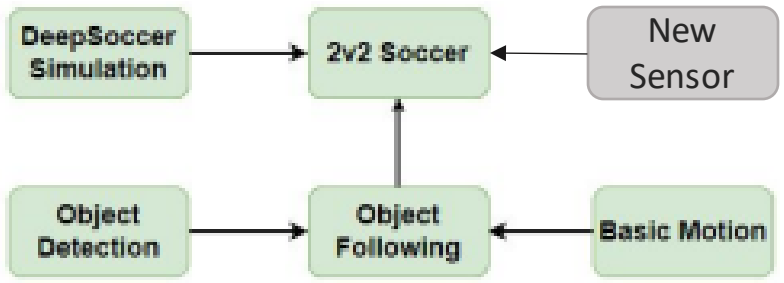
Overview

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

Overall Concept:



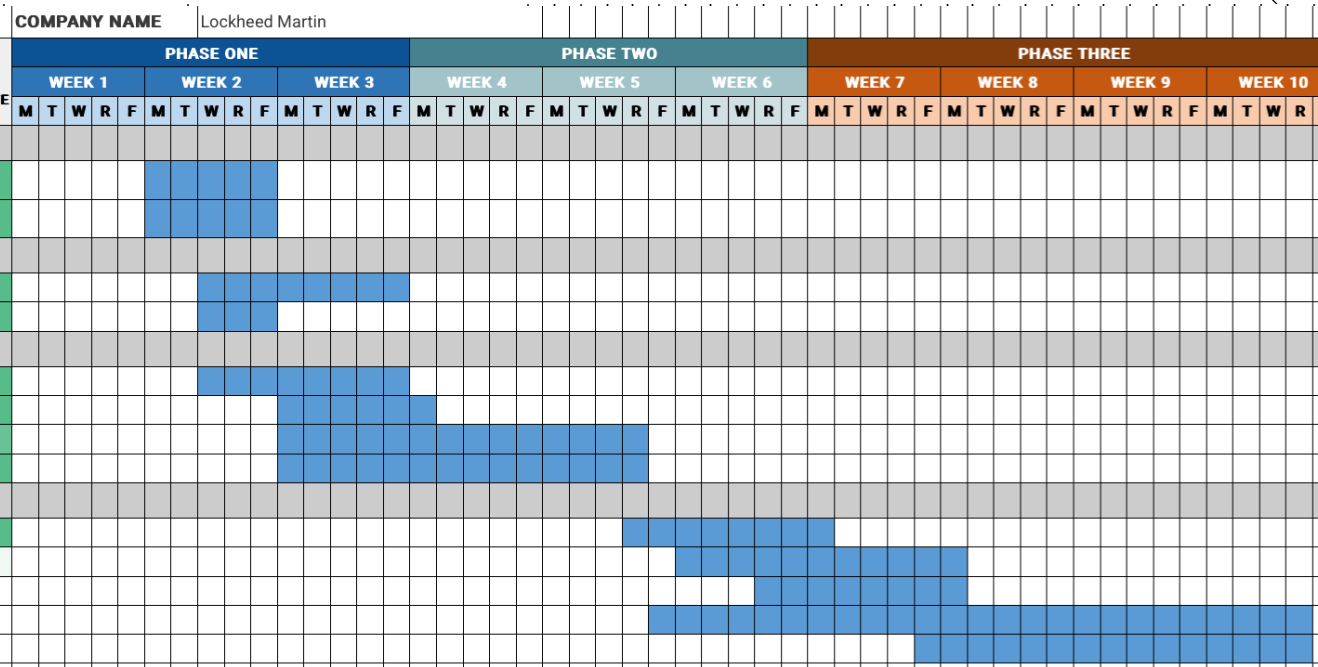
Overall Project Deliverable	Progress
Basic Movement	Done
Image recognition	Done
New sensor implementation	In progress
Object following/Ball Striking	In progress
Co-op and Versus	Not started
Github with documentation	In progress
Summary and report	Not started

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	90%
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	100%
4.2	Object Following	2/5/24	2/19/24	10%
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

JetRacer Soccer
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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	Jarod	Feb 19	Done
5	Implement new sensor onto car	Everyone	Feb 12	In progress

Significant Roadblocks/ Non-developing Items:

