UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

ECE 445: Antweight Battlebot

Electrical & Computer Engineering

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Group 15

Problem

- Create an Antweight BattleBot for Professor Gruev's competition.
- This competition has several requirements that conditioned our project design.

Requirements

Antweight BattleBot

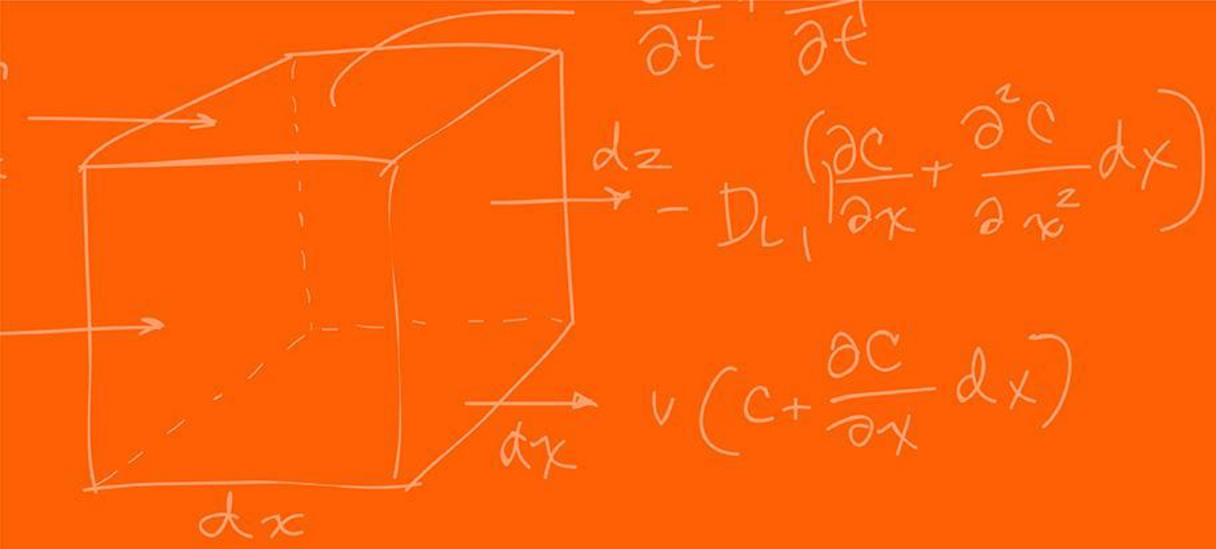
- Safety features like voltage limit and weapon time to stop
- Manual disconnect for batteries
- A 3D printed chassis and weapon
- Controlled via wireless connection
- A 2 pound weight limit
- A Custom PCB

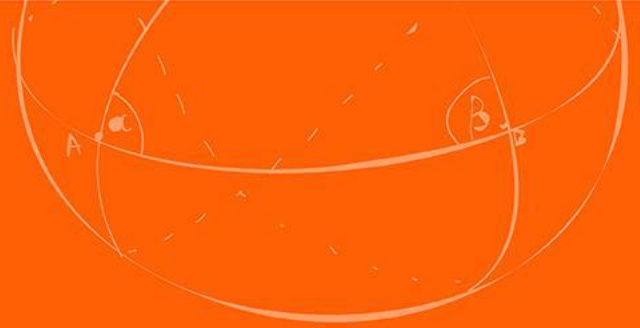
High Level Requirements

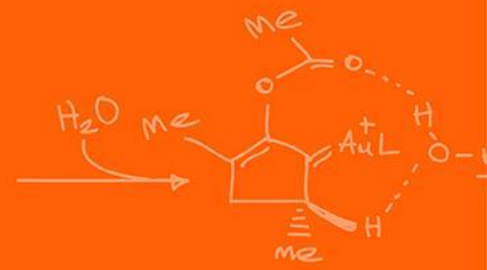
Total Car Weight Under 2 Lbs

Wifi connection between -50 dBm to -60 dBm

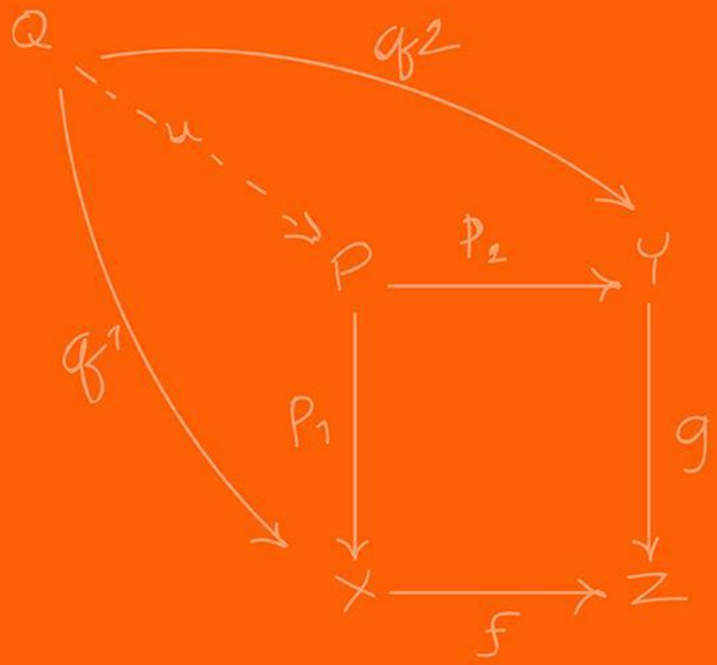
- Velocity of 4.5 feet/s
- Wheel Rpm of 900 revolutions per minute
- Independent wheel movement



