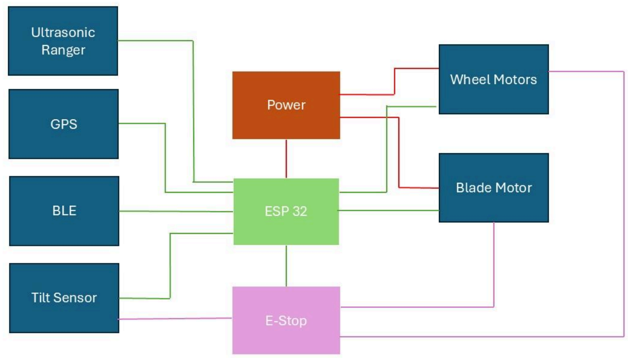
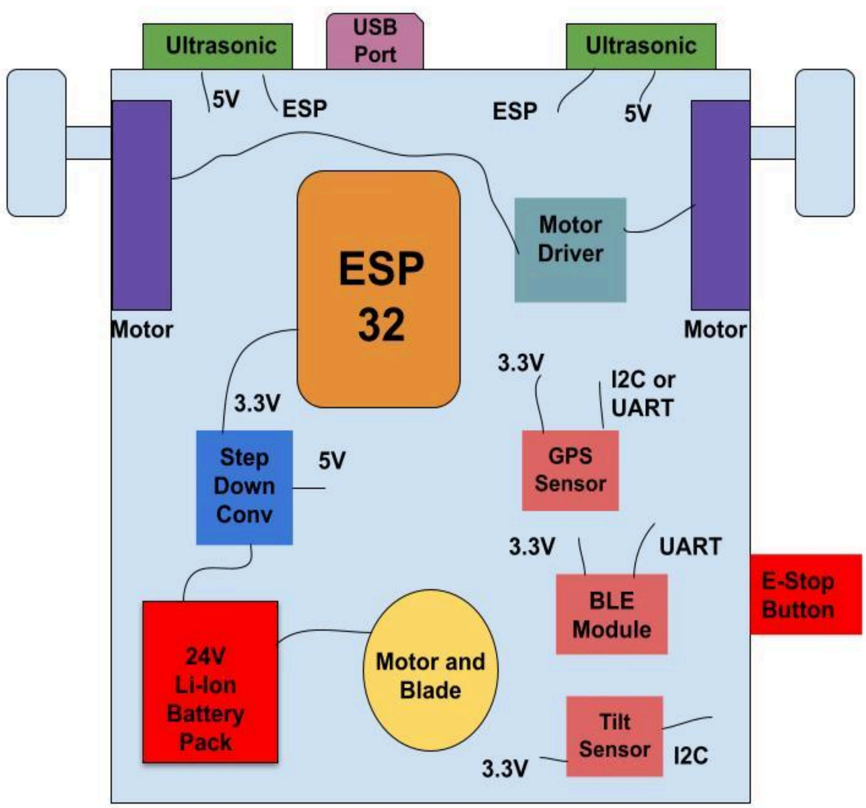
Design Review 0

1.1 Overall System:





1.2 Power Management (Battery, ESP32)

Description: Supplies power to all components in the system.

Requirements:

- Supply power for 45 minutes
  - Enough time to mow a small to medium lawn at a walking pace
- Step-down converters provide 5V and 3.3V outputs for MCU, sensors, and BLE
  - 3.3V needed to power the electronic components responsible for the "Autonomous" actions.

Interfaces:

- **Input:** Lithium-ion battery pack (includes 4-7 batteries that are rechargeable)
- **Output:** Power to ESP32, motors, GPS module, BLE, and sensors

Considerations:

- Should take at most a week to design the interfaces
- The weight of the battery will affect the type of the motors, which will influence the battery sizes needed. Designing for around 15-20 lbs for a final weight to set a goal.
- 12V vs 24V motors (will be mainly dependent on power consumption, cost, weight, especially given a 24V motors would require more battery packs).
  - Need to test/establish these requirements

1.3 Navigation and Obstacle Detection (Ultrasonic Sensors, GPS, ESP32)

Description: Enables autonomous movement and obstacle avoidance.