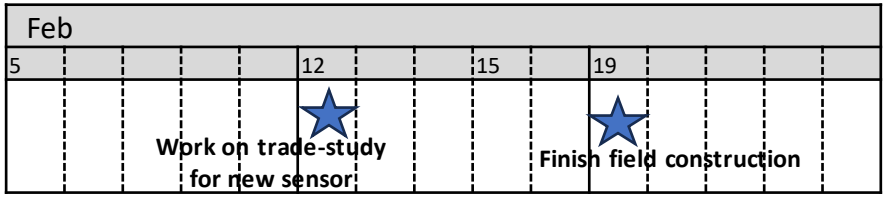
- New sensor on car (Zed 2) needs to be ordered and shipped to us

Request for teaching staff:

Budget:

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

Short Term Schedule:



Team Progress

ROS (Casey and Cooper)

Previous Work:

- Fixed throttle stalling
- Calibrated steering/throttle gains and offsets
- Printed field brackets
- Servo mount CAD for ZED2/servo
- Created trade study for sensor choice

Future Work:

- Continue Ubuntu 20.04 update and ROS Noetic install if Zed 2 is selected
- Modify CV to publish results to ROS topic

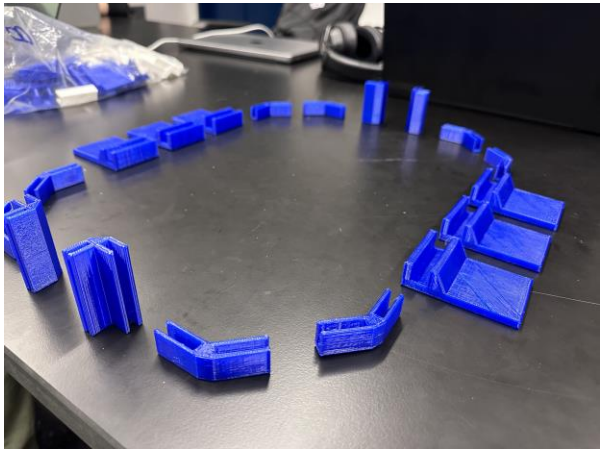
LiDAR (Arjun and Jarod)

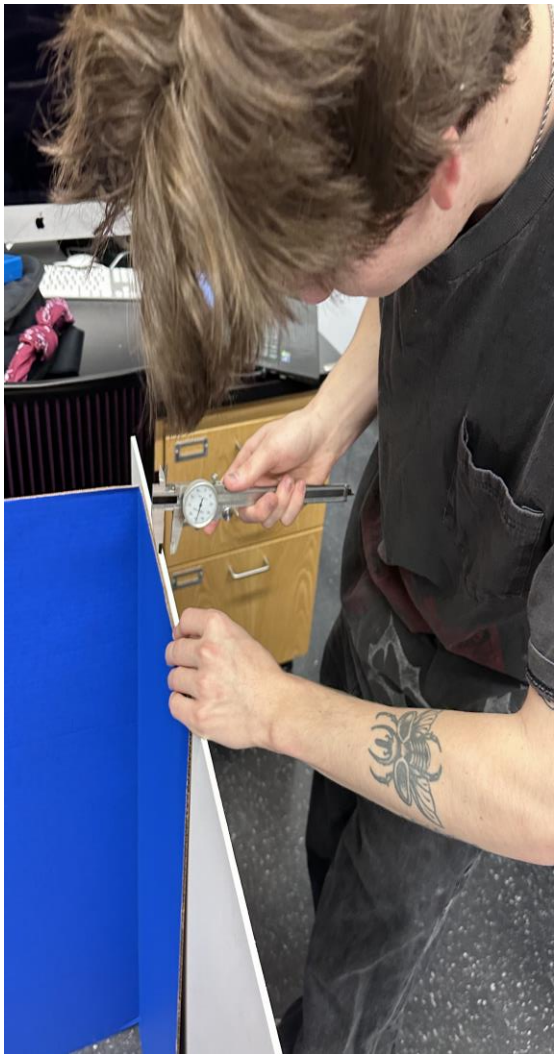
Previous Work:

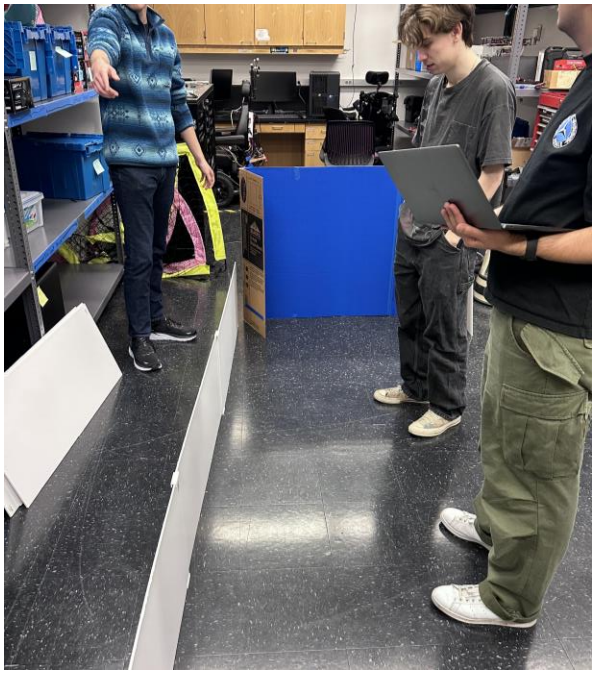
- Purchased supplies for field
- Constructed field using poster board and 3D printer brackets
  - Goals will be red and blue
  - Walls will be white
- Looked at different sensor tradeoffs as a substitute for LiDAR

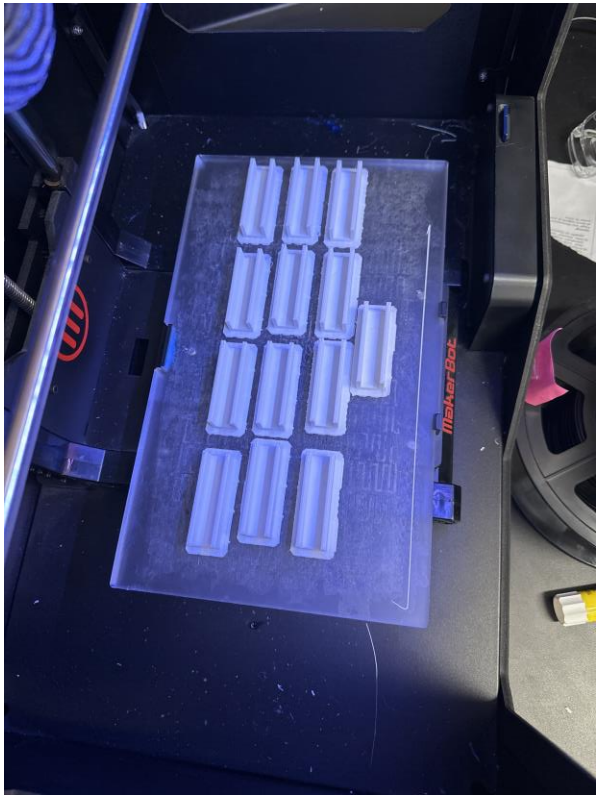
Future Work:

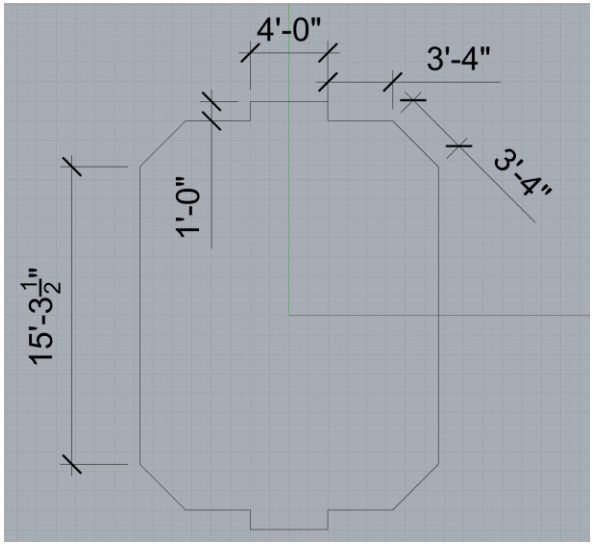
- Use borrowed Zed 2 camera to test feasibility
  - Integration into ROS
  - Sensor capabilities
- Construct full field in basement, try to find good location (lighting, field levelness/flatness, etc.)