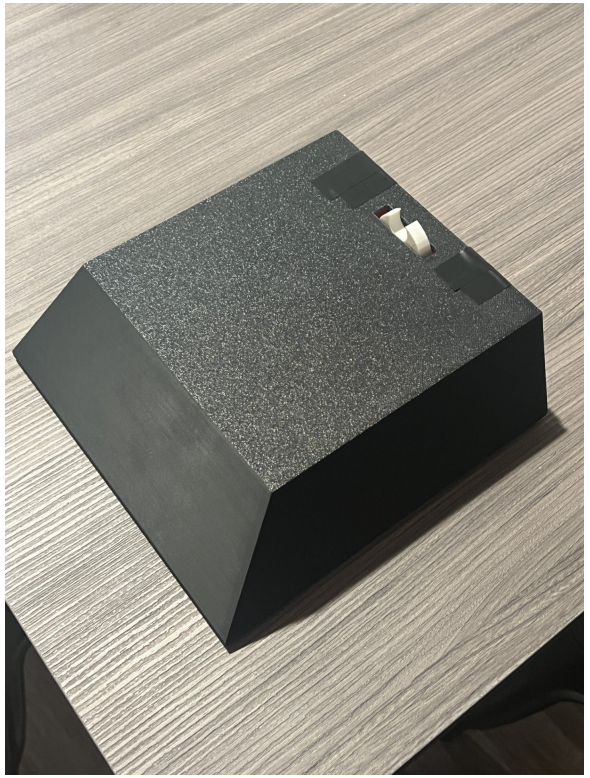


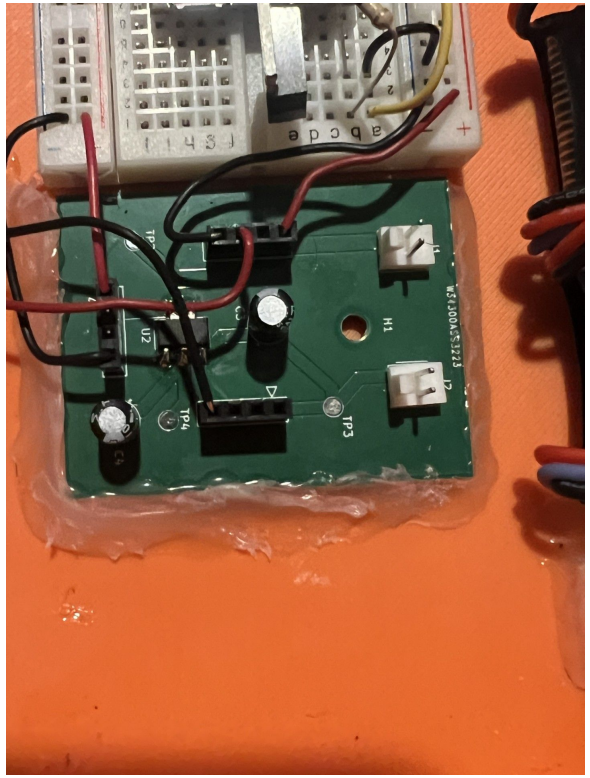


Solution

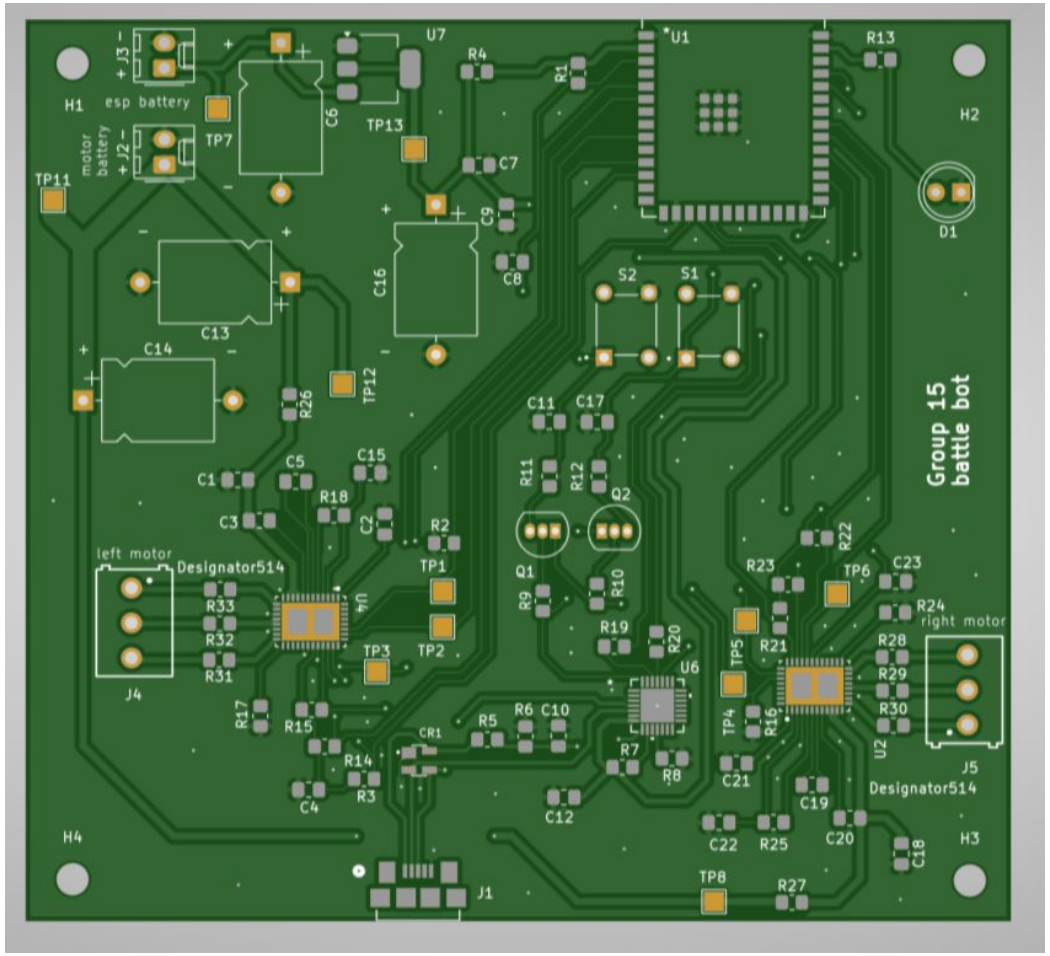


Solution



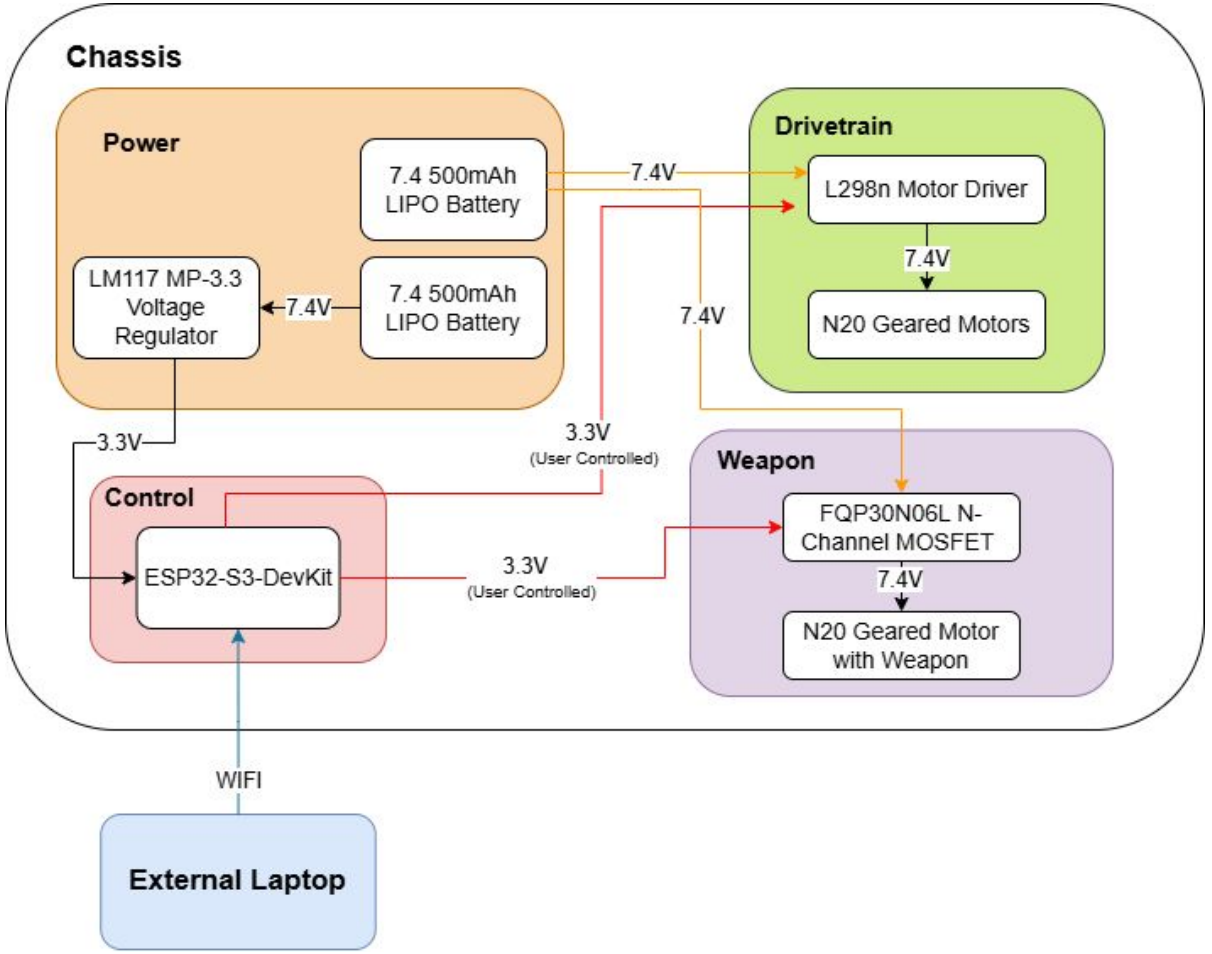


Original Design



