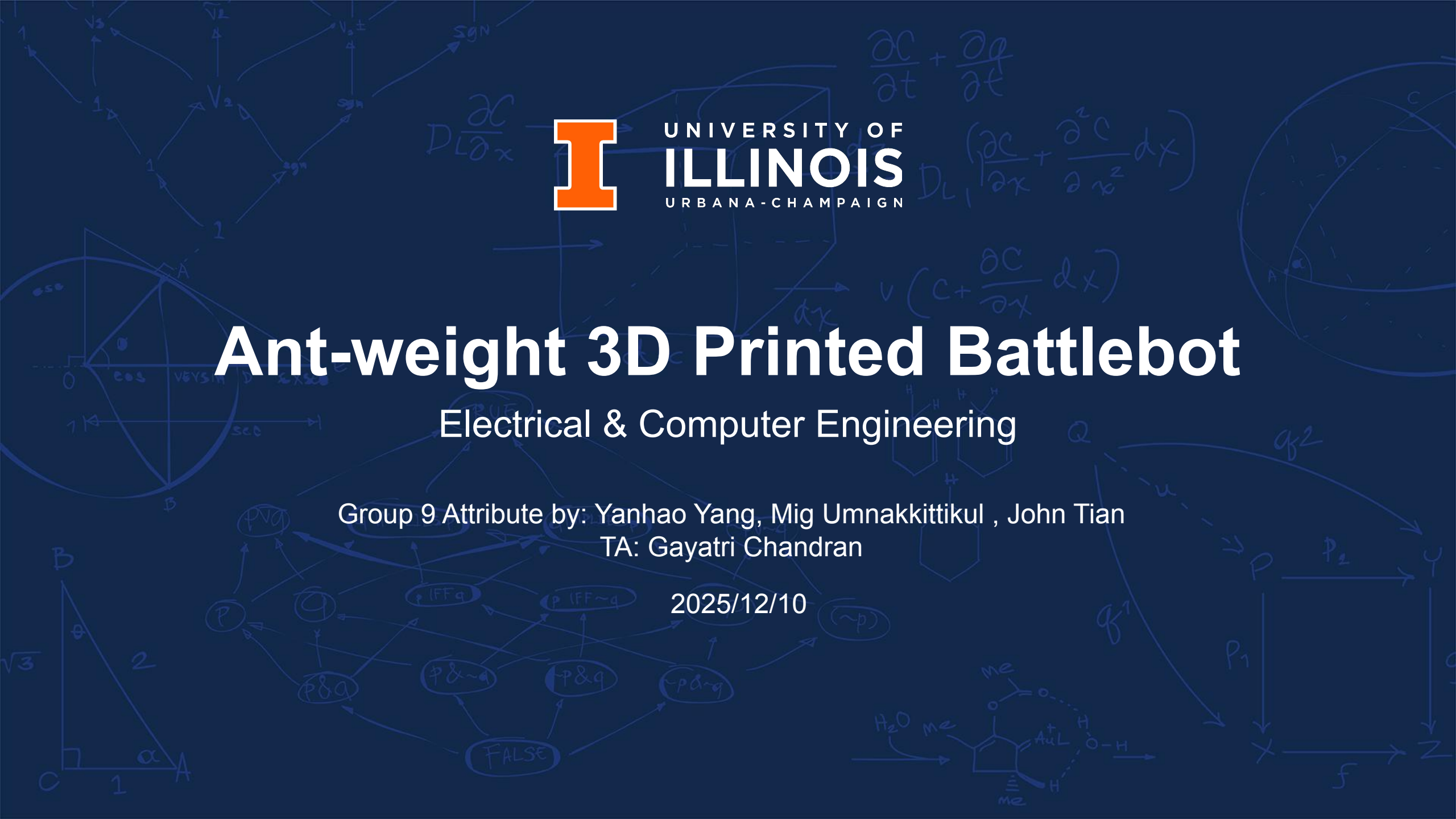

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Ant-weight 3D Printed Battlebot

Electrical & Computer Engineering

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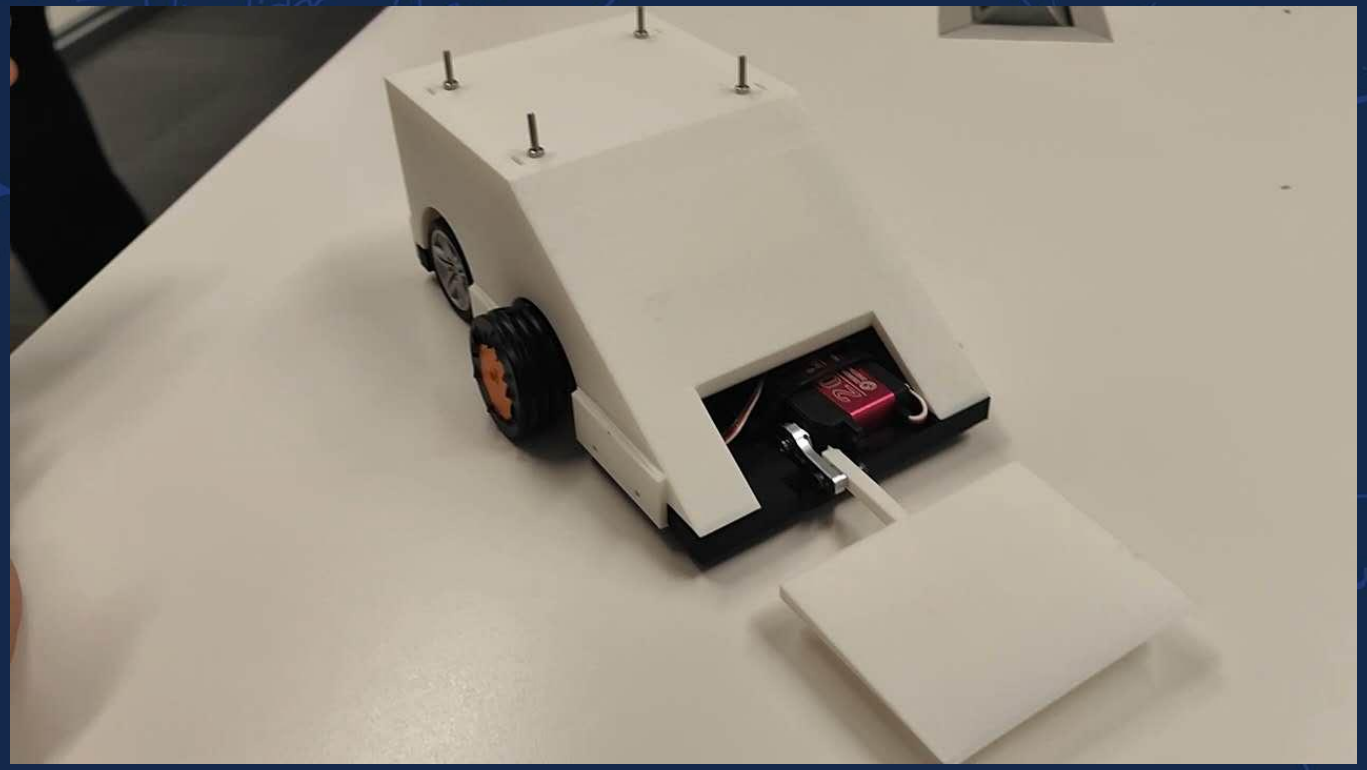
What problems are we working on?

A competition was organized for 3D-printed Antweight BattleBots. All designs had to meet specific constraints—such as a maximum weight of 2 pounds, a fully 3D-printed chassis, and 2-minute battle rounds. The main objective was to build a robot capable of outlasting or defeating opponents with varying designs.