MakerBot


4'-0"
3'-4"
3'-4"
1'-0"
15'-3½"

Computer Vision (K and Julie)

Previous Work:

- Encountered some setbacks:
  - SD card from Jetson went missing
  - Reflashed with Ubuntu 20.04
  - Downloading CV packages on that new version bricked it, but we found the old SD card
- Got bounding box offset to be printed to terminal
  - Working with ROS team to set up publisher/subscriber for the topic
  - Use it to steer car

Future Work:

- Work with ROS team to set up publisher and subscriber for steering servo
- Test steering towards ball position
- Test ball following (with throttle)
- Might need to update detection once ZED2 arrives

Unity (Mason)

Previous Work:

- Optimized the simulation further, start looking to the movement parameter of the machine learning agents, the goal is to simulate the cars movement IRL as realistic as possible.

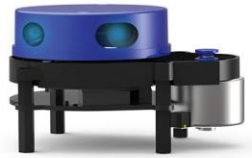
Future Work:

- Create a 3rd year repo for the JetRacer github page for the sake of progress tracking.
- Improve the machine learning agent model so that they have a realistic collision model.
- Continue to improve the movement of the simulated cars and the integration of the environment using the SDK.
- May shift focus to other aspects of the project

Tradeoff Study

Sensor Choice

2D Lidar



Benefits:

- Provides map of field
- Limited position data for car
- Able to share car position data with teammate/opponents

Limitations:

- Space inefficient/ difficult to mount
- Does not provide ball information
- Tracking ball requires car to turn

Ultrasonic

Benefits:

- Able to track ball and provide distance to ball
- More space efficient
- Cost effective (compared tgo LiDar
- Short lead time
- Conical detection gives more margin for error
- Larger FOV
- Can see transparent objects

Limitations:

- Short range
- Limited accuracy
- Noisy signal
- Lower sensing accuracy than LiDAR
- Can't sense soft materials (fabric)

1D LiDAR

Benefits:

- More accurate and less noisy than ultrasonic
- Can detect smaller objects
- Larger detection range
- Fast polling/detection rate

Limitations:

- Narrower FOV than ultrasonic
- Can be costly ($50-$100)
- Can't see transparent objects

ZED 2

Benefits:

- Onboard processor for sensor fusion (reduces computation overhead)
- Stereo camera for better depth perception
- Wide FOV (110°(H) x 70°(V) x 120°(D))
- Replicates functionality of LiDAR + more
- Easily integrates with ROS
- Built-in SDKs for a variety of applications, including object tracking
- Large detection range (up to 40m)
- Able to test without purchase

Limitations:

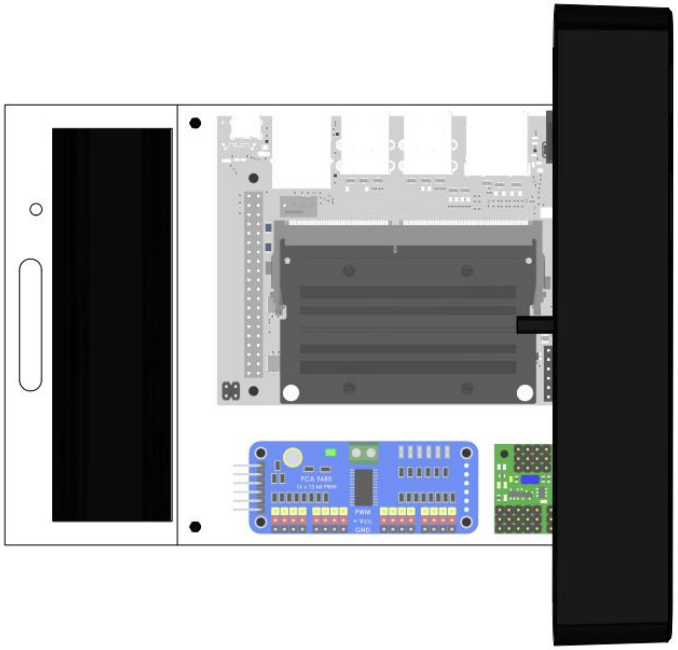
- Cost ($450 each)
- Size (6.90 x 1.19 x 1.69")
- Weight (0.5 lbs)