5 main subsystems: Control, Drivetrain, Power, Chassis, Weapon

Final Subsystems Flowchart



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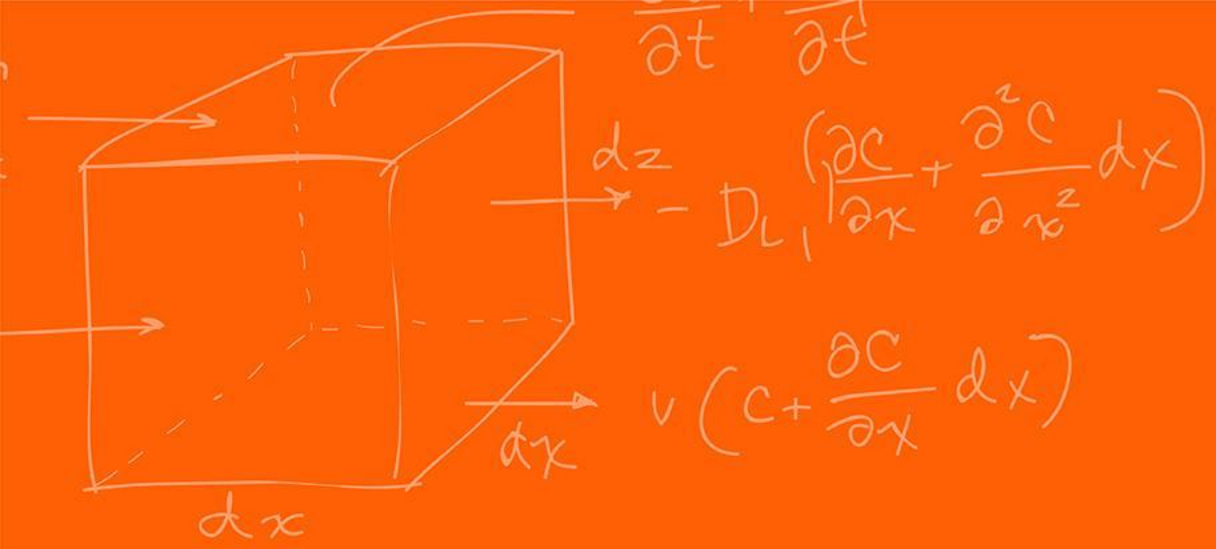
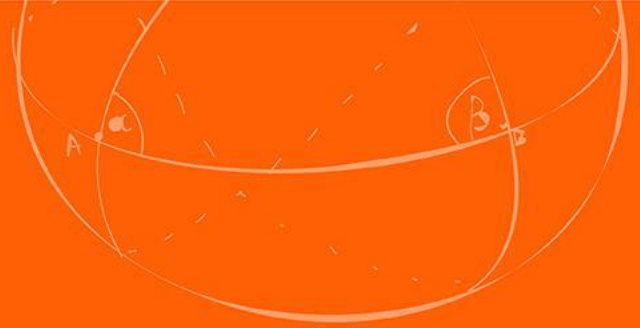
