ECE 445 - Spring 2025

Senior Design Project Proposal
Antweight Battlebot

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1. Introduction

1.1. Problem

This project aims to create an antweight battlebot that would weigh less than 2 lbs to participate in the Antweight Battlebot Competition. The criteria given are that The goal of this project is to create an antweight battlebot that would weigh less than 2 lbs to participate in the Antweight Battlebot Competition. The criteria given are that all robots must have visible and controlled mobility such as rolling, non-wheeled, shuffling, or other methods; must be controlled via either Bluetooth or WIFI using a microcontroller with a manual operation for disconnection; and mounted with an attacking mechanism which would contact the arena 5 inches above the ground level and could come to a complete stop within 60 seconds.

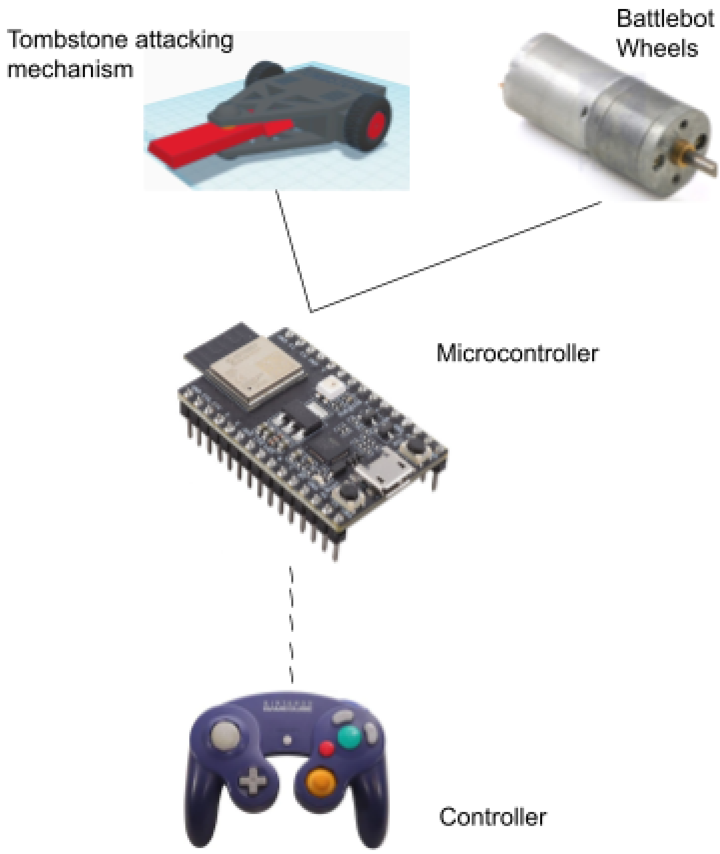
1.2. Solution

The battle bot will have a tombstone-style horizontal spinning weapon that disables opponents by striking with high-speed impacts. We will use the Emax RS2205 2600KV brushless motor for the weapon, utilizing its high RPM and strong striking force. The weapon will be controlled by an ESP32-C3 microcontroller and operated through user input via Wi-Fi or Bluetooth.

The battle bot will use Pololu Micro Metal Gear Motors, controlled by a DRV8833 motor driver, for smooth maneuvering. We will use a Thunder Power 325mAh 3S battery to provide efficient power while keeping the design lightweight. The microcontroller will control mobility and weapon activation to ensure precise control. The design will focus on precise control, durability, and optimized weapon operation while maintaining a lightweight frame within the 2-pound limit.

1.3. Visual Aid

We plan to use a tombstone weapon mechanism like the visual aid above and the Nintendo GameCube Controller to control the battle bot through the ESP32 - C3.

