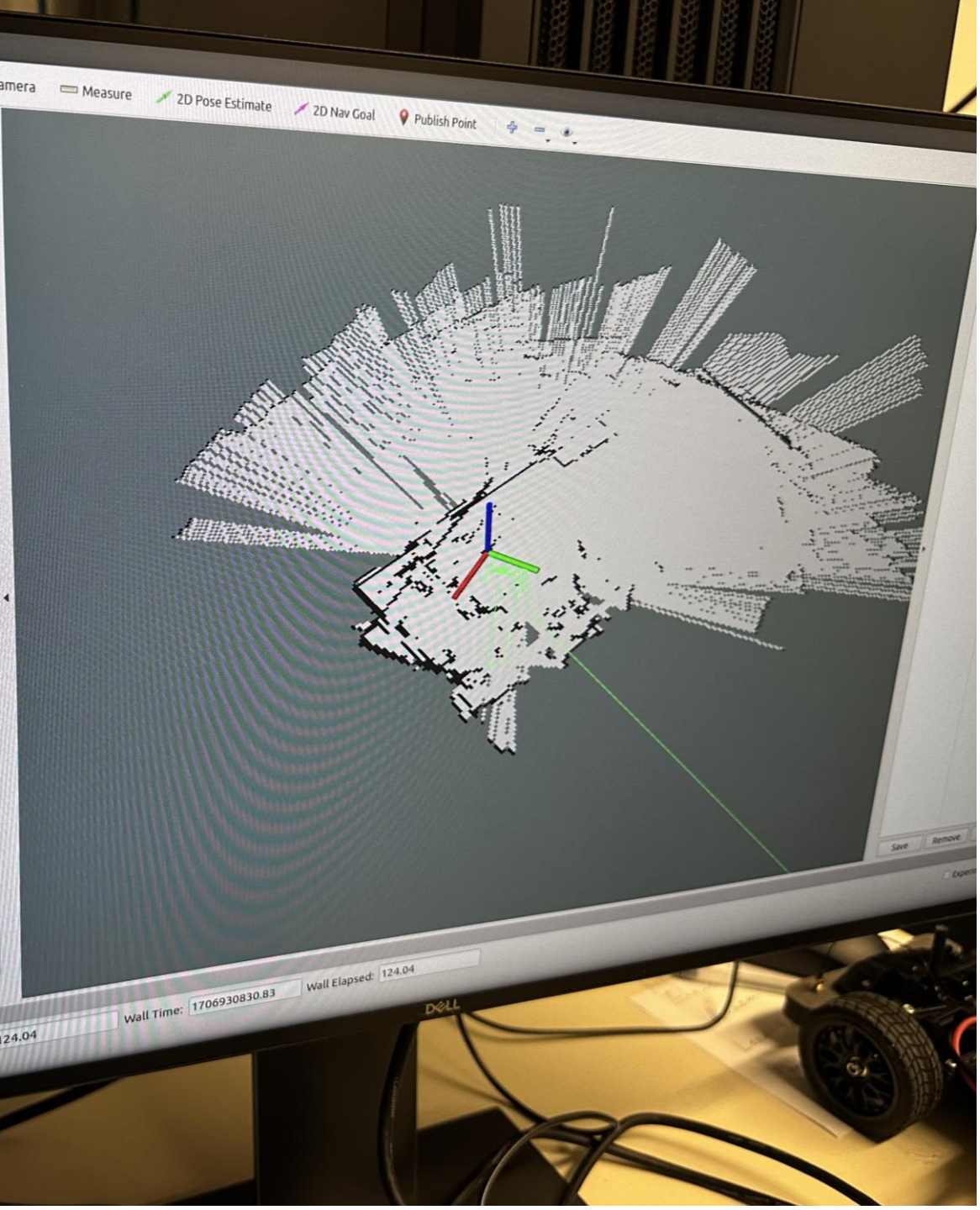
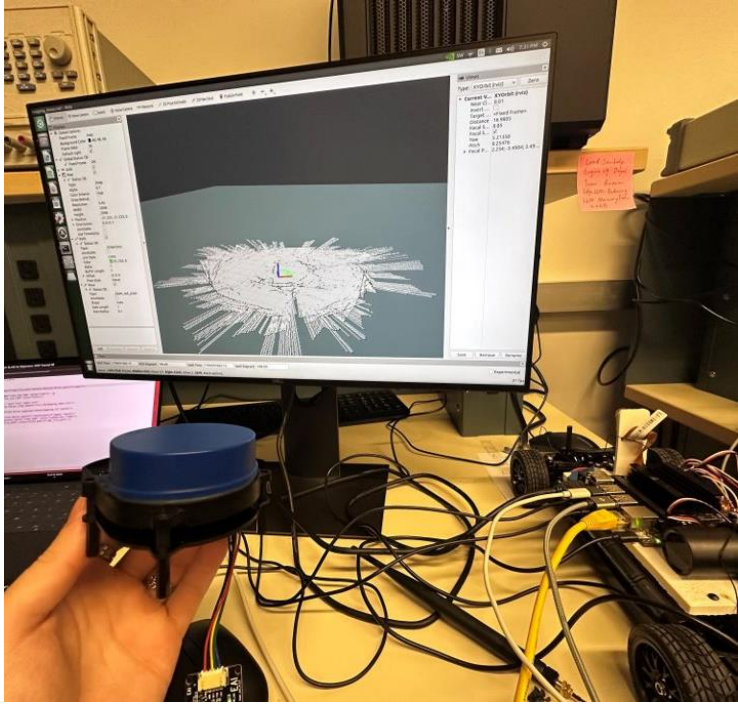
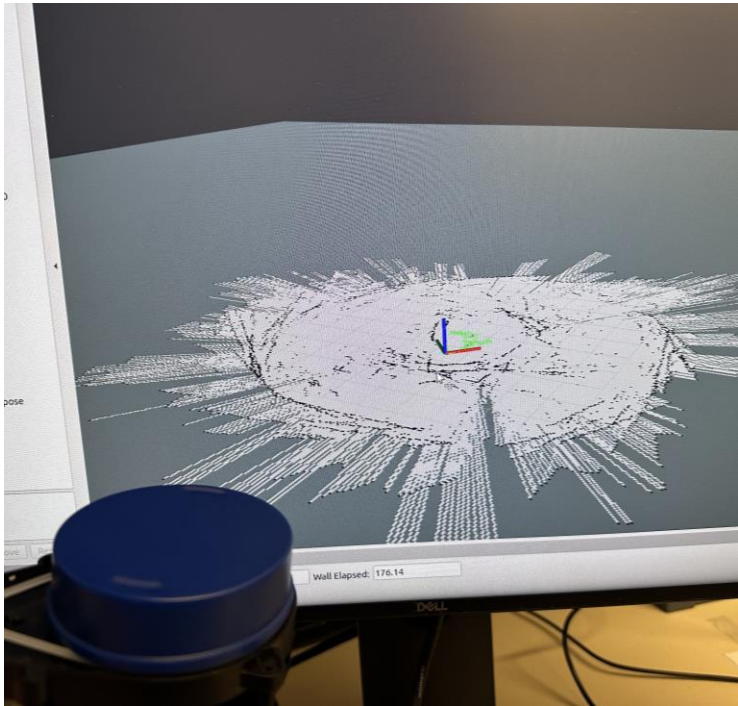