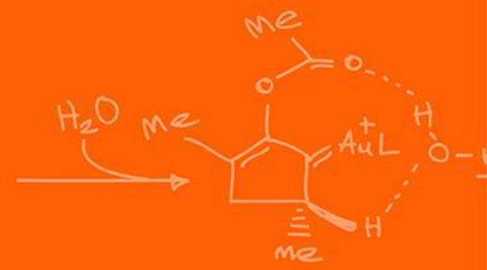
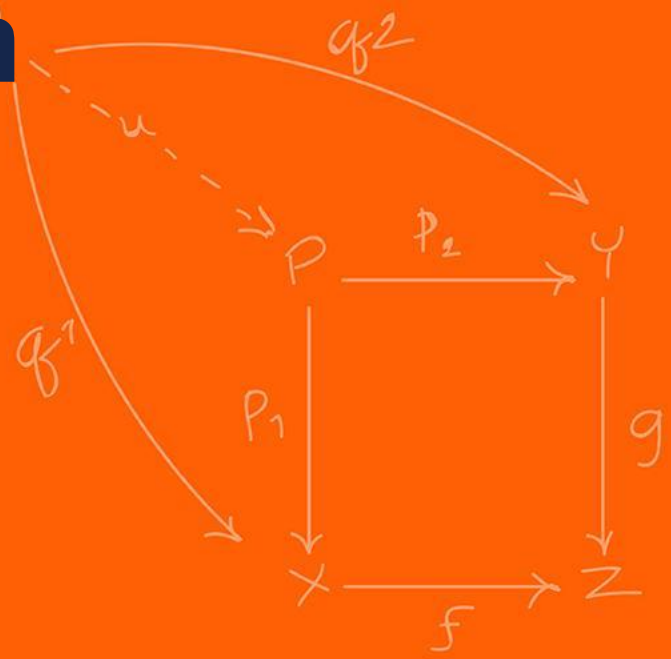






Control Subsystem



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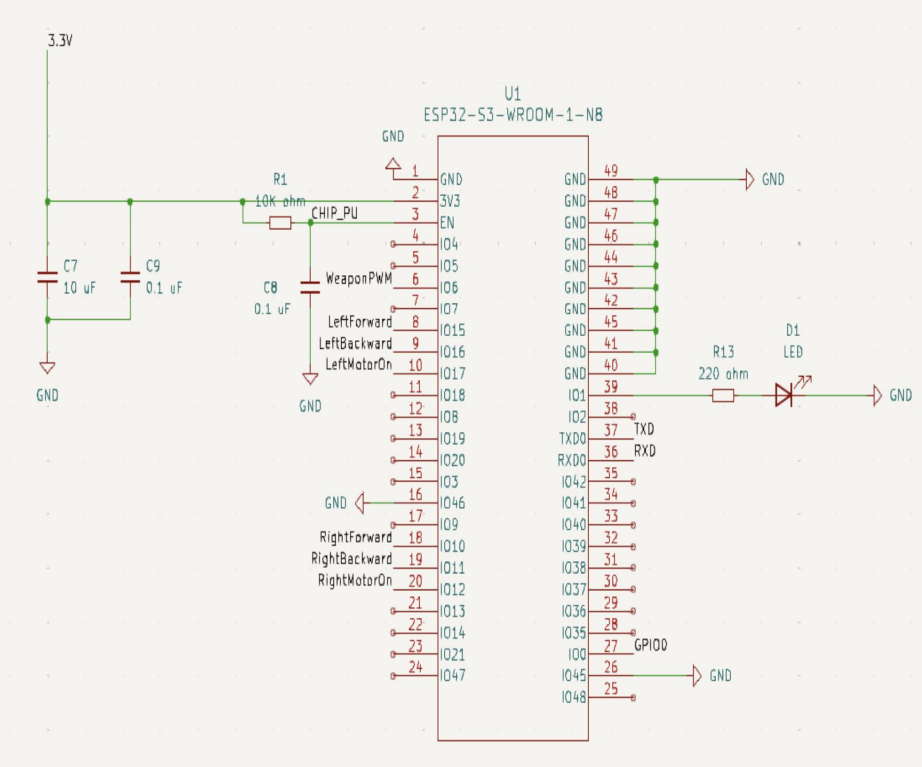