Problem List:

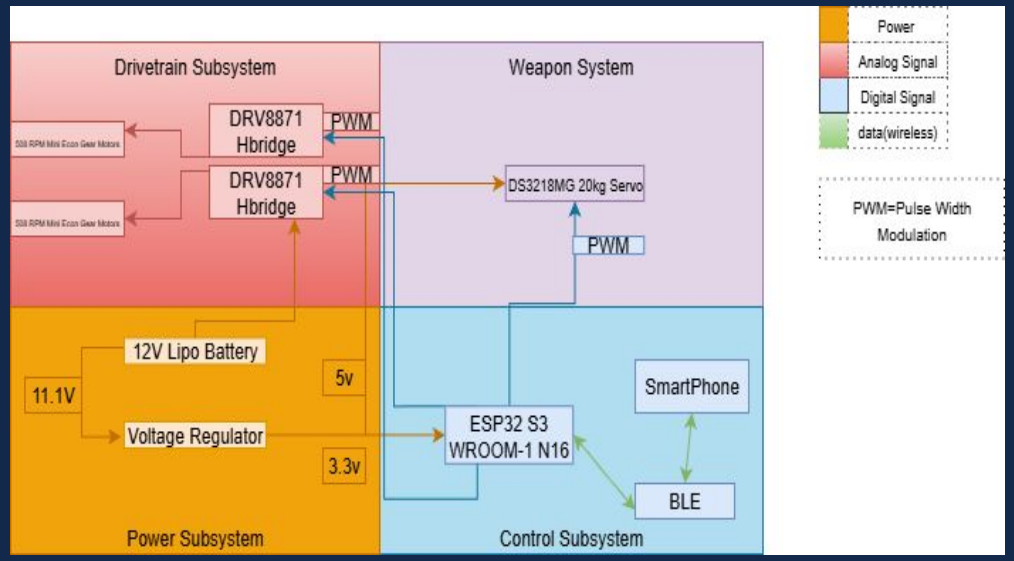
- Building an durable, stubborn battlebot within 2 pounds limit
- Design and solder our pcb that includes Microprocessor, voltage regulators, and H-bridge
- Use a shovel weapon to lift up and demobilize our competitors
- Bluetooth control over the battlebot



A Glimpse on our final battlebot!

Battle Stats: Win: 2, Lost: 1

Our Design Approach



ESP32-S3 Microprocessor:

- Inherited BLE module: Energy saving while responsive

PLA Material in 3D printing:

- Good Surface quality, lightweight and easy to print

Shovel Weapon:

- Tested and ensured to lift up 2 lbs of objects at the tip of shovel

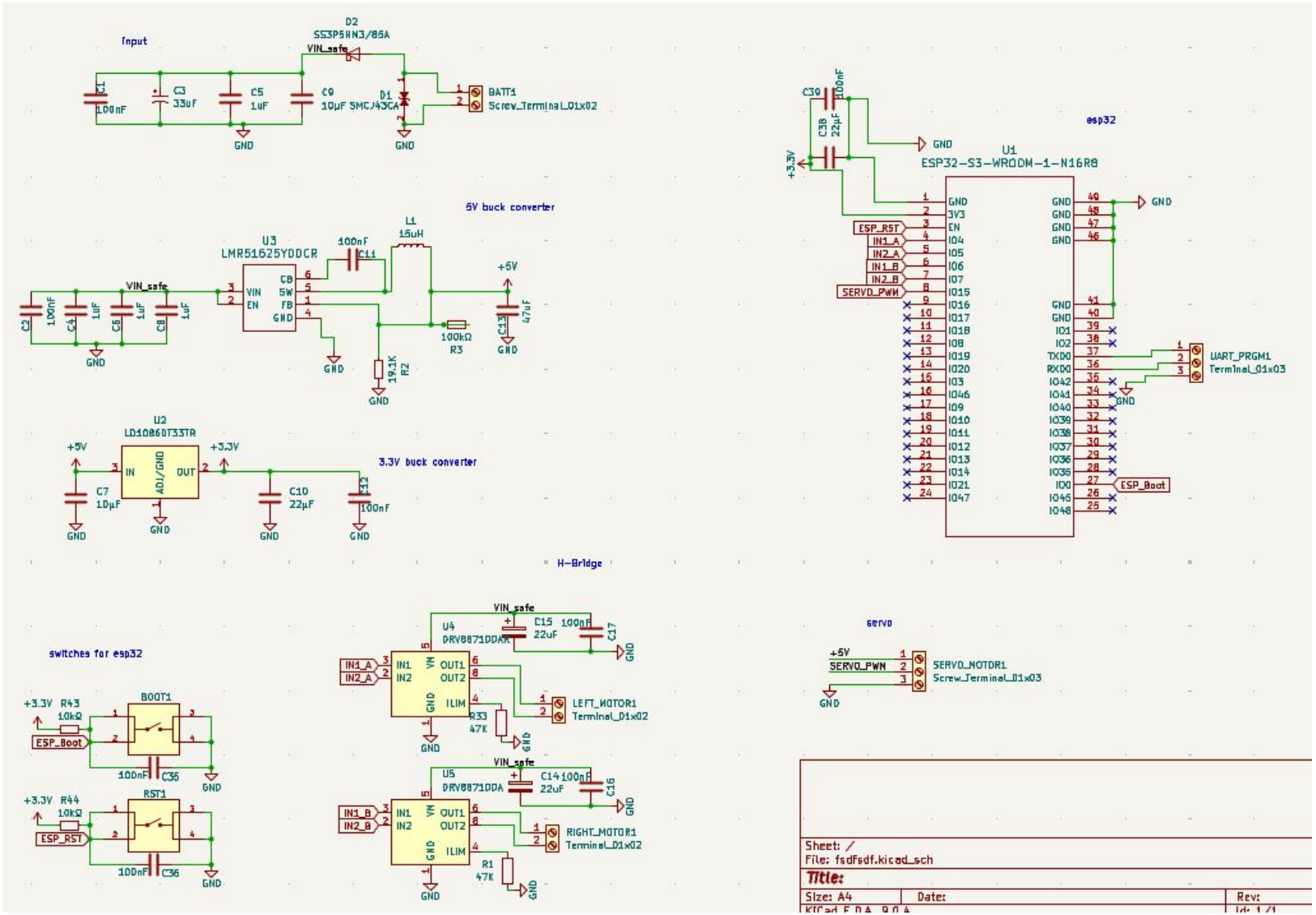
Buck Converters:

- One Converter that converts 12V into 3.3V for ESP32-S3
- One Converter that converts 12V into 5V for Servo Motor

H-Bridges:

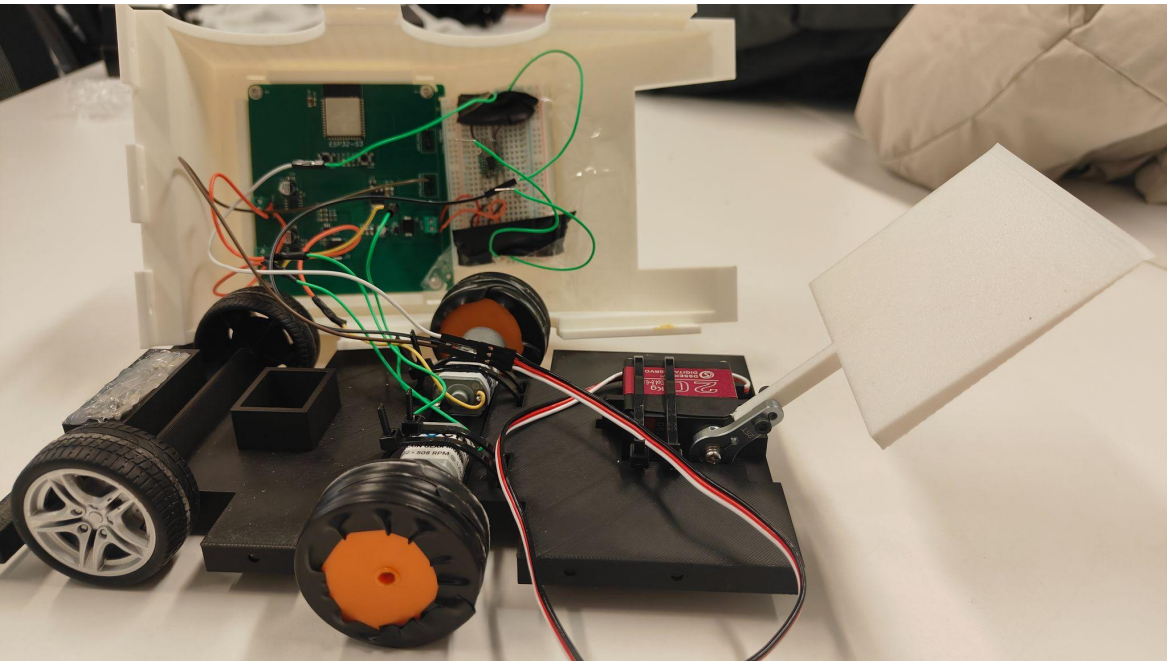
- Output for motor speed and direction control