amera
Measure
2D Pose Estimate
2D Nav Goal
Publish Point
Save
Remove
Wall Time: 1706930830.83
Wall Elapsed: 124.04
124.04
DELL




Wall Elapsed: 176.14
DELL

Questions:

- How to manage ROS package dependencies?
  - Need to figure out which packages depend on which Python versions
  - Way to isolate ROS python to specific bin
- How to proceed with SLAM?
- Hector SLAM vs. GMapping?
  - Need for odometry? Encoder vs. optical tachometer?
- How to store ideal map (w/ size known)?
- How to locate ball position? What if ball is not in camera view?
  - Necessary?
- Field location

Team Roles

- **Project Manager** - Jarod
- **Point of Contact** - Arjun
- **Budget Manager** - Casey

- **ROS/Hardware (Layout, PCB, CAD, LiDAR):**
  - Cooper, Casey, Jarod, Arjun
- **Unity Team:**
  - Mason
- **CV/Image Recognition Team:**
  - K, Julie

ROS (Casey, Cooper)

Previous Work:

- Cont. ROS melodic setup
- Setup GNOME VNC server
- Created navigation package (navigation topic + sub/pub)
- Started integrating NVIDIA racecar package with ROS
- Created package installation instructions doc (OS Flash, VNC, ROS, LiDAR)

Future Work:

- Configure package dependencies
- Car tele-op control
- Navigation stack (odometry?)