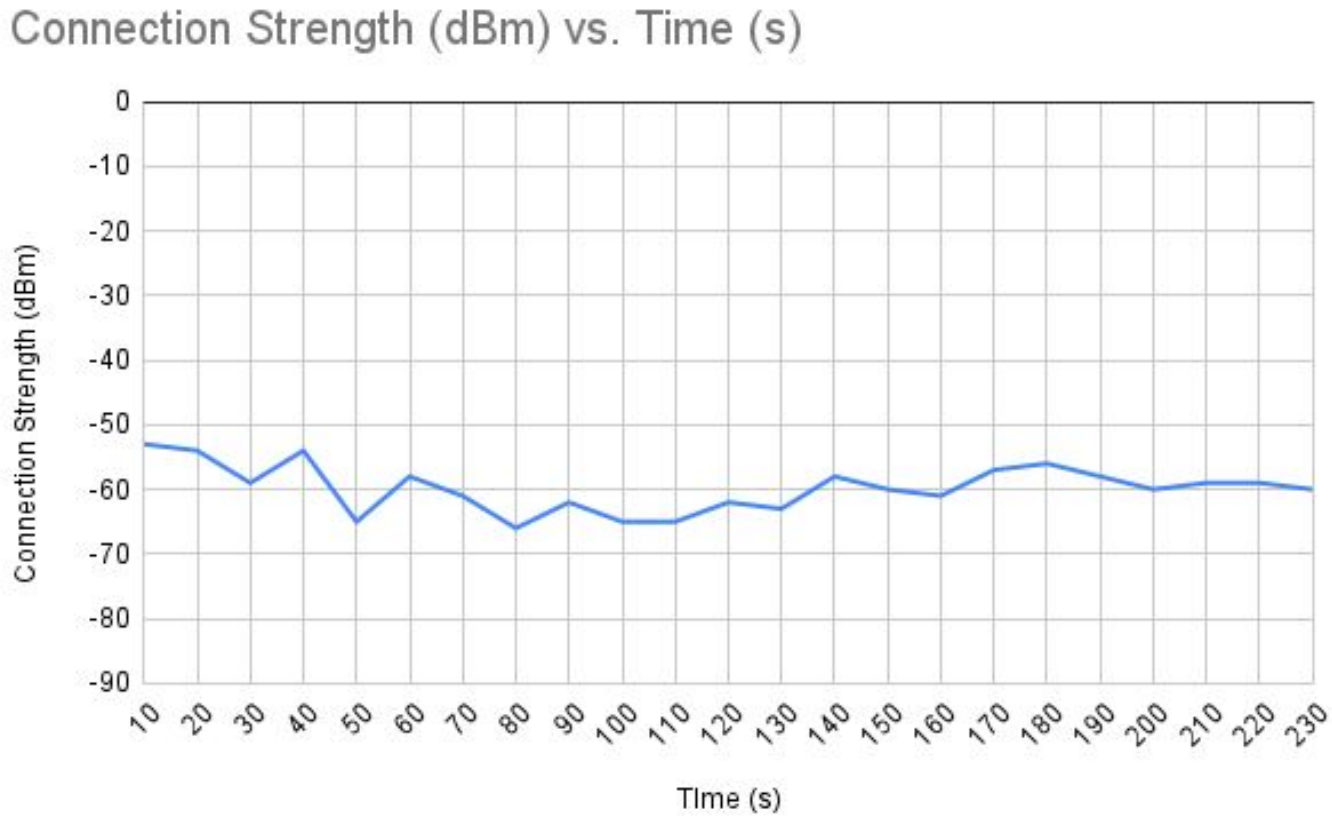
ESP32

The main way we control the battlebot was using an ESP32 dev kit. We can speak to the ESP32 over wifi. It has outputs out to the motor driver to control not only speed but the direction we want to spin.

Strong -50 dBm to -60 dBm Wifi Connection

The wifi connection at a distance of 10ft average around -50dBm to -60 dBm connection speeds which satisfied our high level requirement.

Control Subsystem



Drivetrain Subsystem

Drivetrain Subsystem

Motor Driver

L298n motor driver which is capable of controlling two DC motors. It does so using dual half bridge internal logic with an

- Input voltage (Vss): 3.2V - 40V
- Max current: 2A
- Logic voltage: Low between, -0.3V <= Vin <= 1.5V
  High between, 2.3V <= Vin <= Vss
- Operating current: 0 - 36mA

DC Motors

N20 Geared box motors rated for 6V and 1000 RPM with no load. These motors are affordable and easy to operate but under load are not as strong as rated. This caused our car not to turn as intended with the weight of the chassis being too much for them motors.