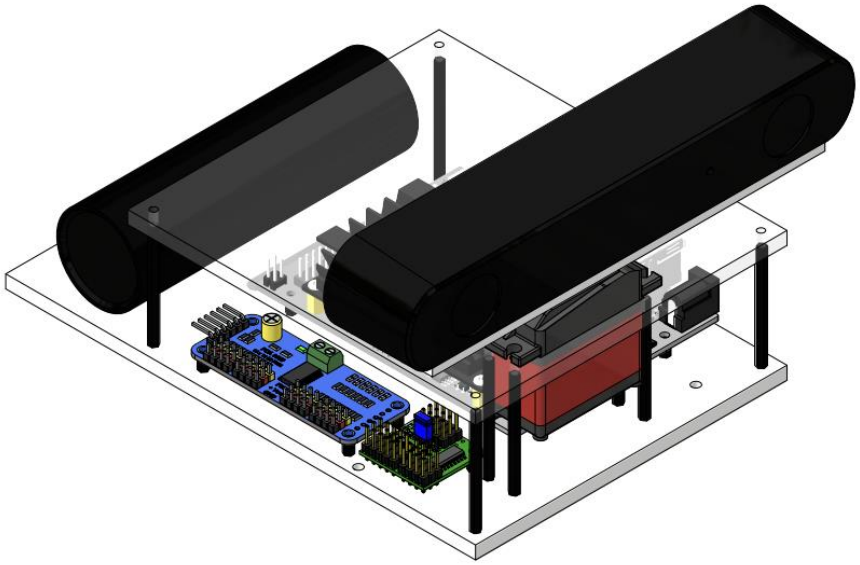
Pugh Matrix

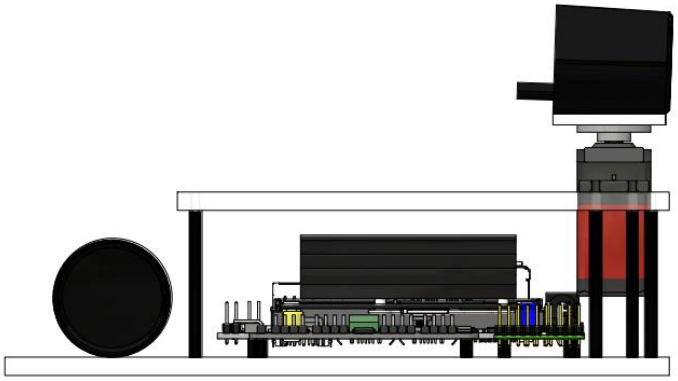
		Alternatives			
		2D LiDAR	1D LiDAR	Ultrasonic	Zed 2
Criteria	Score				
Cost	1 to 3	3	2	3	1
Ease of Integration	1 to 3	2	2	2	2
Accuracy	1 to 3	1	2	1	3
Range	1 to 3	2	2	1	3
Size	1 to 3	1	2	3	2
Car Position Data	1 to 3	2	1	1	3
Ball Position Data	1 to 3	1	2	2	3
Reliability	1 to 3	2	2	2	3
	Totals	14	15	15	20
	Rank	4	2	2	1

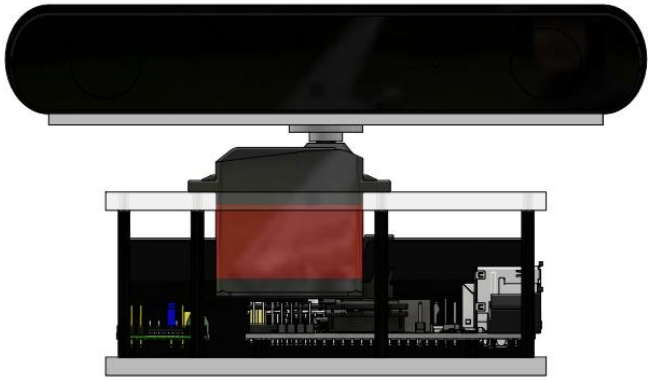
Recommendation

- We have access to a ZED 2 camera that we can use for preliminary testing
- After verifying that it meets our needs and that we can integrate it properly, we should order 4 cameras
- Won't waste too much time – can easily pivot to 1D LiDAR or ultrasonic
  - Would still use servo for mounting (see following slide)









Questions:

- Project scope
  - What level of co-op soccer are we looking for?
  - Might be hard to get true soccer strategy
- Unity integration onto cars
  - Realistic constraints
  - Pipeline to port models onto cars
- Zed camera
  - What additional capabilities does this unlock?
  - What capabilities do we lose?
  - Servo mount