Our Final Schematics Used For Our PCB

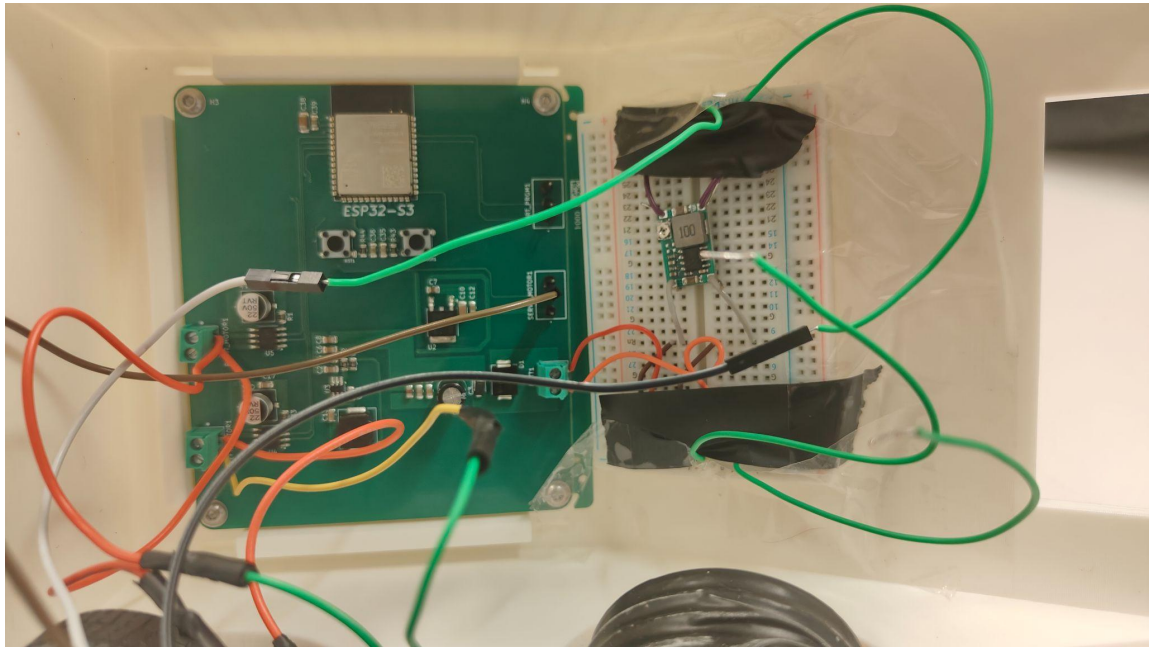


What’s inside our Battle Bot

Internal Connections and chassis

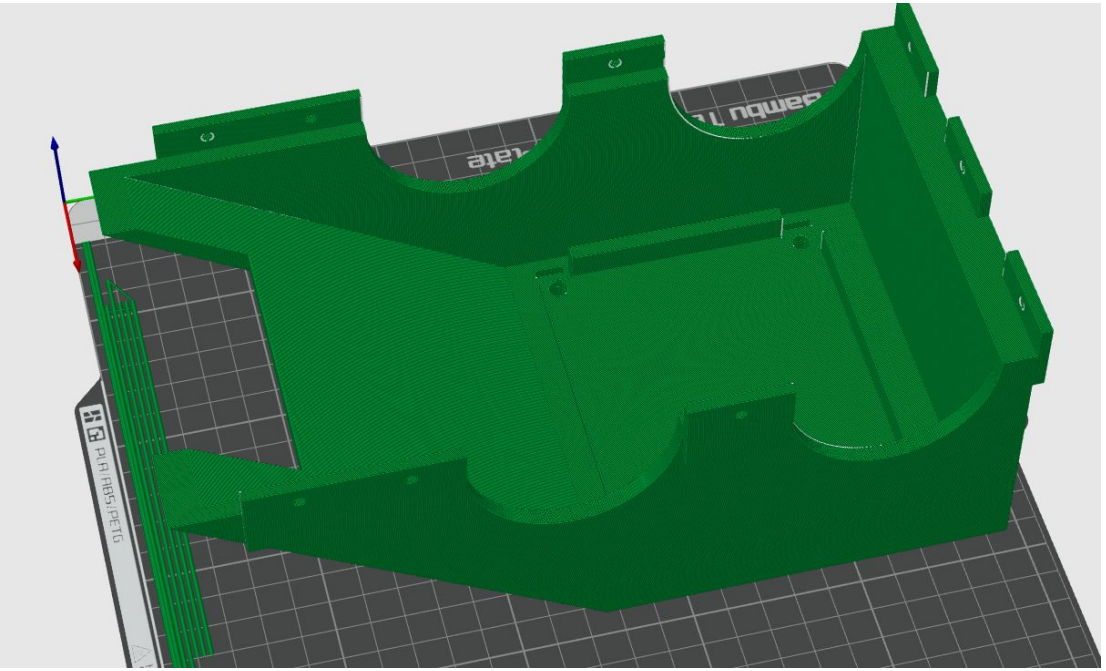


PCB and BreadBoard

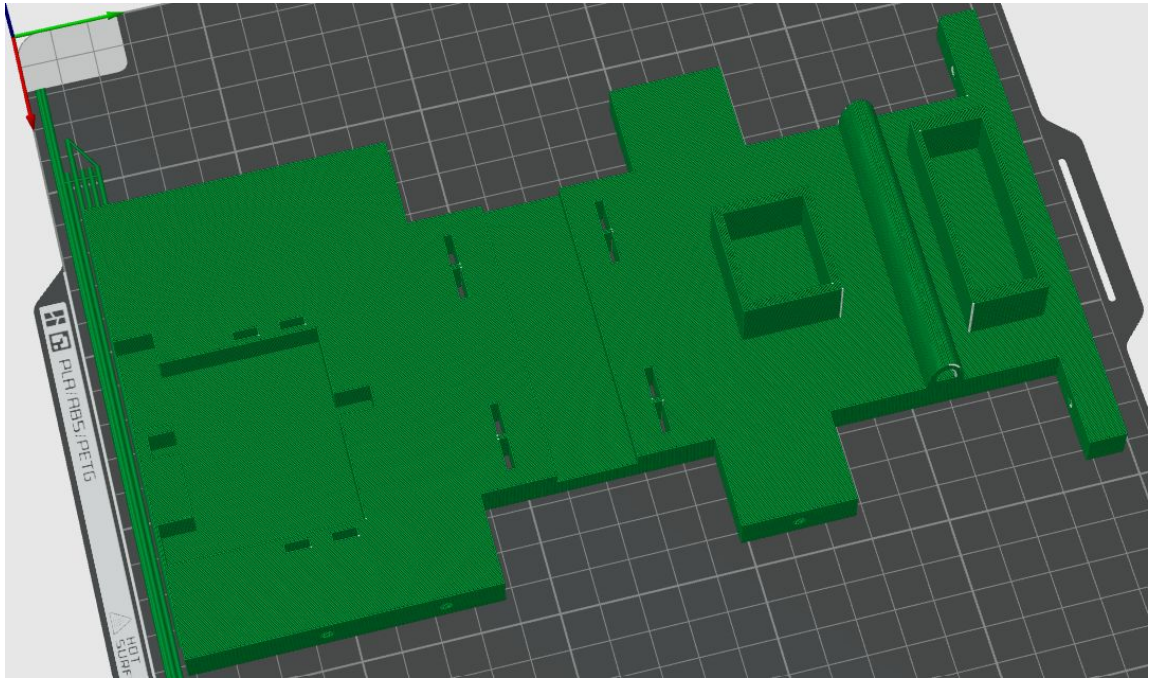


Final 3D printing structure

Outer chassis



Bottom Plate

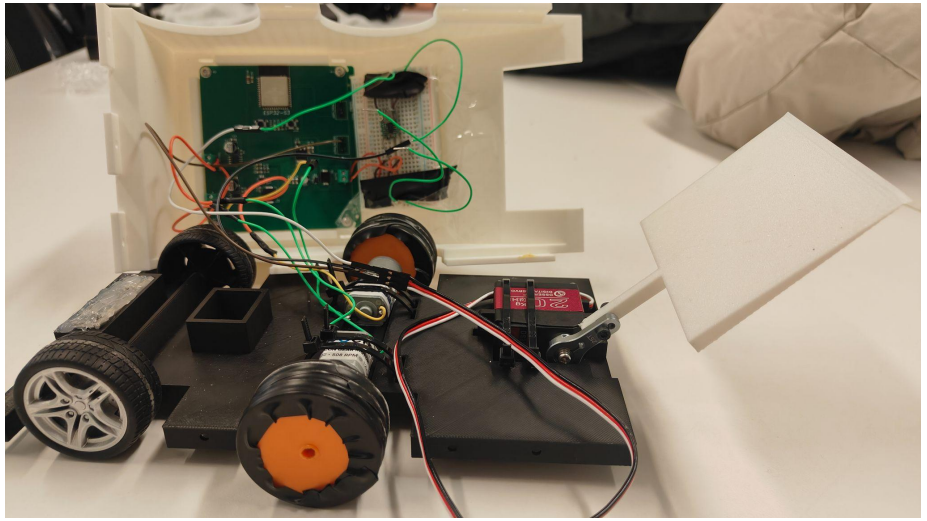


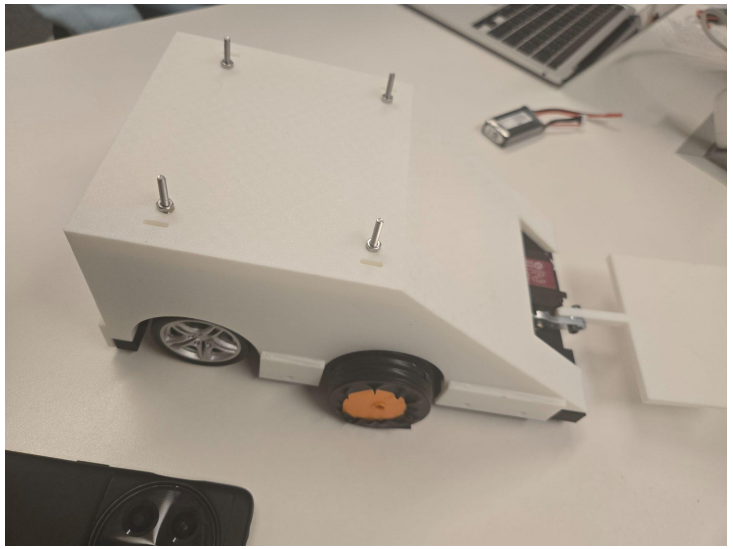
High Level Requirement

1. Performance requirement: The lifting wedge must be able to lift a 1 lbs load to around 30° within 2 seconds and return to the starting position within seconds.

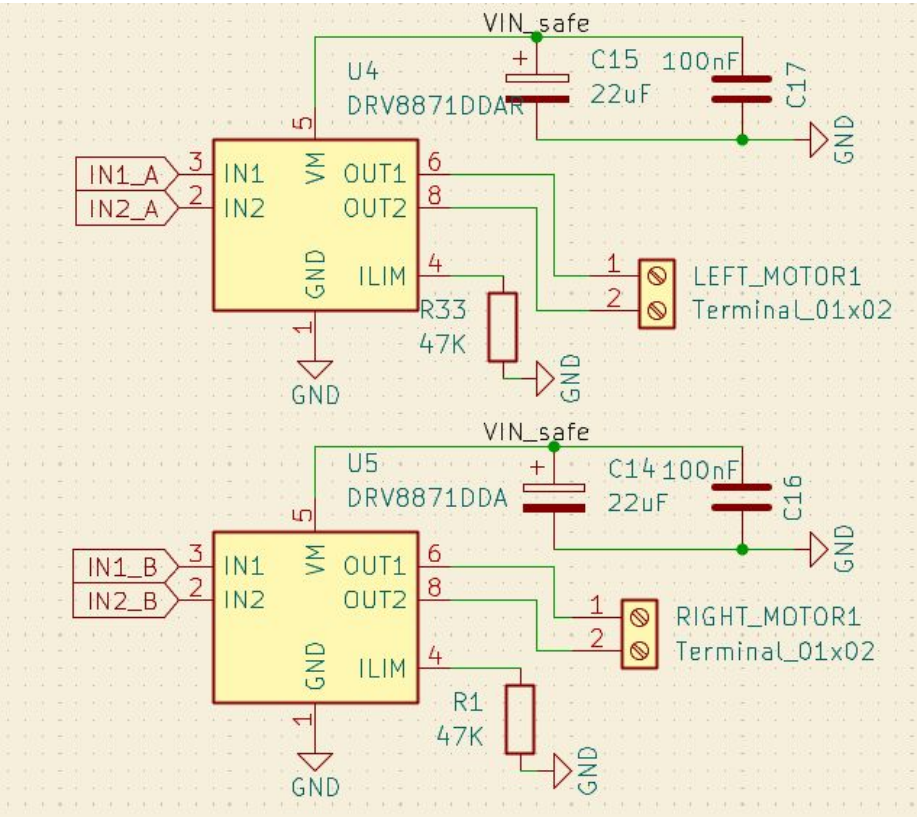
2. Control requirement:
The control system must process commands and actuate movement/weapon within 300 ms of the remote command and maintain stable wireless communication over at least 5 meters without signal loss.

3. Mobility requirement:
The drivetrain must move the bot at a minimum forward speed of 20 cm/s on a flat surface and produce at enough power to move around for the entirety of 2 minute battle time





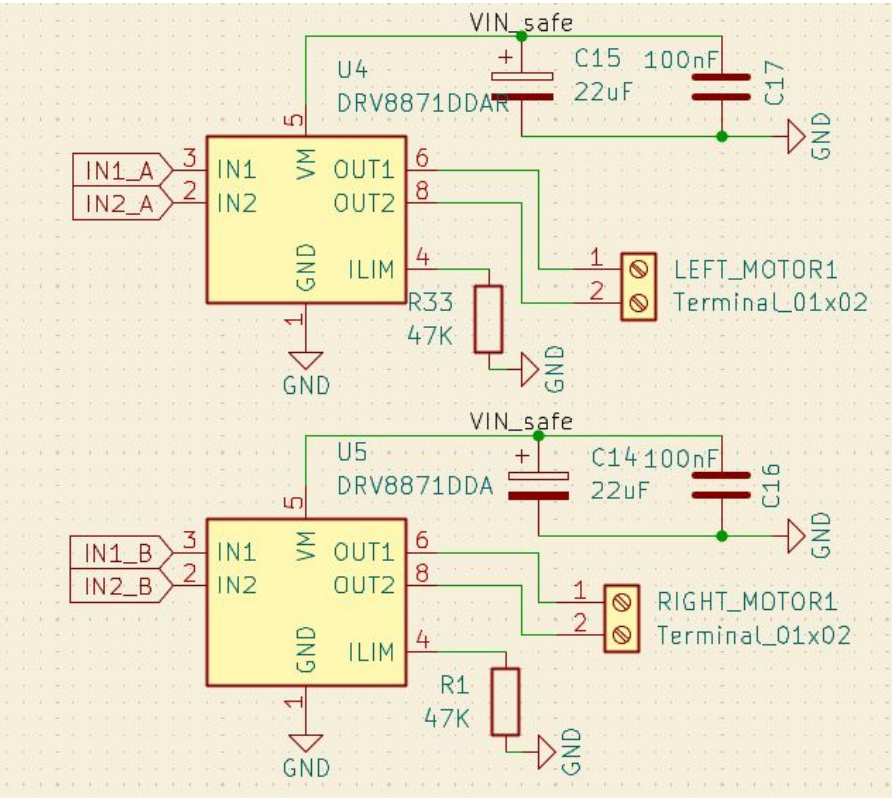
Drivetrain Subsystem



The drivetrain subsystem is responsible for the maneuvering of our bot.

- Converts energy from the 12 V battery into mechanical motion at the wheels
- Utilizes two 508 RPM Mini Econ Gear Motors (ServoCity), each driving one wheel
- Operating them from a 12 V supply corresponds to an approximate wheel speed of 450 RPM
- Top linear velocity of around 0.2 m/s for 2.25” wheels.