- Operating Current: 35mA
- Peak Current: 50mA

Drivetrain Subsystem

Final Velocity: 3.3ft/s or 1.006 m/s

This was measured using a tape measure on the ground and a stopwatch. Our battle bot was able to move forward 4.5 feet in 1.36 seconds. Obvious human error is involved from manually stopping the stopwatch but it is a good relative speed reading

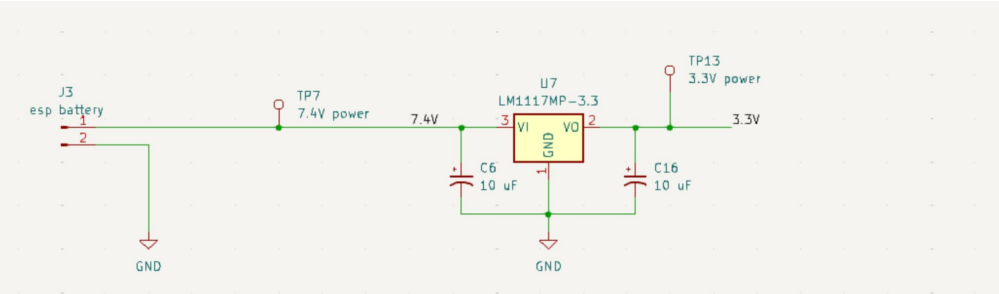
Final RPM:

- Wheel Diameter: 41 mm = 0.041 m
- Max Velocity: 1.006 m/s

Circumference = PI*Diameter = 0.1288 m
Angular velocity = v/r = 1.006m/s / 0.0205m = 49.07 rad/s
RPM = (angular velocity*60) / (2*PI) = (49.07 rad/s * 60) / (2*PI) = 468.6 revolutions per minute

Power Subsystem

Power Subsystem



Dual 7.4V 500mAh Batteries

In order to have enough power for the drivetrain motors, the weapon motor, and the ESP32 we employed 2 7.4 500mAh batteries.

Battery for Motors

The drivetrain motor driver, powering 2 motors, and the weapon motor were all driven directly from the 7.4V battery.

Battery and Voltage Regulator for ESP32

The ESP32 required 3.3V so the LM1117MP-3.3 voltage regulator was used to step down the voltage from 7.4V.

- Max input voltage: 15V
- max current: 800mA

Power Subsystem

Battery Analysis

Maximum Current Draw Per Battery

$$I_{max} = C_{rate} * Capacity = 30C * 500mAh = 15A$$

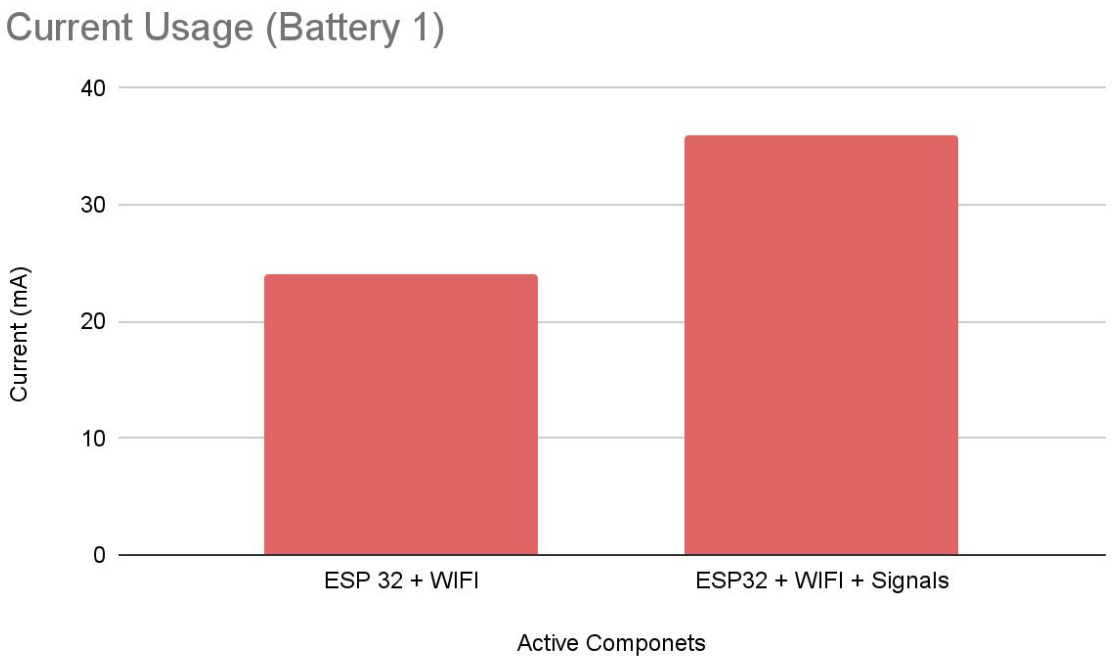
Maximum Run Time (Battery 1)

