ECE 445 Fall 2025 Project Proposal

Antweight Battlebot - Blade Blade

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1. Introduction

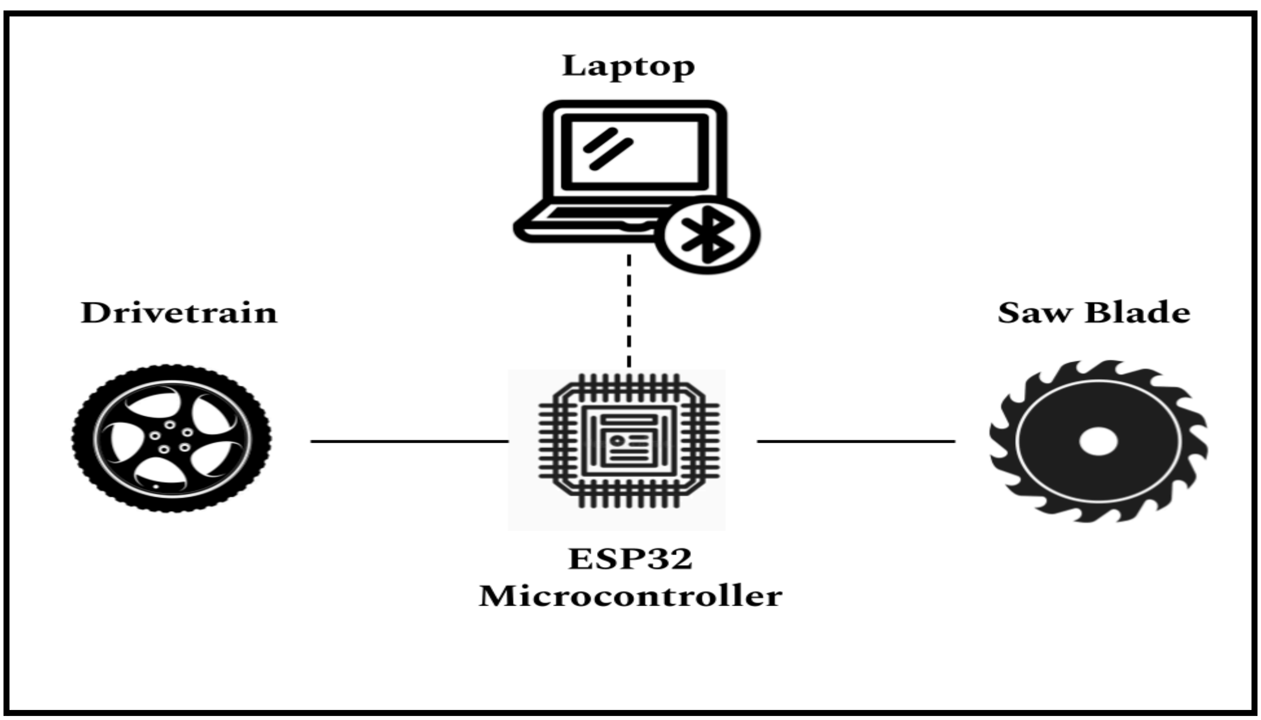
1.1 Problem

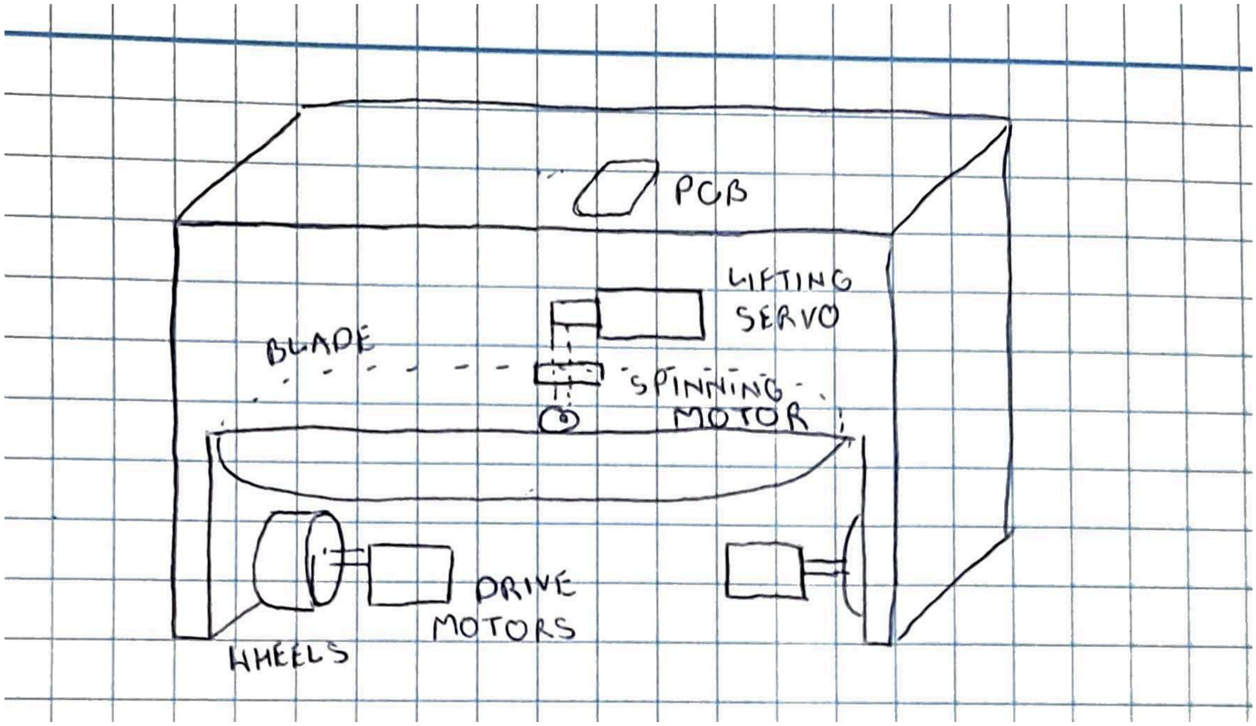
Our problem and goal is to compete and win an antweight battlebot competition. We must keep in mind certain design limitations to be eligible for competition, such as the battlebot weighing under 2 pounds and the components being 3-D printed. The battlebot must have a balance of being indestructible, lightweight, offensive, and long-lasting to survive the entire 2 minute battle. Ultimately, we want a bot that can disable, destroy, or outlast other bots in battle.

1.2 Solution

Our design will consist of a sturdy body for our bot, which has a horizontal, circular saw blade in the front that has the ability to not only spin, but also lift vertically. This will allow us to damage our opponent by exploiting their weakness, in that we can choose to damage them with a blunt force or by trying to throw them off balance. The bot will consist of a 3D printed chassis, an ESP32 microcontroller, two wheels with two associated motors, a motor to spin the saw blade, and a servo to lift the blade. It will also include batteries and a system to power every component. This will all be controlled over Bluetooth using the microcontroller and a custom made computer program.