Drivetrain Subsystem Requirements

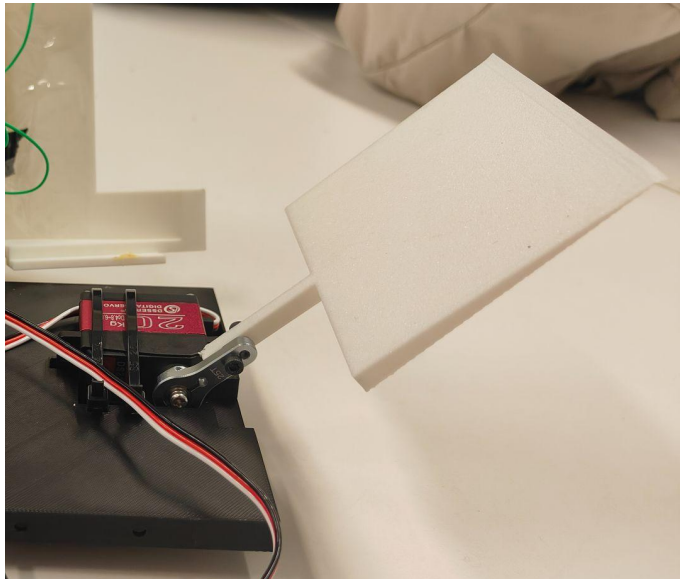


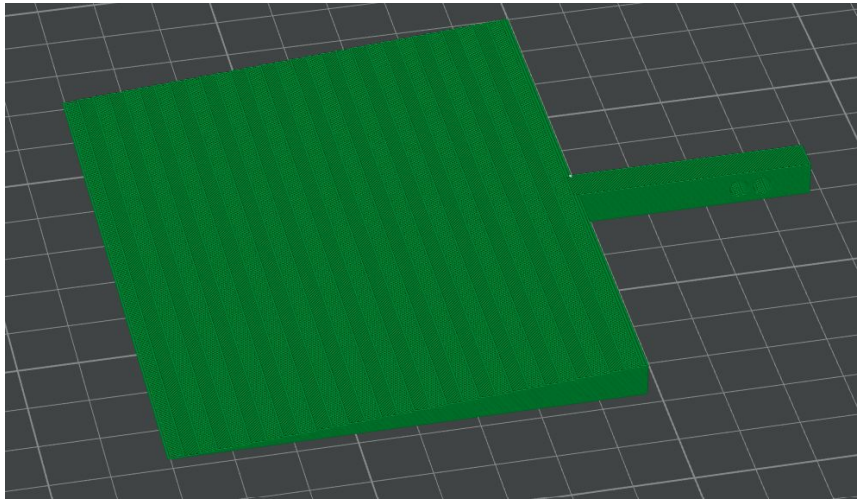
Requirement	Verification
Robot is able to move forward and backward	Visual check
The linear speed of the bot has to reach 20 cm/s speed	Record distance traveled and time it took
Robot is able to turn left and right	Visual check (left and right motor move in opposite direction when turning)

Weapon Subsystem

The weapon subsystem is our attack mechanism.

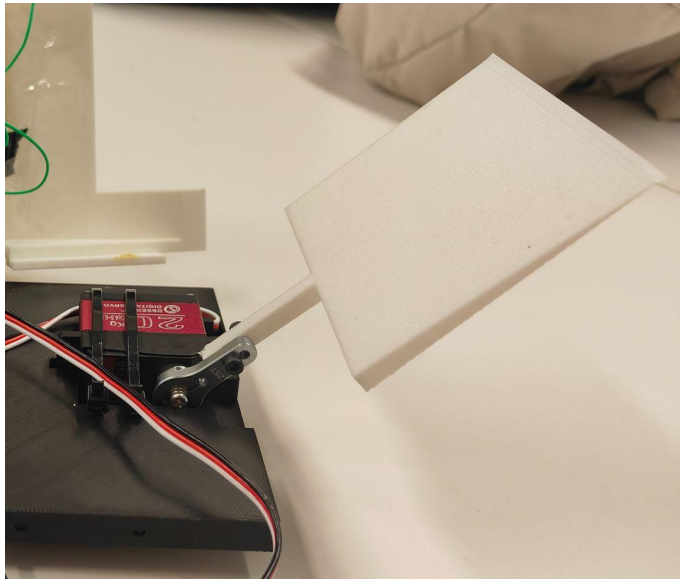
- High Torque Waterproof Metal Gear Digital Servo (20KG, 270°) operating at 5V
- Shovel arm length of around 14 cm.
- Output torque of approximately 20 kg·cm (1.96 N·m)

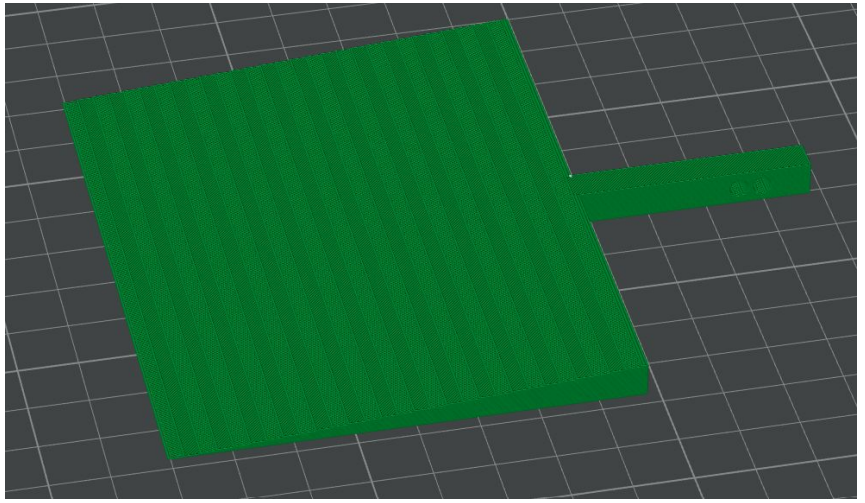




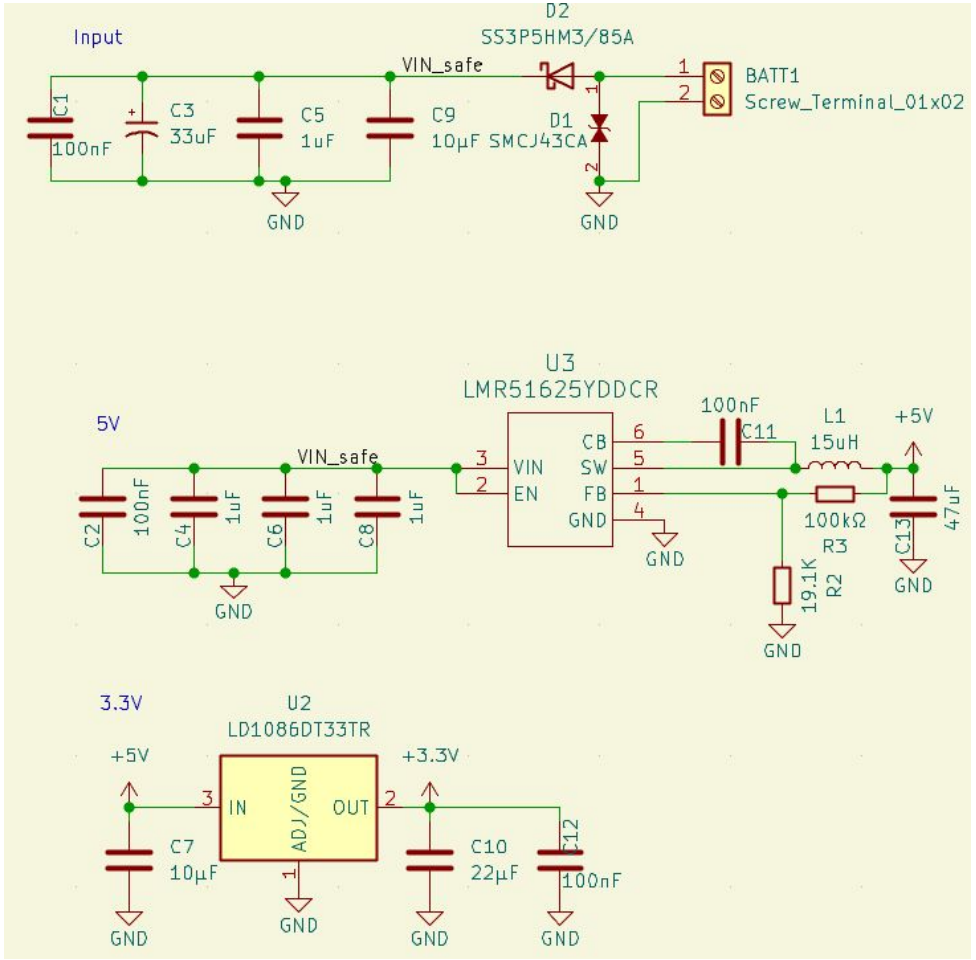
Weapon Subsystem Requirements

Requirement	Verification
The shovel is able to lift 1 lb	Check height above the ground for 5 cm
The shovel should be activated by the control system and reach the destination position in 3s	Measure using timer





