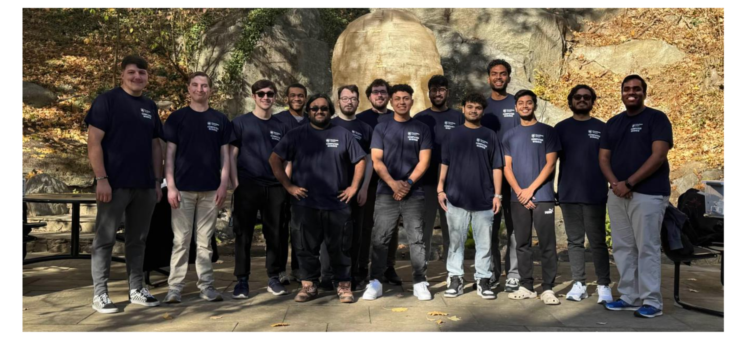
CMPSC 488 Capstone
Robot Laser Tag
Program of Computer Science, Penn State Abington, Pennsylvania 19001

PennState Abington

CMPSC 488 Capstone Team


Team 1 Section 1 Ultra-bot


Team 2 Section 1 Cyber Rex


CMPSC 488 Section 1 Team Members


Team 3 Section 1 Giant Robo

Section 1

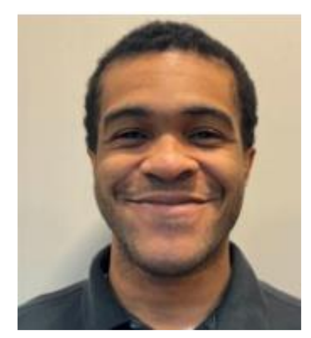

Project Manager
Colin George

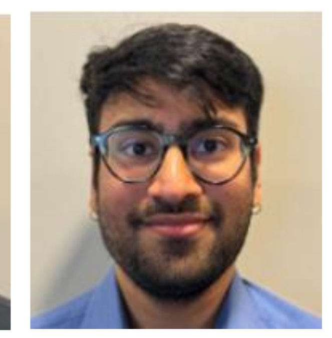

Professor
Joseph Oakes

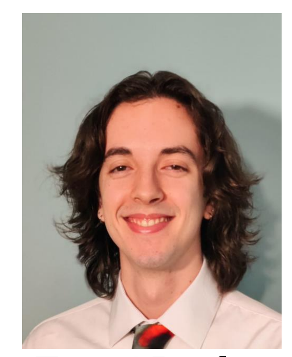
Section 2


Project Manager
Zachary Whitaker

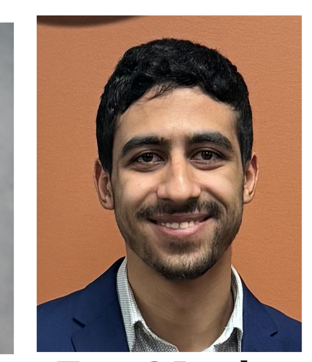

Team 1 Leader
Dev Zaveri


Team 2 Leader
Israel Coleman Jr


Team 3 Leader
Krish Parikh


Team 1 Leader
Paul Jensen

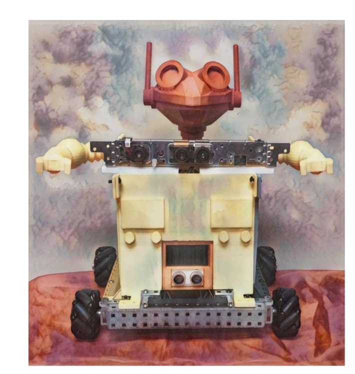

Team 2 Leader
Aaron Feinberg


Team 3 Leader
Osama Aljamal


Team 1 Section 2 Kei Prime


Team 2 Section 2 Laser Wolf


CMPSC 488 Section 2 Team Members


Team 3 Section 2 Amphibious

Mission Statement

To design and build a fully autonomous robot with advanced AI capabilities for indoor laser tag, utilizing intelligent navigation, targeting, and object detection within a simulated environment.