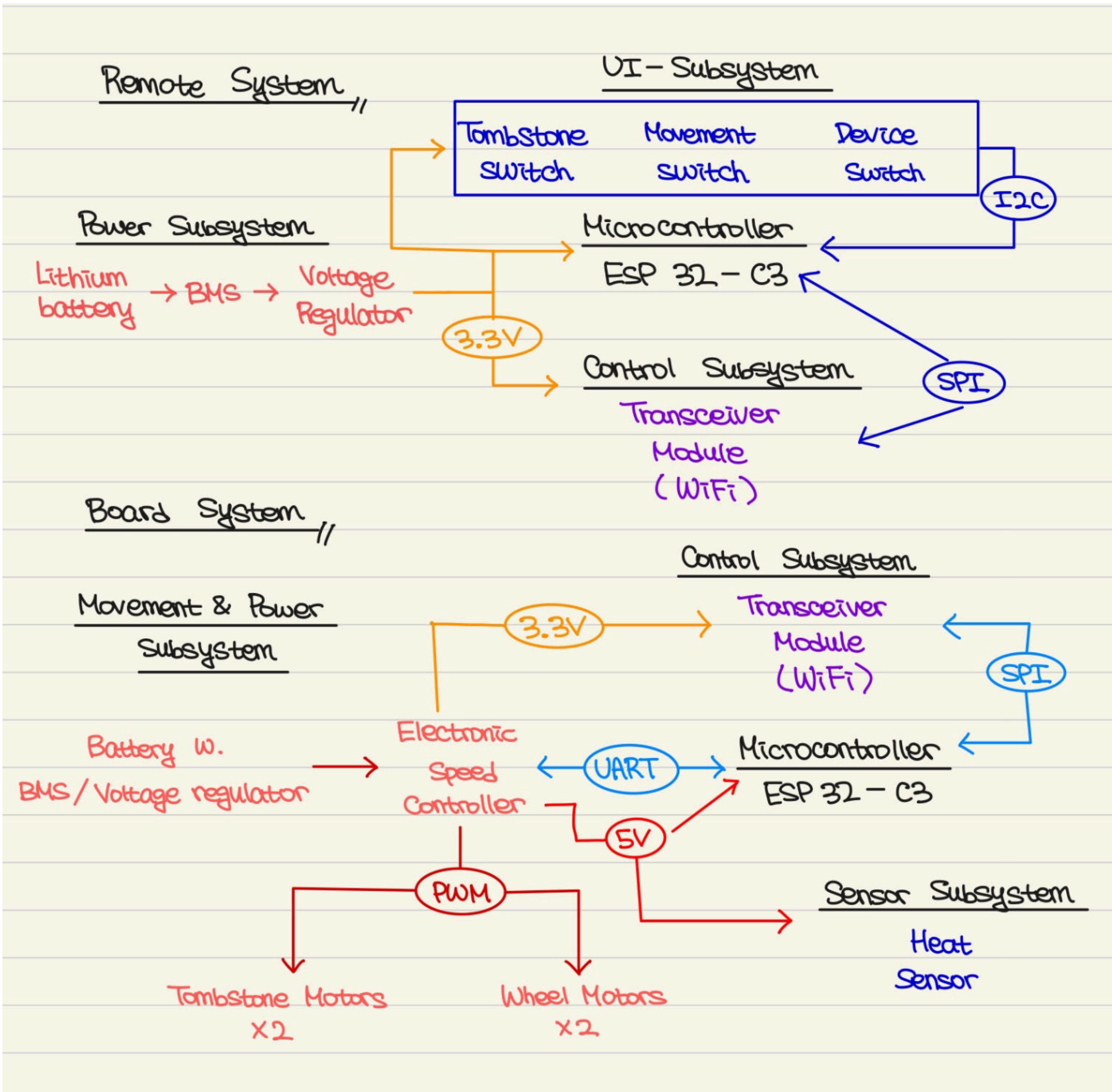


1.4. High-Level Requirements

- The total weight of the battlebot should not exceed 2 lbs. Therefore, the backbone of the battle bot will be obtained from a 3D printer using low-weight material PET-G, lowest weighing THP 325-3SR70J battery, and low-weight Emax RS2205 2600KV motor.
- The ESP32-C3 microcontroller processes input signals from buttons and controls the motor via DRV8833, which would be controlled by ESP32-C3-DevKitM-1. This supports stable operation for the ESP32-C3 microcontroller.
- The speed of the attacking mechanism, tombstone, will have multiple speed options for blade rotation. Enough power from the battery as well as control of the voltage regulator and motor control would be essential for controlling the speed of the blade. We expect to have 3 options for the speed of blade rotation.k