Power Subsystem

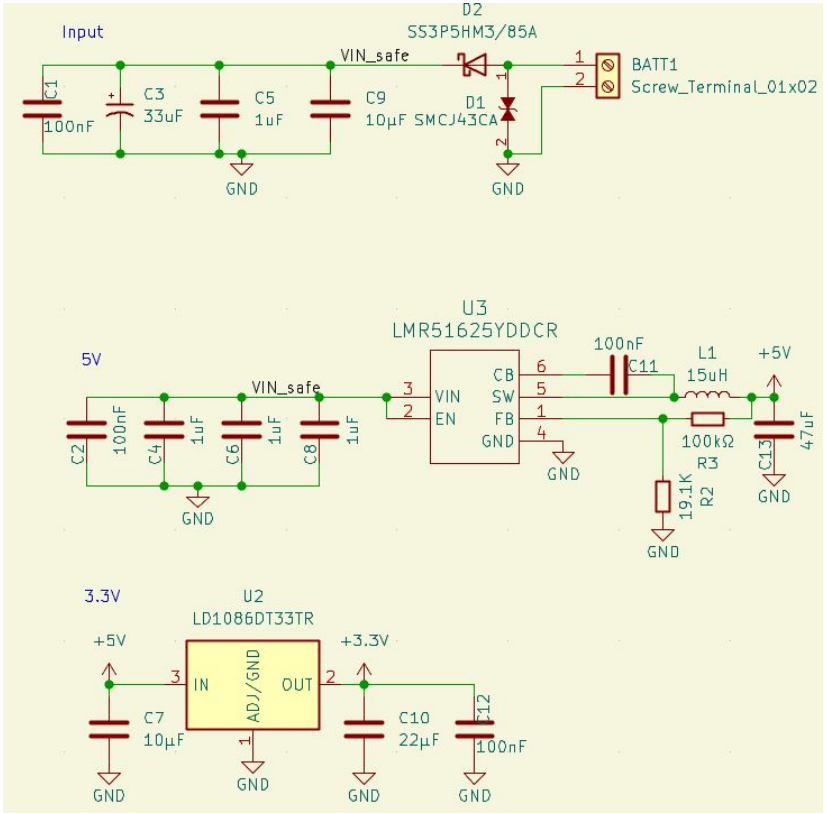


The power subsystem is responsible for supplying sufficient power to all other components.

- Supplying the necessary voltage for the other subsystems
- LiPo batteries: 3S, 12 V, 450 mAh with a continuous discharge rate of 80C(Turnigy Nano-Tech Plus)

- Utilizes 2 buck converters
- 12 V to 3.3 V for ESP32 power input
- 12 V to 5V to supply the servo motor for the weapon subsystem.

Power Subsystem Requirements

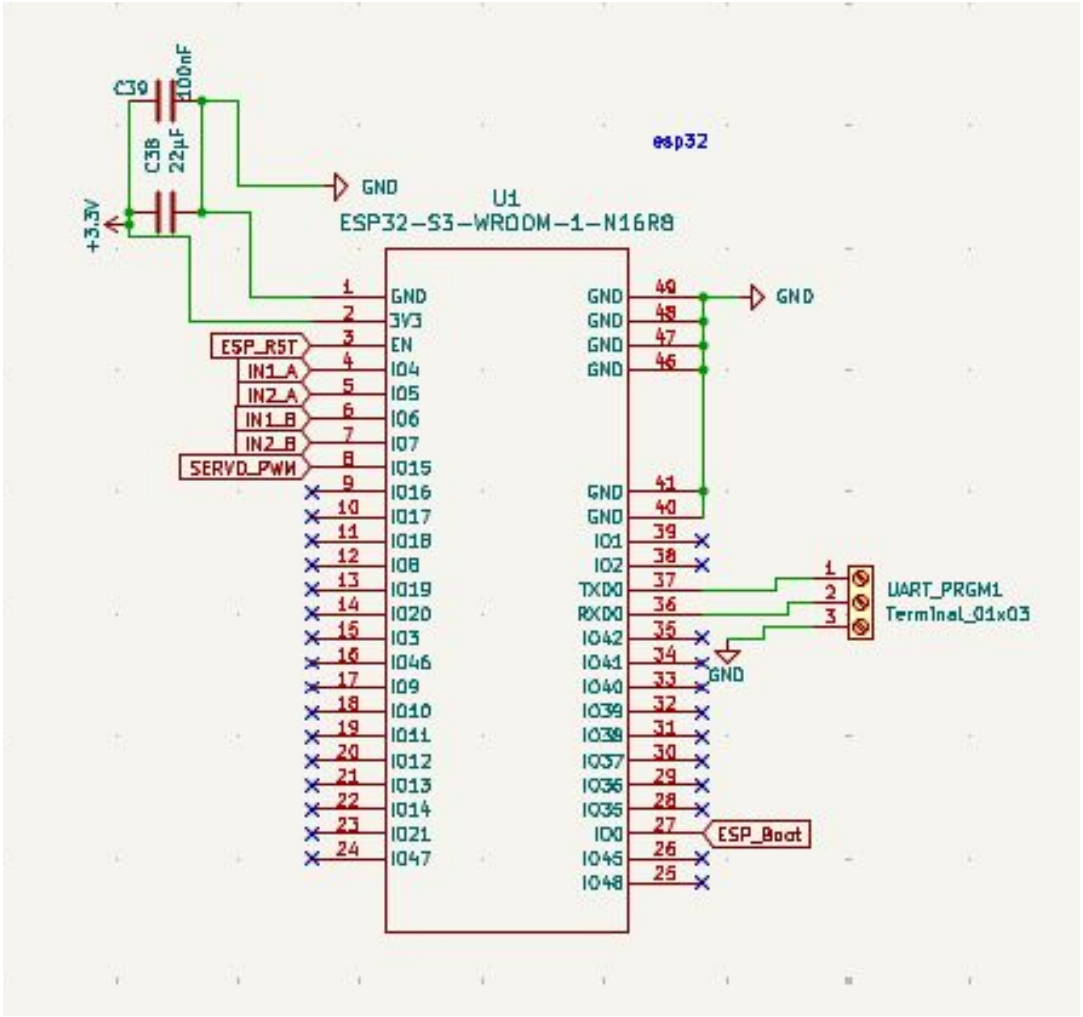


Requirement	Verification
The battery has to last for at least 2 mins	Timer to measure whether the robot can function for the entirety of 2 min battle time
12 V supplying H-bridge	Voltmeter to check each output of the buck converter
3.3 V supplying ESP32	
5 V supplying the servo	