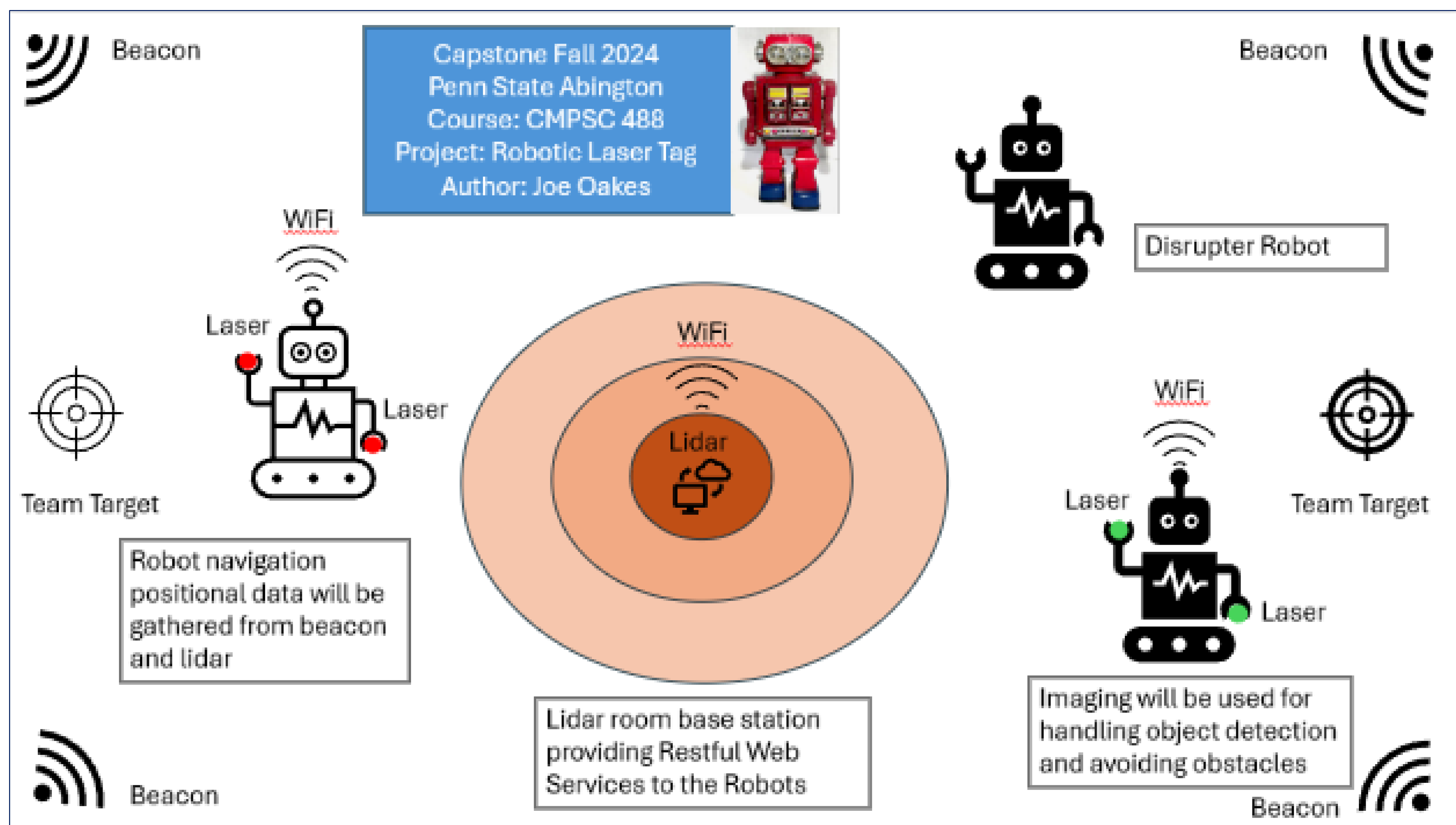


Fig. 1 – Overview of Capstone Project

Materials and Technologies

1. Computer Board: Jetson Nano, RaspPi4 & RaspPi5
2. I2C Servo Controller: PCA9685 16 channel
3. Motion Control: PWM Control Algorithm
4. Laser Diode: 10pcs 5V 650nm 5mW Red Dot Laser
5. Ultrasonic Sensor: M5 Stack Core S3 Microcontroller
6. Wheels: Mecanum Wheels, Omni Movement
7. Chassis: 3D-Printed Model PLA plastic
8. M5 Stack Core S3 Microcontroller