LiDAR (Arjun, Jarod)

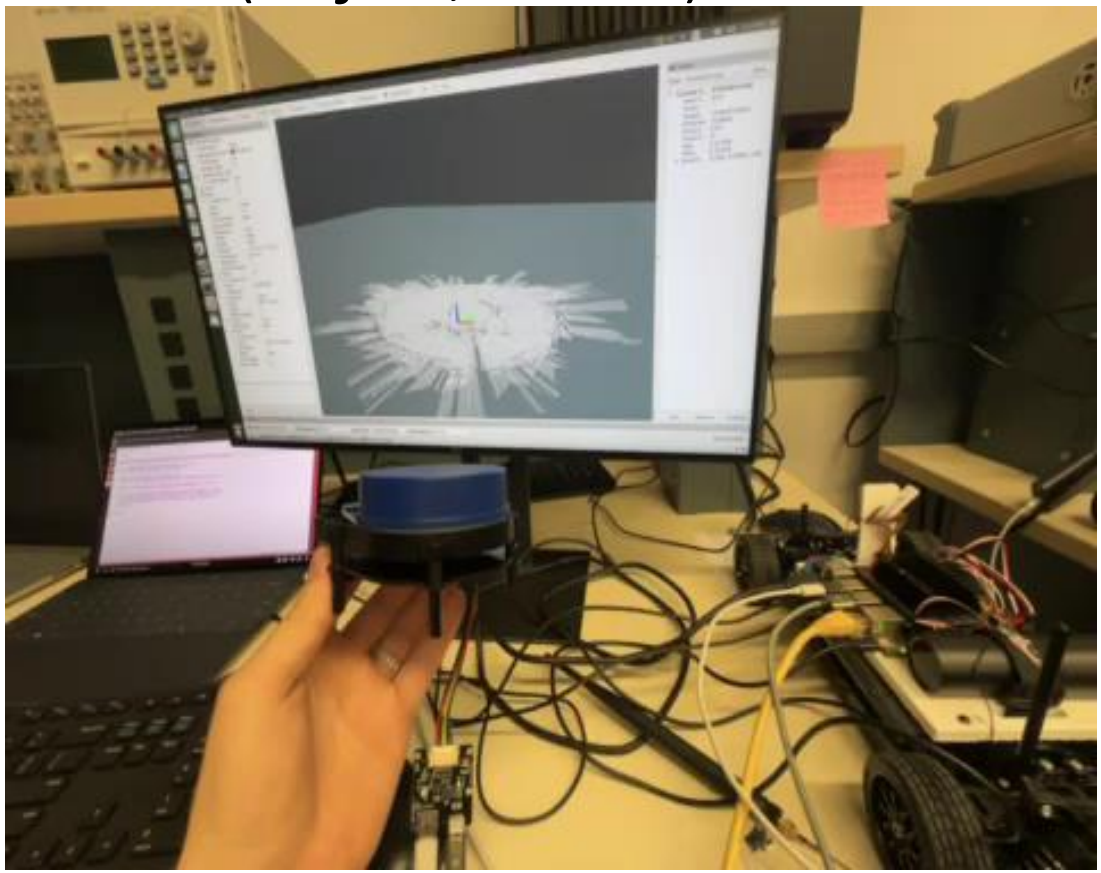
Previous Work:

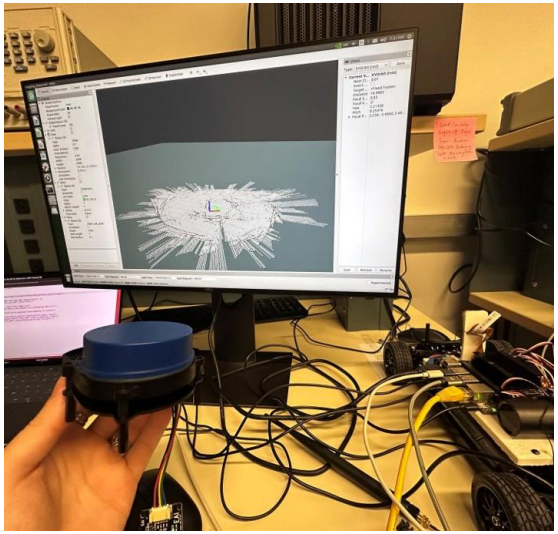
- Setup hector SLAM (installed packages, troubleshooted)
- Tested SLAM mapping capabilities
- Tested for LiDAR crosstalk (no visible issues)