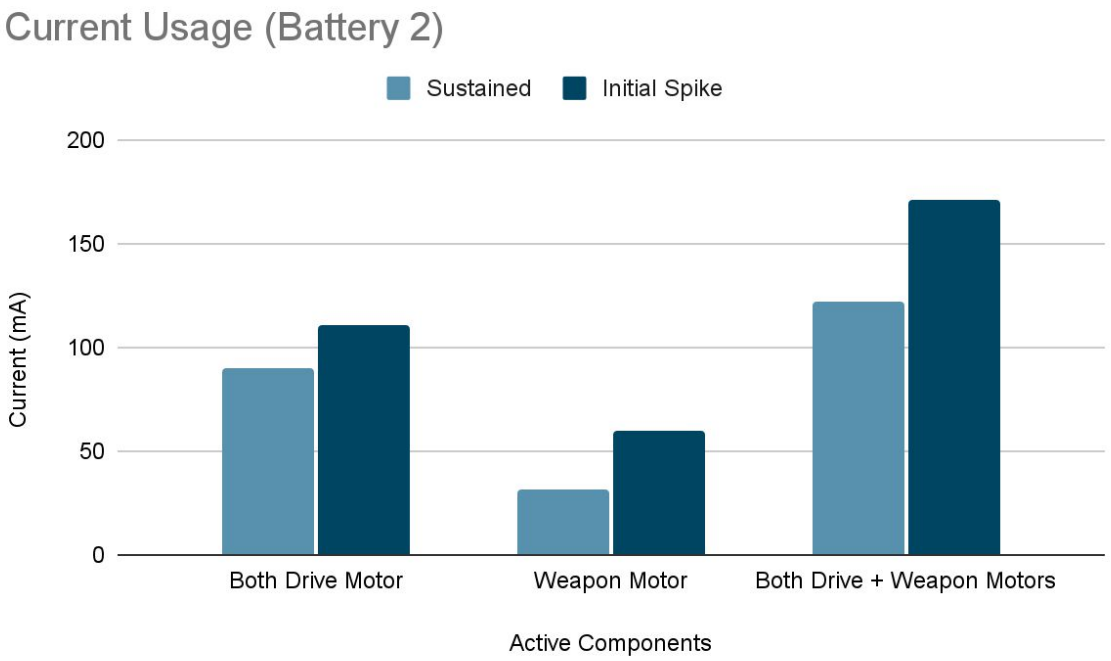
$$Time = \frac{Energy}{Power} = \frac{7.4V*500mAh}{4.1V*120mA+3.3V*120mAh} = 2.882\ hours$$

Maximum Run Time (Battery 2)

$$Time = \frac{Energy}{Power} = \frac{7.4V*500mAh}{7.4V*90mA+6.5V*35mA} = 4.141\ hours$$

Power Subsystem



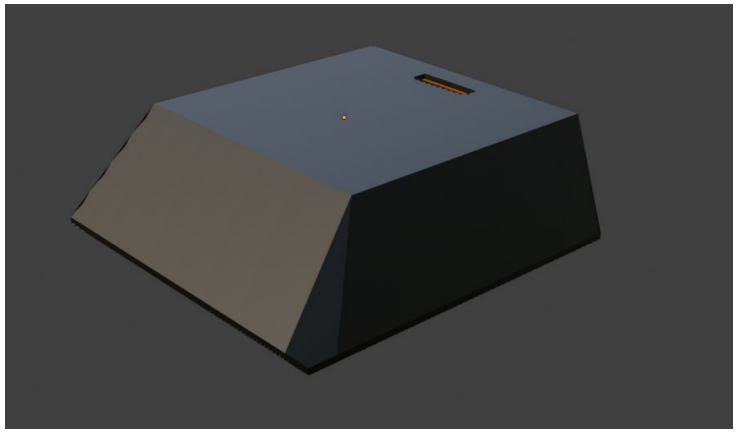


Max Current: 800mA

Max Current for Drive Motors: 2A
Max Current for Drive+Weapon Motor: 15A

Chassis Subsystem

Chassis Subsystem



3D Printed Chassis, Wheels, and Axles

The chassis consists of a bottom and top piece which are placed one over the other and secured in place with a hinge. The axle and wheels had to be glued on separately in order to allow the wheels to spin freely. All parts were printed using PLA filament.

- 472.95 Grams
- 57 degree slope
- Dimensions: 22cm x 21.5cm x 7.5cm

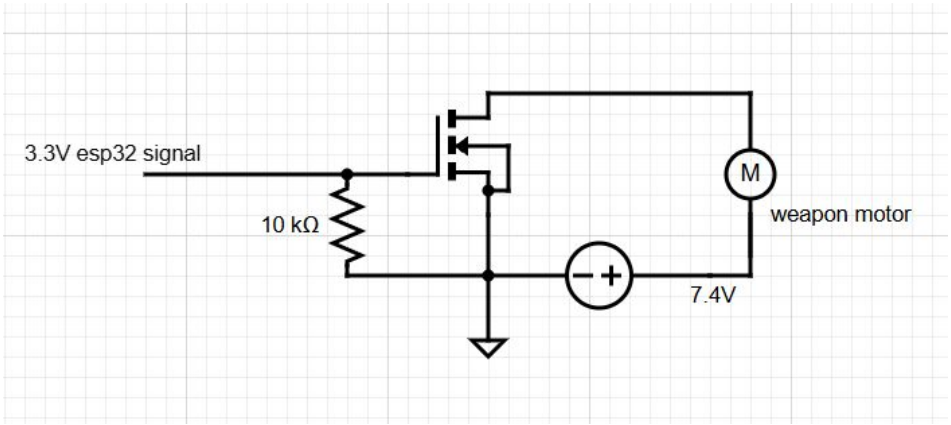
PLA Filament

PLA is easy to print, affordable, and offers good dimensional accuracy, making it ideal for prototyping Antweight battlebot parts quickly.