Fig. 1 - Jetson Nano

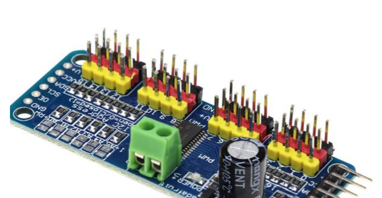


Fig. 2 - Servo Controller

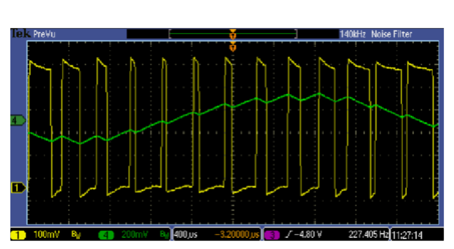


Fig. 3 - Pulse With Modulation


Fig. 4 - Laser


Fig. 5 – Ultrasonic Sensor


Fig. 6 – Omni Movement Wheels

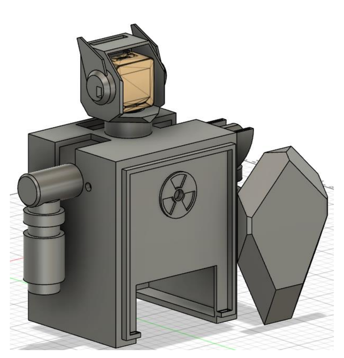
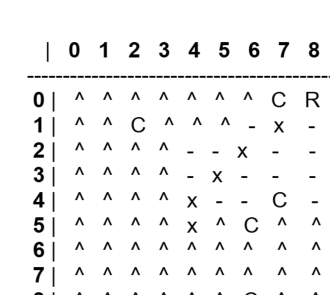


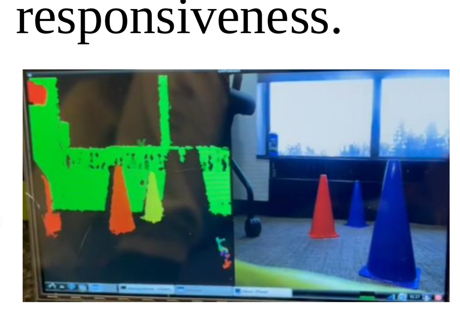
Fig. 7 – 3D model of robot chassis

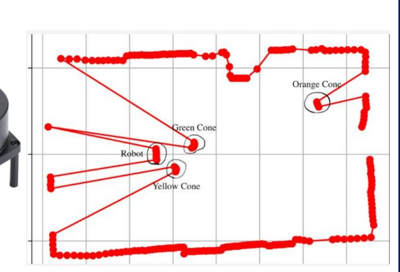

Fig. 8 - M5 Stack Core S3 Microcontroller

Key Features

This project integrates modern technologies for an autonomous game experience. The 3D printed chassis provides a lightweight and customizable platform, while computer vision object detection enables precise environmental awareness. LIDAR navigation allows the robot to autonomously map and traverse complex terrains, supporting independent movement during gameplay. The autonomous driving capability ensures strategic positioning and movement, while an AI-powered targeting system leverages advanced algorithms to track and engage opponents with remarkable accuracy and responsiveness.