2. Design

2.1. Block Diagram



2.2. Subsystem Overview

2.2.1. Power System

The Power System includes the Lithium-Ion battery and the voltage regulators which is a part of the development kit. The voltage regulators are necessary as they provide adequate voltage to various components in the system. ESP32-C requires 3.3V to operate correctly, the DRV8833 motor driver needs a maximum of 5 V(someone fact-check this pls) and the motors require at least 5 volts. Without the regulators, these components may be exposed to voltages that exceed requirements and may lead to damage. The Thunder Power 325 mAh 3S Battery is a 3-cell lithium polymer battery providing 11.1 nominal voltage. Its maximum continuous discharge is 70C and its maximum continuous current is 22.75A (capacitance t325mAh times discharge). The ESP32-C3 requires 3.3 Volts and the DevKit we are using has a voltage regulator that can take up to 5V input and step it down to 3.3, however, the battery exceeds that so we will require an additional voltage step-down converter to bring 11.1 V to 5 volts before connecting it to ESP32-C3. The 22.75 A max continuous current is more than enough for the microcontroller, motor driver, and hopefully another voltage regulator.

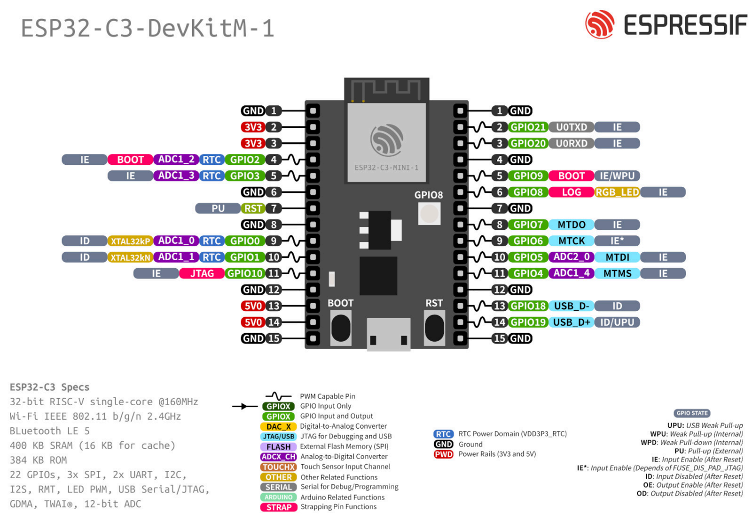
Figure 3. Thunder Power 325 mAh 3S Battery

2.2.2. Communications Subsystem

The communication system would be in charge of handling communication between the microcontroller and motor drivers as well as communication between the microcontroller of the remote controller and the microcontroller of the battlebot. The microcontroller has Bluetooth/WiFi feature which would allow the two microcontrollers to communicate with each other. The battery and motors which are controlled by the electronic speed controller will communicate with the microcontroller on the board system using the UART cable and switches on the remote controller for the tombstone and movement as well as the power will communicate with the microcontroller on the remote system through I2C cable.

2.2.3. Control Subsystem

The ESP32-C3 is the central control unit for the battlebot. It provides wireless communication between the robot and the user controller. It will receive commands via Wifi or Bluetooth and translate them into control signals for the robot's function. It will send the control signals to the DRV8833 motor driver which is the drive control and the Emax RS2205 which is the motor used as the attacking mechanism.