1.3 Visual Aid



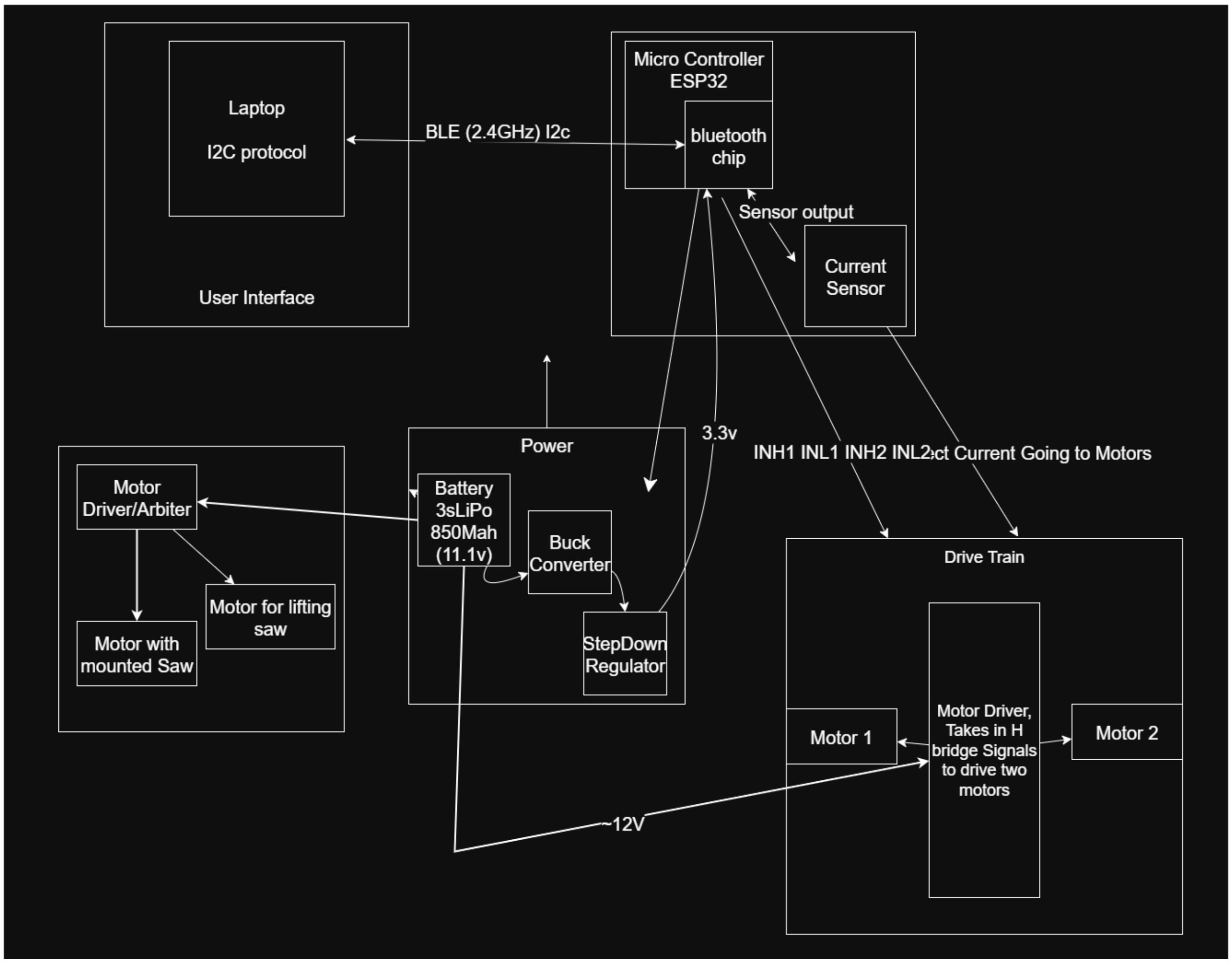


1.4 High-level requirements list

- Our battle bot is able to sustain 40N of force from a top down direction. This will ensure that if our opponents are using a weapon or flips the chassis readily protects the “brain” inside.
- The battlebot will be controlled through Bluetooth over a laptop. The laptop app will have an interface to be able to adjust direction, speed, and attack mode. It will also allow us to monitor the battery health.
- The attacking mechanism will have two modes, one for controlling the spin speed of the saw and the other for lifting the saw itself. This requires us to allow the saw to lift 2 pounds at its outermost edge. This would require us to use a motor with a high speed for the spinning mechanism and a high torque for the lifting mechanism.

2. Design

2.1 Block Diagram:



2.2 Subsystem Overview:

Controller Subsystem

We will use an ESP32 microcontroller. The primary benefit is that it has integrated WIFI and Bluetooth. This will allow us to add custom telemetry to our laptop to control our bot, such as controlling the motor speed, raising our blade to flip the opponent's bot, or cutting out power as a fail-safe. The ESP32 has plenty of peripheral support. There are many PWM outputs, so we can directly drive multiple items at different pulses. There are also ADC inputs that would allow us to detect battery life or sensor information. It provides everything needed, is very compact, and doesn't use much power.

Mechanical Subsystem

We are going to opt for PETG and ABS for the chassis and mechanical components of the bot. PETG tends to be lighter and stronger than PET, is easier to build with, and more flexible than ABS. Because of this, it is optimal for the chassis. For the saw itself will be built out of ABS, which is a stronger and sturdier plastic, but harder to print with. Since manufacturing defects are not as important as being lightweight and strong, ABS is a better choice.

Power Subsystem

Our batteries are limited to 12V DC for the motors. Evaluating batteries, we chose a 11.1V 3S LiPo battery with a capacity of 850mAh and is 80g (0.18lbs). This gives us a good enough battery life to survive for a round, but won't sacrifice too much weight that could be used elsewhere.

Drive Subsystem

We plan to use a 12V Brushed DC Gear Motor with a 37mm gearbox and an RPM of 60. These motors were chosen to give us high torque for reliable control of the bot's movement. We will also implement a dual h-bridge connected to 2 wheels. This will allow us to have reverse and forward acceleration as well as steering while saving weight.

Attack Subsystem

When it comes to our weapon, it is going to be a tombstone design with a circular saw blade instead of a bar spinner. We plan on spinning it with a high speed motor to inflict the most damage. The EMAX MT2204 motor is a good candidate for this.