Control Subsystem

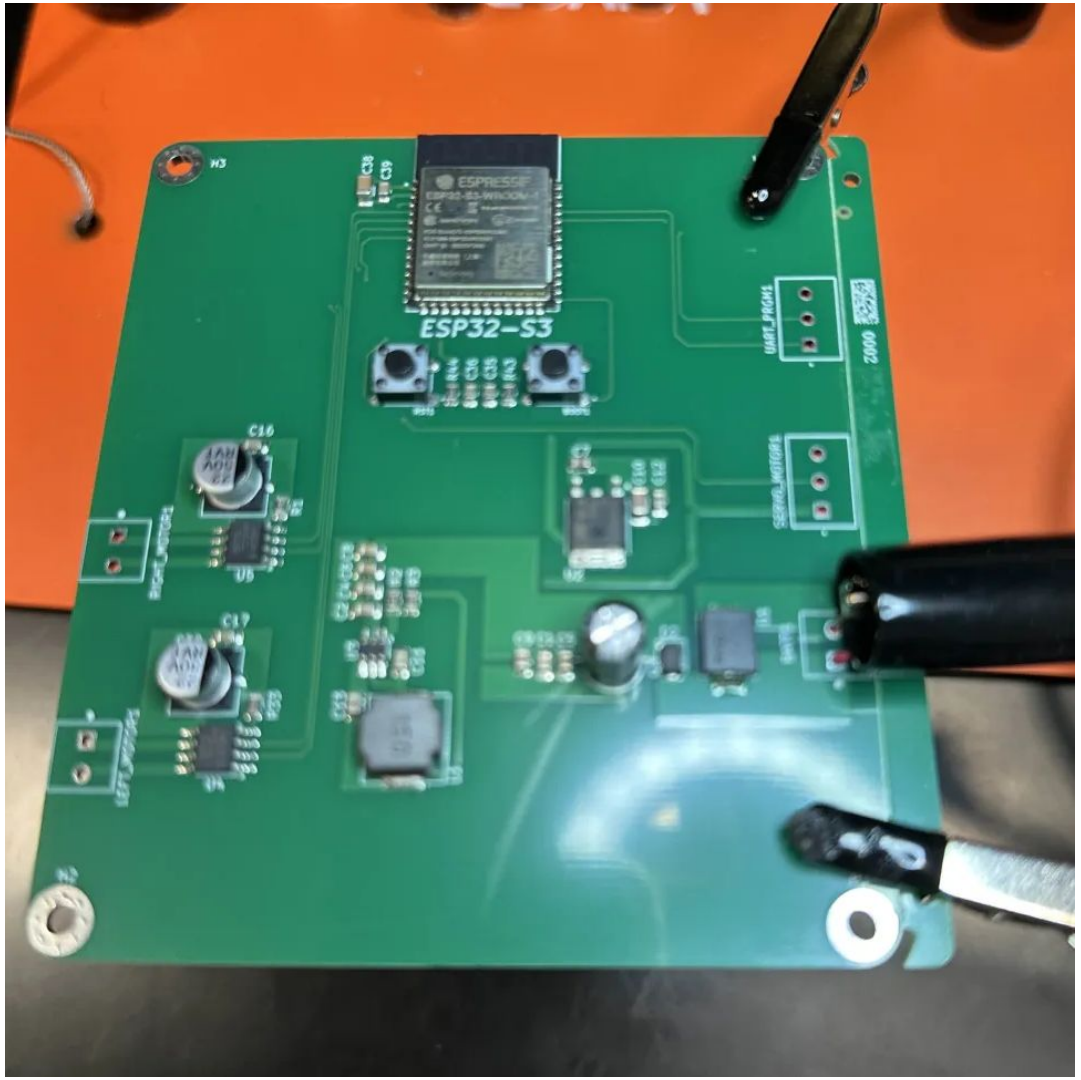
ESP32-S3 microcontroller serves as the battlebot's brain.

- Uses dual-core processor that handles motor control and wireless communication (Bluetooth Low-Energy) simultaneously for responsive operation
- Generates control signals to drive the wheels for movement and operate the weapon servo for lifting opponents
- Lightweight, integrated solution meets all mobility, performance, and control requirements while offering superior size and cost efficiency compared to alternative platforms



Control Subsystem Requirements

Requirement	Verification
Command latency of at most 300 ms	Filming video of controlling the battlebot and used to video frames to calculate latency
Maintain control of robot by controlling from a distance	Being able to control the battlebot standing at least 5 meters away with tables and benches as obstacles



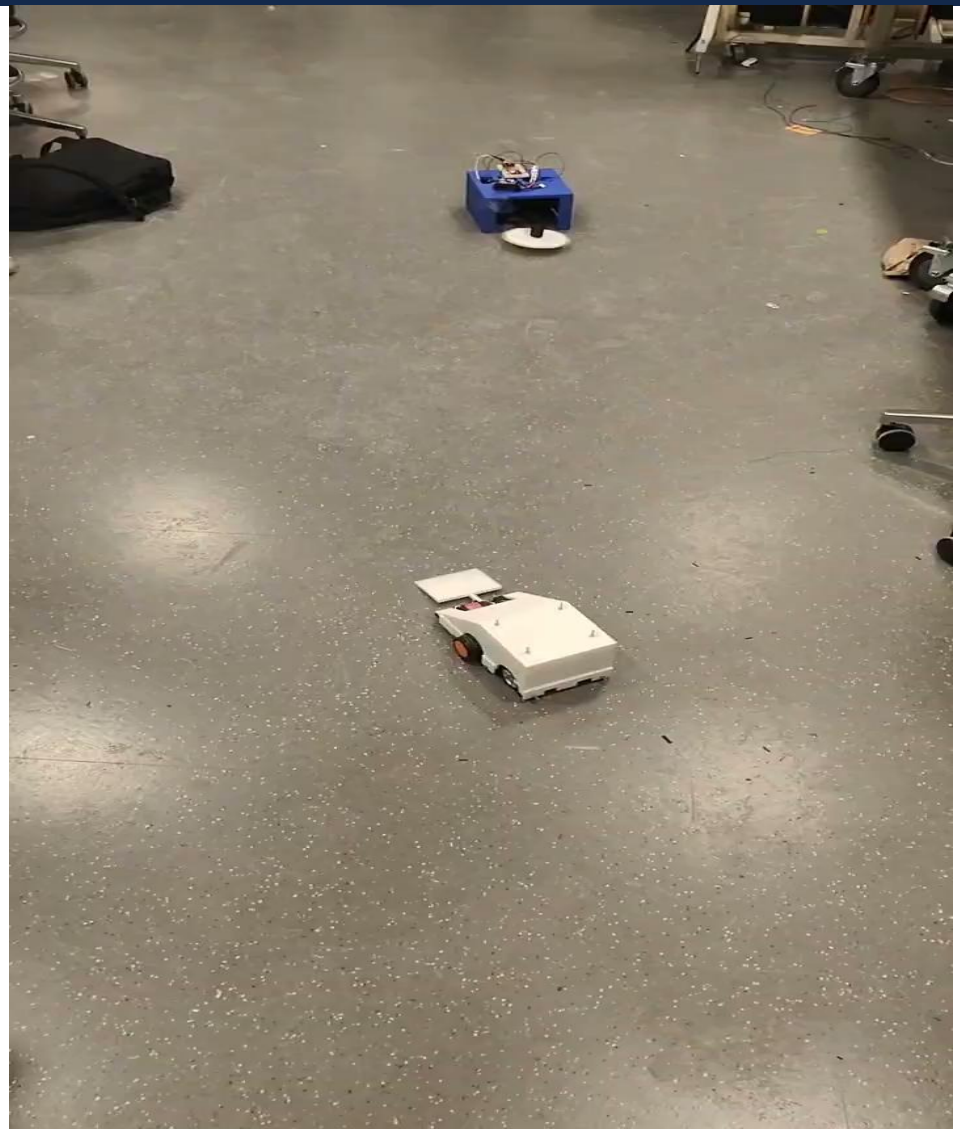
Tolerance Analysis Calculations

Peak Current Draw Calculations:
ESP32 peak current : 0.8 A
Rear drive motors: 2 × 4.3 A = 8.6 A
Weapon motor peak: 5.2 A
Ipeak=0.8A+8.6A+5.2A=14.6A

Battery Continuous current capability:450mah*80C= **31.5A >14.6 A**
Battery runtime = 450mah*3600s/h /**14.6A=110.959s**

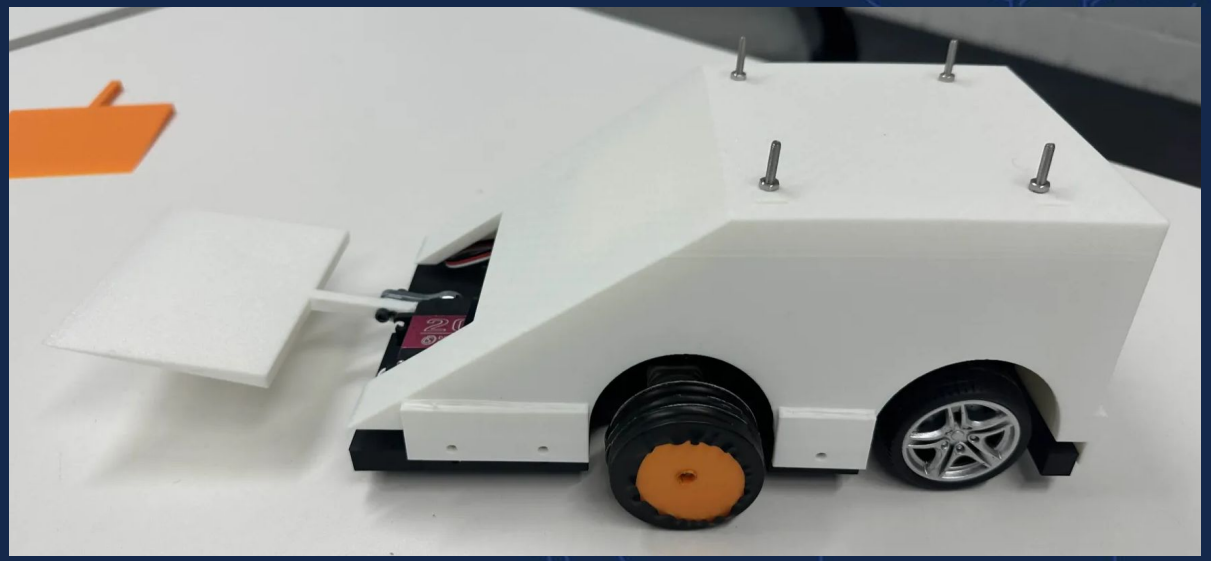
So battery continuous current capability can handle peak current draw easily, and even we assume all part are working at peak current, the battery can stand 1m51s