2.2.4. Attacking Mechanism

For our attacking mechanism, we plan to use the Emax RS2205 2600KV brushless motor, which is known for its high-speed rpm. This motor is usually used for drones, but we plan to repurpose it as a spinning weapon for the battle bot. It will receive power from a battery and be controlled by the ESP32 to determine when and at what speed to spin.

2.2.5. Robot Mobility

We will use the Pololu Micro Metal Gear Motors controlled by the DRV8833 motor driver. The DRV8833 dual H-bridge configuration enables independent control between the motors to provide forward, backward, and turning movements. The ESP32-C3 sends control signals to the DRV8833, adjusting the speed and direction based on the user's inputs. And the battery will provide the necessary energy to ensure efficient movement around the arena.

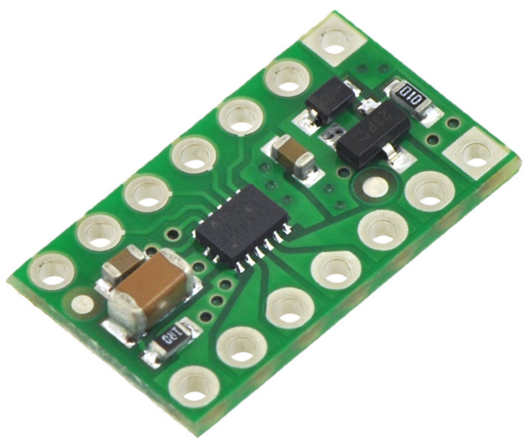


Figure. DRV8833 motor driver.

Figure. Pololu Micro Metal Gear Motors

2.3. Subsystem Requirements

2.3.1. Power Subsystem

The power subsystem must be able to supply at least 500mA to the rest of the system continuously at 5V +/- 0.1V considering the 5V voltage required for electronic speed control, ESP-32 microcontroller, and the sensor subsystem. The battery provides 11.1 V with a continuous discharge of 22.75 A.

2.3.2. UI-Subsystem

The UI-subsystem will consist of a tombstone switch, movement controller, and device power switch, which will all be powered by the 3.3V voltage which is regulated by the voltage controller originating from the battery. It will be controlled by the ESP-32 microcontroller via I2C connection.

2.3.3. Control Subsystem

The microcontroller ESP32-C3 operates at 3.3 volts so the voltage must be stepped down icing a DC-DC buck converter to 5V (for the motor driver, etc) and also 3.3V for the microcontroller. The ESP32-C3 devkit regulates the 5V to 3.3V for proper operation of the microcontroller. MUST MUST have 3.3 V at all times as it handles communication.

2.3.4. Movement Subsystem

The movement subsystem is controlled by the Pololu 12V 99:1 Motor consumes up to 5A at stall, operated at 100 RPM at no load with a torque of 29 kg*cm. When converting the power supply from the battery to the motor, a step-down converter would be needed in order to convert the 11.1 V from the battery to 5 V to power the DRV8833 motor driver.

These motors are powered directly by the DRV8833 and require a minimum of 5 V to operate, the battery must be at least 5V at all times for the motor driver to operate but the driver can handle 10.8V.

$Speed\ calculation:\ RPM\ =\ KV\ *\ Voltage$

$RPM\ =\ 2600\ *\ 7.4\ =\ 19,240\ RPM$

$Angular\ Velocity\ =\ (19,240\ *\ 2\pi)\ /\ 60\ =\ 2,014.\ rad/s$

$Linear\ Velocity\ =\ 2,014.2\ *\ .05\ =\ 100.71\ m/s \sim 362.5\ km/hr$

2.3.6. Sensor Subsystem

The board system will be mounted with a heat sensor in order to prevent overheating of the tombstone blade rotation. The heat sensor will be powered at 5V from the battery and produce a warning message on the display if it exceeds 80 °C since majority of the materials used for 3D printing for the backbone of the battlebot exhibits a long-term heat deflection temperature of 100 to 120 °C.