- Cost to print: 4 + $0.10 * 472.95 = $51.295

Weapon Subsystem

Weapon Subsystem



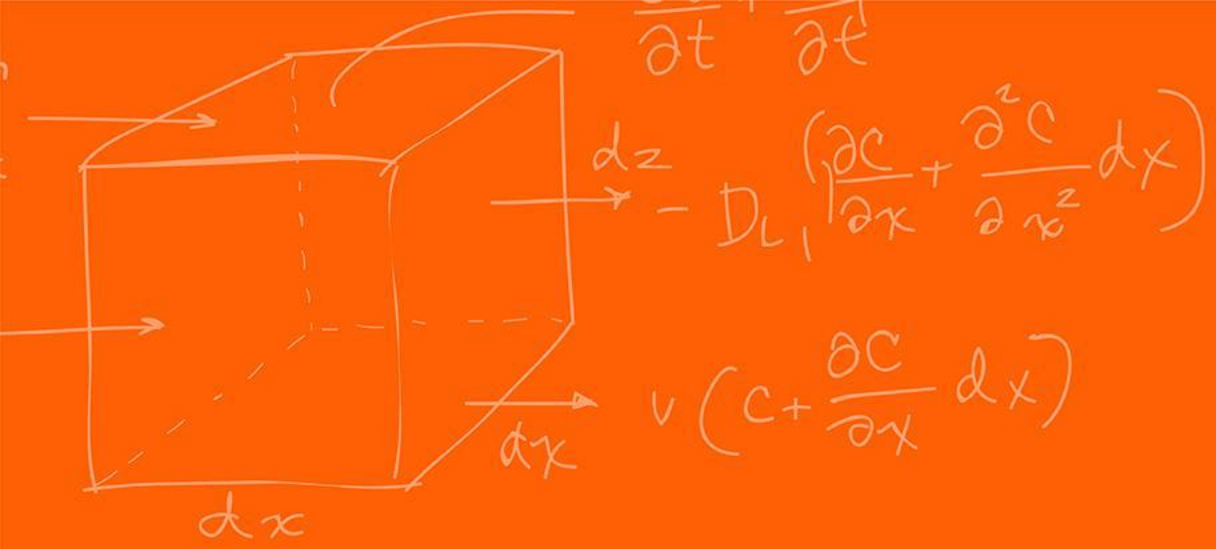
Spinning Blade Weapon

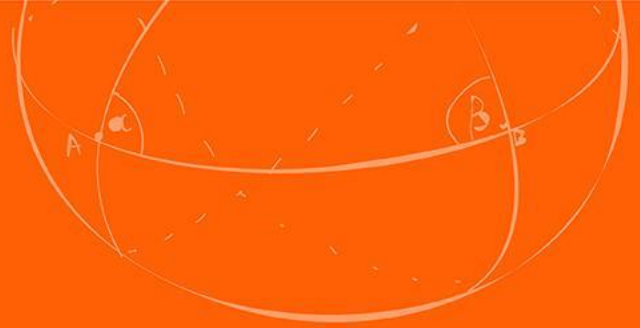
The weapon consisted of a motor glued to the top part of the car that spun a 3D printed blade that can immobilize other opponents that find themselves above our car. The blade was 3D printed out of PLA and could spin over our required 100 rpm.

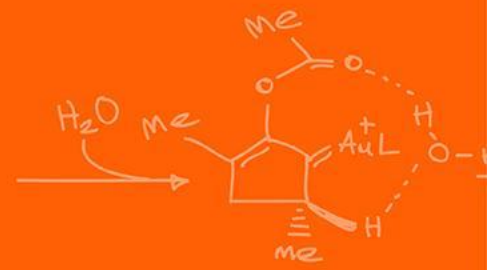
Simple Mosfet implementation

Due to direction not being needed for the weapon a mosfet was sufficient for allowing the weapon motor to connect and disconnect from the 7.4V battery whenever a 3.3V signal is supplied to the gate by the ESP32.

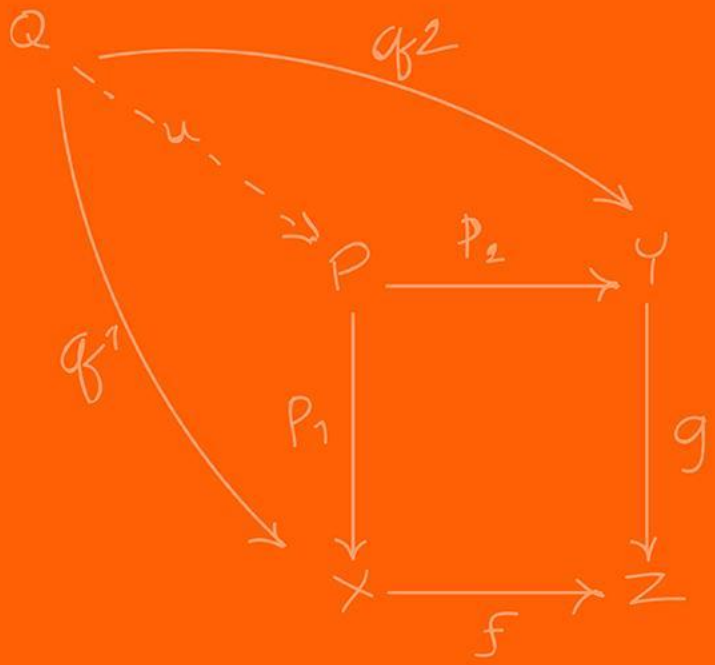
- FQP30N06L N-Channel MOSFET
- 2.5 V gate turn on voltage
- 60V max voltage and 32 Amps max current







Conclusion



Conclusion

Reflection:

- Due to design issues in the pcb design our final product was affected greatly.
- Not having a complete pcb restricted many design choices we planned for early on.
- The victim of this was a drivetrain that did not perform as we wanted.
- Lack of experience with 3D design software.

Future work:

- Fix our programming circuit for the esp32.
- Upgrade motors for a better performance under full load.
- Make full use of the 3D printer footprint to design a better chassis.