Some Highlights

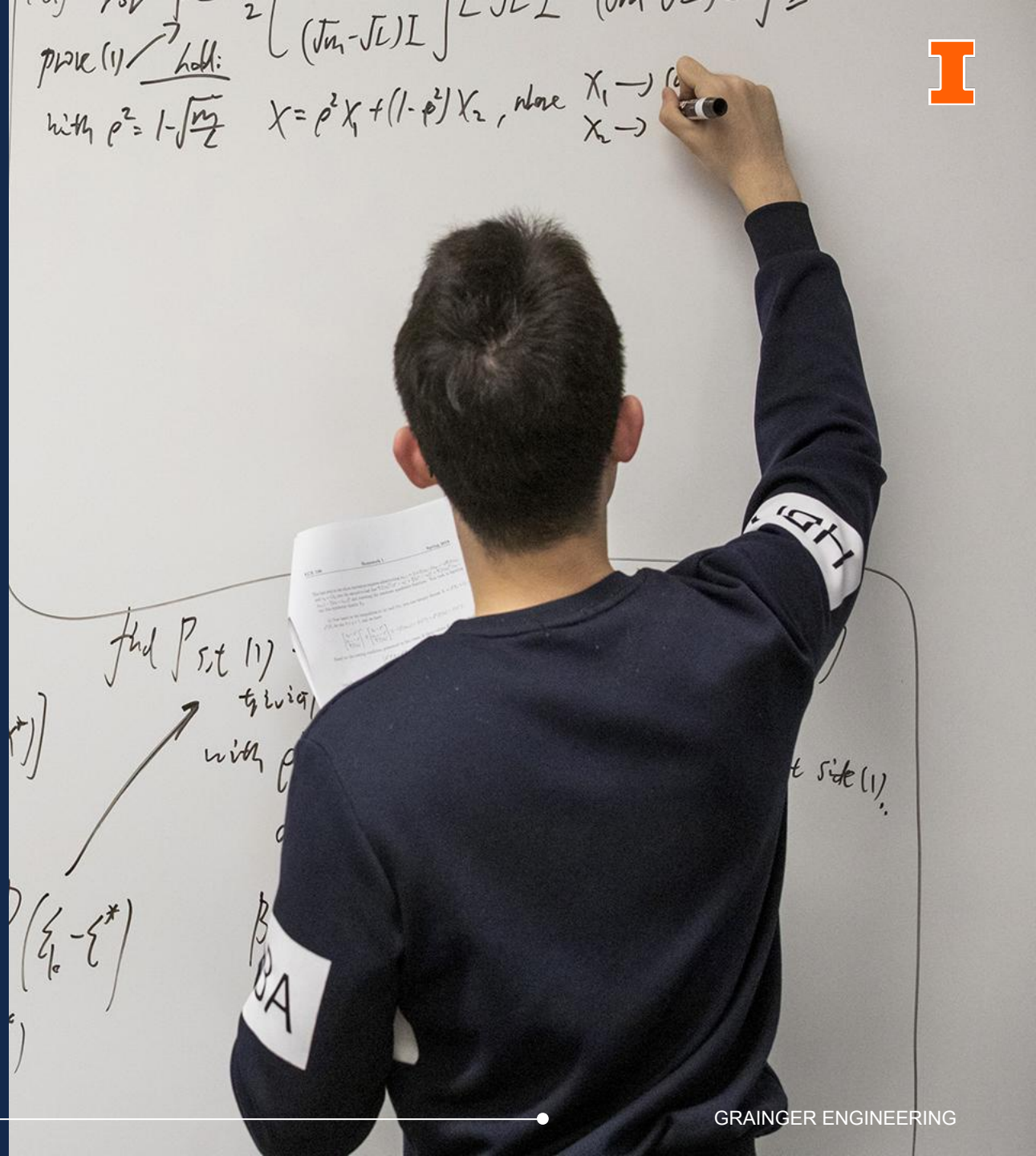


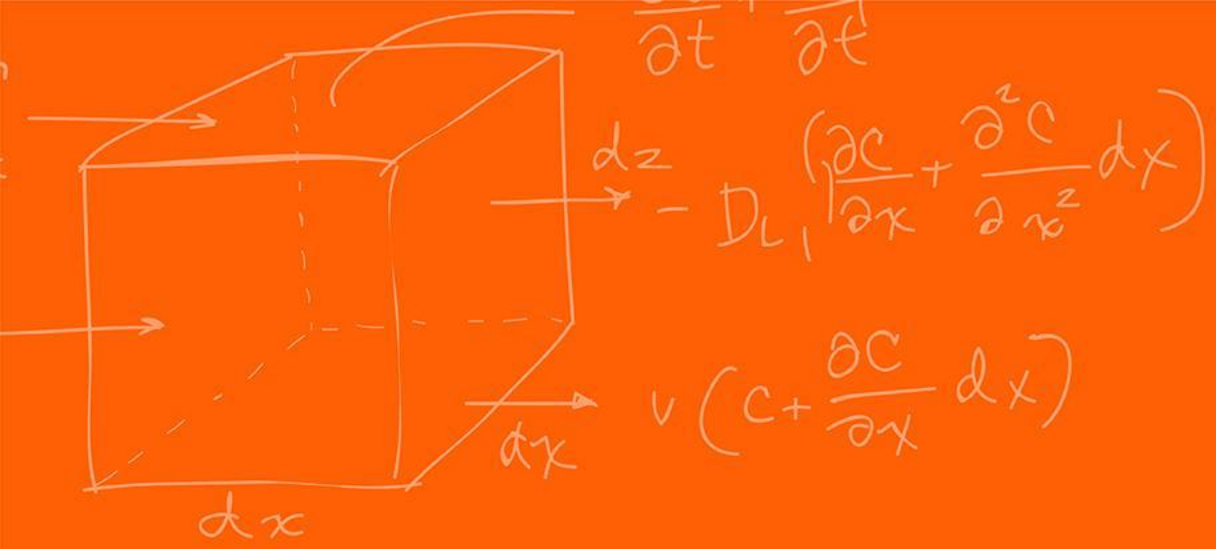
Conclusion

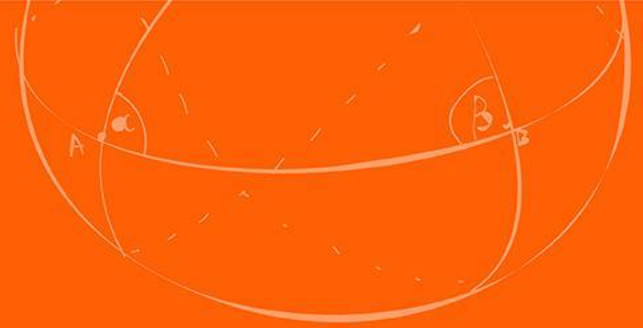
- We Successfully built a Bluetooth-controlled Antweight Battlebot with a shovel, servo-controller weapon, drivetrain motors, and 3D-printed wheels.
- We successfully combined the drivetrain, power, servo shovel weapon, 3D-printed chassis, and control system into fully functional robot under the 2 lb weight requirements and can last for 2 minutes minimum in real battle.
- In the future, we can redesign the chassis to be more protective and add more functionality to the battlebot such as power management and different modes of operation.

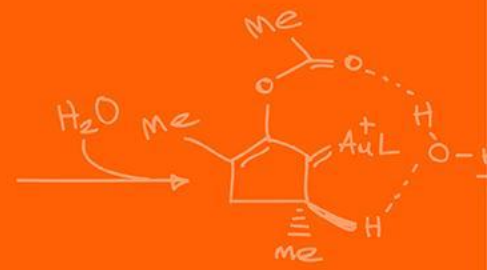


Thank you for listening









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