2.4. Tolerance Analysis

One aspect that could pose a huge risk to the completion of the project is the battery we decided to use, we are using the THP 325-3SR70J which is 35g. As the key problem is to make the battlebot under 2 lbs, this battery could be a huge problem as it takes a significant portion of the allotted 2 lbs. With this as a major criterion, we would have to make changes to the power system if needed as well. Another consideration would be the weight of motors. Initially, we planned to use Pololu Micro Metal GearMotors due to its lightweight merit. However, the Pololo 99:1 Metal Gearmotor has significantly higher torque despite its heavier weight. This would result in a more powerful and faster battlebot, which leads to cutting weight on frame weight or elsewhere. Using this motor would also allow more precise speed control as well as controlling the speed of the tombstone attacking mechanism

Mathematical analysis:

- Emax RS2205 2600KV: 29 grams
- ESP-32 Dev kit: 28.34952 grams
- THP 325-3SR70J Battery: 35 grams
- Pololo 99:1 Metal Gearmotor: 91 grams
- DRV8833 Motor Driver Board: 1.5 grams
- 2 wheels: 140 grams
- Estimation for 3D printed parts: 200 grams

- Total Weight: 524.84 grams
- Weight Limit: 907.185 grams

3. Ethics and Safety

3.1. IEEE Code of Ethics #1: Safety

We will prioritize the safety of the surrounding environment, operators, and spectators to ensure that the battle bot operates in a controlled environment. The bot will be tested in safe conditions and follow the necessary steps to handle the high-speed motors, batteries, and wireless communications.

A few components we will need to watch out for safety are the LiPo Battery which we will make sure not to overcharge, or improperly handle, and use safe charging and discharging procedures. Another component would be the motors for which we will make sure to use a cover to ensure the motor doesn't rotate when not in use and has a guard to prevent it from injuring anyone.

3.2. IEEE Code of Ethics #9: Privacy and Security Concerns

We will be using Wi-Fi or Bluetooth, so we will ensure secure connectivity to prevent unauthorized access and hacking of the bot. We will ensure this by using a secure authentication mechanism for the ESP32-C3 so that the operator can only use it to control the bot.

3.3. ACM Code of Ethics 2.2: Fair Competition

Our bot will comply with the competition rules and regulations to ensure fair play and participation. We will not use unauthorized material or unfair advantages

4. References

- https://www.youtube.com/watch?v=_omEluWFqsU
- https://www.espressif.com/sites/default/files/documentation/esp32-c3_datasheet_en.pdf
- https://www.ti.com/lit/ds/symlink/drv8833.pdf?ts=1739085202074&ref_url=https%253A%252F%252Fwww.google.com%252F
- https://www.thunderpowerrc.com/products/tp325-3sr70j
- https://docs.espressif.com/projects/esp-idf/en/v5.0/esp32c3/hw-reference/esp32c3/user-guide-devkitm-1.html
- https://druav.com/products/4pcs-emax-rs2205-2300kv-2600kv?variant=49281606582485&country=US&currency=USD&utm_medium=product_sync&utm_source=google&utm_content=sag_organic&utm_campaign=sag_organic&gad_source=1&gclid=CjwKCAiAh6y9BhBREiwApBLHC24JyV_lzqQbjjeo0NuXc5qmwhL8mpw_yISX2KHZv3LGWYs7LA8HfhoCELQQAvD_BwE
- https://www.technobotsonline.com/pololu-99-1-100rpm-25d-high-power-12v-geared-motor.html
- https://www.acm.org/binaries/content/assets/about/acm-code-of-ethics-booklet.pdf
- https://www.ieee.org/about/corporate/governance/p7-8.html
- https://www.gamestop.com/gaming-accessories/controllers/retro/products/nintendo-gamecube-controller-styles-may-vary/122695.html
- https://calculator.academy/rpm-to-angular-velocity-calculator/
- https://www.digikey.com/en/products/detail/espressif-systems/ESP32-C3-DEVKITM-1/13684315