The saw lift mechanism will be controlled by a servo that includes a high enough torque and speed to lift the weight of the blade as well as doing it quick enough to flip over an opponent. We found an Adafruit Micro Servo that has 20 kg-cm of torque and rotates quickly.

Current Sensor/Battery life detector

To allow for kill switch functionality, we will have a current sensor which detects current being sent to the motors. If current ever goes above a certain threshold, a signal is sent saying to turn off the system. This is important for motor longevity in a battle bot competition, where current might spike if the motors are stalled. Additionally, this can be used to monitor current draw of the system and with given voltage drops we can approximate battery life. With this information, we can choose to turn on or off different subsystems to conserve battery power.

Adafruit 6340

2.3 Subsystem Requirements:

Microcontroller Subsystem

- The microcontroller must have GPIO pins for system control and GPIO pins for ADC.\
- The controller must sport bluetooth capabilities to remotely connect to the computer.
- The microcontroller implements a current sensor to detect if the motors are stalled and turn them off.

Mechanical Subsystem

- The entire battlebot must be under 2lbs.
- The chassis must have a physically sound structure so that our opponent is not able to break into it, flip it over, or destroy its internal circuitry.

Power Subsystem

- The battery must supply power to all motors for the duration of the battle at 22A.
- 11.1V must be supplied to driving motors
- The battery must be stepped down to 3.3V for the microcontroller
- The battery must be stepped down to 8.4V for the servo

Drive Subsystem

- An H-Bridge circuit can control direction of the wheel motors

Attack Subsystem

- We want an rpm of 10000 for the blade spinning

- We want a servo with at l0 kg*cm of torque to be able to lift an opponent at the tip of the saw blade

2.4 Tolerance Analysis:

The largest concern in our project is the weight restriction. Having two functionalities to our weapon means more weight space has to be allocated to adding these objects. In addition, it also means our system will have a larger current draw, which means to sustain for 2 minutes of operation we need an increasingly larger battery. With some initial estimates:

Wheel Motors (Kohree's 12V 60 RPM 37 mm) x 2 = 276g
Saw Motors (EMAX MT2204) = 25g
Metal Gear Servo Motor = 55g
Current Sensor = 5g
500mah battery (Ovonic 3S 500 mAh) = 44g

These components add up to 410g which constrains our chassis and PCB to weigh about 500g. Given this and the density of the plastic, about 1.2g/cm^3, we can determine what dimensions the chassis of the bot could be. We determined that the blade will have a 5cm radius and .5cm thickness, while the box will have dimensions of 18cm in both length and width, 6cm height, and .5cm thickness of the walls. This will be about 470g total. The extra weight will go into the PCB holder.

Ethics and Safety

3.1 IEEE Code of Ethics - Safety and Well-Being
In line with the IEE Code of Ethics, we will ensure that our team, *Blade Blade*, will take all steps necessary to protect the safety of our team, other participants, and any spectators. We however cannot ensure the safety of the opposing bot. The robot will only be tested in environments that are entirely controlled such as enclosed labs or designed competition arenas. Attention will be given to safely handling batteries, motors, and our blade blade weapon. We will use safe practices when charging our battery, fire-resistant containers for storage, and physical guards to minimize the risk of accidental injury

3.2 IEEE Code of Ethics - Security and Responsible Use
Since our project uses wireless communication between our laptop and the ESP32 microcontroller, we see the potential risk of unauthorized access. Following IEEE guidelines on responsible technology use, we will make sure that we can safely and securely pair and authenticate to prevent issues such as remote hijacking or intentional harm by unwanted individuals.

3.3 ACM Code of Ethics - Fairness and Compliance
The ACM code puts an emphasis on adherence to rules and fairness. We will build our bot to fully comply with the regulations of the competition. We will ensure there are no hidden features or modifications that give us an unfair advantage in the competition. The materials we choose to use will be properly documented and transparent to the organizers. We are big fans of supporting integrity and fair competition.

3.4 Anticipated Safety Concerns

- Battery risks: Overcharging or overheating could lead to a disastrous fire. We will ensure this is mitigated by balanced charging, fire-safe storage, and regular monitoring
- Mechanical risks: Since we do have a spinning blade, we will need to mitigate danger using mechanical guards, kill-switches, and potential disassembly when transporting
- Electrical risks: Short circuits and exposed wires. We will mitigate this through excellent insulation, fuses, and circuit breakers.