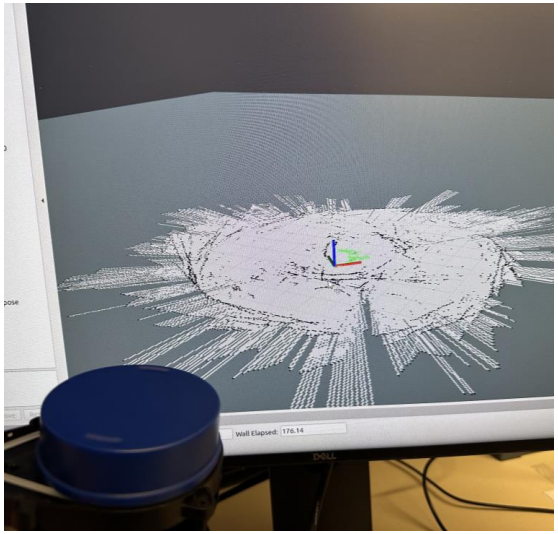
Future Work:

- Look into odometry (could provide more accurate results with gmapping)
- Mount LiDAR on cars, test mapping in real-world
- Use SLAM maps to inform navigation

LiDAR (Arjun, Jarod)

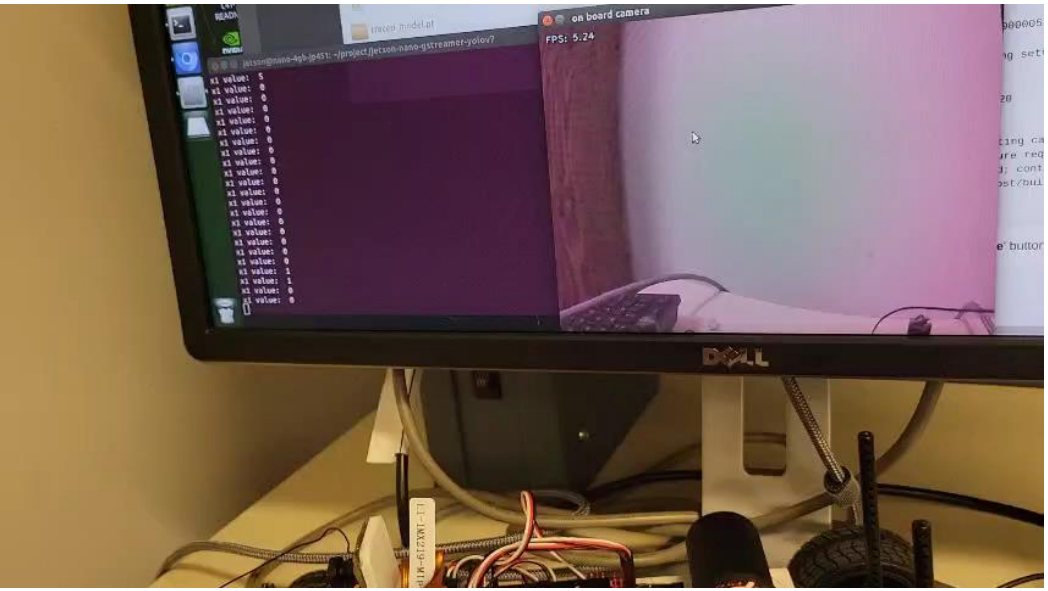






Object Recognition (K, Julie)

- Previous work:
  - Object detection (YOLOv7) runs on car 4
  - Started looking into object following



- Future work:
  - Get object detection working on all cars
  - May need to update image dataset depending on if field boundaries/cars look the same as previous years
  - Implement object following onto cars

Unity (Mason)

Progress: Optimized the simulation further, looking to re-train some 1v1 fields as the industry mentors suggested.

For integration of Unity Simulation and JetRacer cars IRL:

Just a premature idea to utilize image recognition to identify objects, might require another onboard computer to process this, and a 360 camera could be a good idea.

Plan is to identify the cars and ball, and then execute certain commands in order to complete a 2v2 soccer game. The difficulty here is to stream the camera footage back to the Unity and translate the action values back to the cars.

Previous Year's Work

- Built and gained full range of motion of 4 JetRacers using software
- Set up a simulation environment to virtually train the agents
- Structured a reward system for the reinforcement learning model
- Implemented object detection model that identifies a soccer ball, opponent, and goal
- Implemented software to follow and strike a ball
- Developed logic process for striking a ball into a goal
- Simulation results with reward structure demonstrate that agents can be trained to efficiently compete in a 2v2 soccer match
- Created a GitHub page documenting the hardware and software instructions to setup JetRacers, a summary of the work completed, and plans for future work

Our Final Deliverables

- Demonstrate basic motion of JetRacer: 01/2024
- Demonstrate JetRacer Image Recognition for soccer play: 01/2024
- Trade study of possible sensor additions: 02/2024
- Preliminary Design Review: 02/2024
- Showcase vehicle scoring soccer ball in the goal in real-world: 03/2024
- Add additional agents in the real world: 04/2024
- Final Data Review: 05/2024