'A Star' navigation simulated output

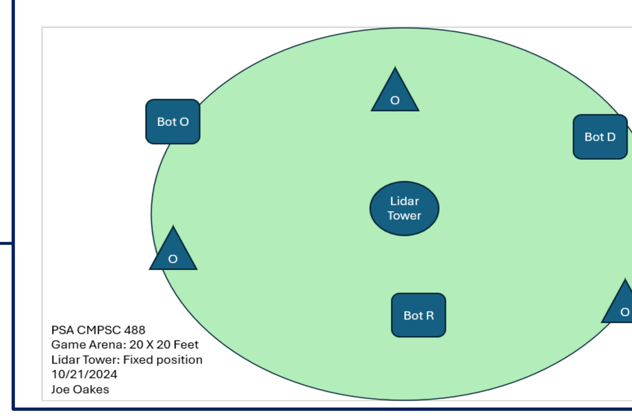

Kinect Depth Camera

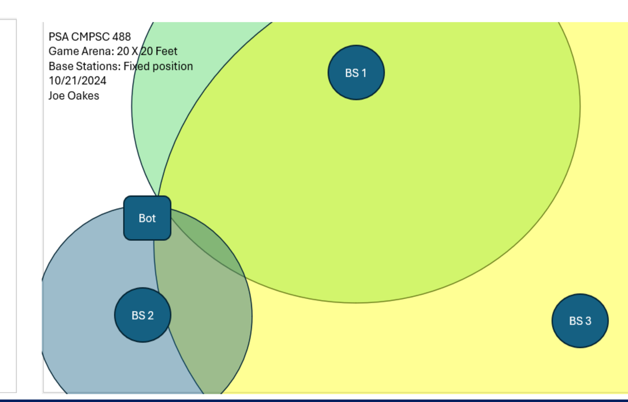

Lidar Mapping

Navigation

In developing an advanced navigation approach, the primary challenge was to design an algorithm capable of efficiently traversing the course while maximizing exploration and strategic movement. Each team's strategy focuses on creating a custom search algorithm that optimizes course navigation through two key objectives: discovering new areas and minimizing redundant exploration.

The navigation strategies are engineered to run multiple times during gameplay, enabling the robot to dynamically adapt its movement based on real-time environmental discoveries. This approach allows for continuous strategy refinement, particularly in response to unexpected encounters with enemy robots. The core purpose is to systematically expand the robot's field of view, ultimately enhancing target acquisition capabilities by ensuring comprehensive environmental awareness.



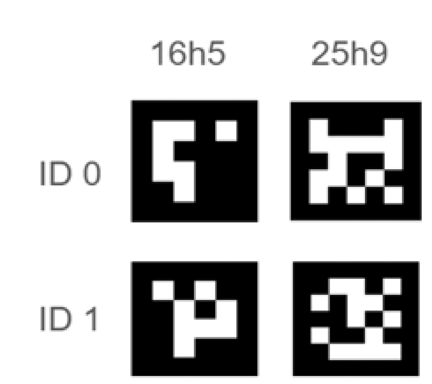


Object Detection

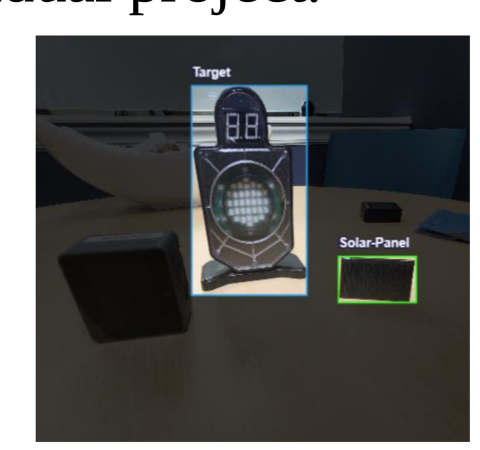
YOLOv5 (You Only Look Once, Version 5) is the latest iteration in the YOLO family of object detection models used for the Jetson Nano.

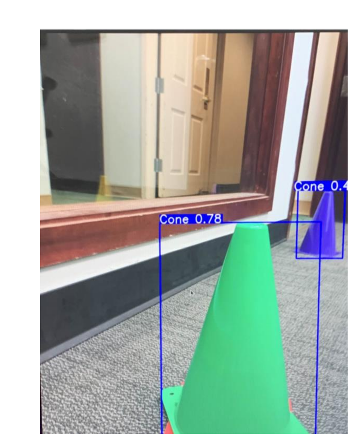
Workflow

- Input video or image frames.
- Process frames with a pre-trained YOLOv5 model.
- Outputs bounding boxes, class labels, and confidence scores.
- Ability to train custom dataset to detect object specific to individual project.



April Tag Code and Identifier Tags


Stationary Target and Solar Panel used for robot hit sensors


Cones identified using YOLOv5