Requirements:

- Lawnmower position data accurate to .25 meters
  - Error to allow lawn mower to overlap with previous run
- Ultrasonic sensors detect obstacle from a distance of 1 meter
  - Allow enough space for the mower to turn or maneuver away from an obstacle
- Be able to navigate around an obstacle
  - Namely, trees and avoiding walls.

Interfaces:

- Input: GPS signals and ultrasonic sensor data
- Output: Motor control commands sent to motors via driver motors
  - MCU will do processing to ensure proper commands

Considerations:

- Will take a longer time to design, due to how complex the autonomous system is with our current requirements.
- Depends on whether we use cheap GPS (3-4m accuracy) vs GNSS rtk (2-3cm accuracy).
  - Price, setup, and time commitment will need to be investigated.
- Will need to program differently if location data has significant error compared to size of the mower. May need redundant runs or allow for random patterns for mowing if the location is not accurate. Inaccurate location data will increase time to complete the subsystem.

1.4 Remote Control and Communication (BLE, ESP32)

Description: Allows lawnmower to be controlled via a mobile app

Requirements:

- BLE communication allows for transmitting coordinates/location data, battery, and mower status, possibly via the design of a phone app as a means of control.
- Mower can receive information for controlling movement for remote control
  - Allow for remote control aspect
- Communication needs to reach 50 meters
  - Range to reach to the end of a small to medium lawn

Interfaces:

- Input: Remote control commands from the app via BLE
- Output: Motor commands and status feedback

Considerations:

- Expecting designing the RF system for the mower to take a moderate amount of time, considering it will require the development of a complete transceiver module (the transmitter being integrated in a phone app, and the receiver being the component in the mower to receive the information).
- Understanding the proper geometry of the receiving antenna will be important and take some time to research, as it needs to be able to handle the right frequencies transmitted from our phones.
- We will need to learn how to use a BLE module to transmit data.
- Expecting designing remote control system to take longer than the data transmission. May need to think about the mechanics of driving the mower.

1.5 Safety Controls (Tilt Sensor, Wheel and Blade Motors, E-Stop Button, ESP32)

Description: Ensure safe operation of lawn mower

Requirements:
- E-Stop button on mower, without breaking the mower
- Detect a 35^{o} tilt for emergency stop

Interfaces:
- Input: Physical E-Stop button, tilt sensor
- Output: Motor shutdown signals

Considerations:

- Designing E-Stop should take a shorter amount of time. Need to understand the electronics of what happens when power is suddenly shut off, may need to design a safe shut off process.
- Will likely need to tinker with emergency stop thresholds.
- Does it need to be waterproof/solid?

2. Plan for Design Review 1 and 2

Design Review 1

1. Establish goal specifications of the final system
    a. Weight, size, shape, frame material options
2. Get essential components with appropriate specs and test functionality
    a. ultrasound, GPS module, motors, BLE, wheels, IMU sensor, etc.
3. Initial focus on driving of the mower
    a. Create power distribution design for motors for wheels, turning, and cutting
    b. Develop to being able to take an uploaded sequence of movements
4. While developing driving, work on an emergency stop. Cutting power/turning off to motors and telling ESP32.

5. From driving, can split development to BLE remote control (Phone Application) and navigation process
    a. BLE remote control will be transmitting the information on how to move to the mower
    b. Specifics of maneuvering can be determined with the completion of driving, knowing how much space is needed to turn and stopping time
6. Navigation process will be developed after determining accuracy of electronics
    a. Coordinates will be read to the ESP32, then being communicated to the BLE for transmitting to an app

Design Review 2

1. Develop PCB design
2. Finalizing the frame and ensuring the body of the lawnmower is able to withstand its environmental demands.
3. Testing systems to make sure they are functioning as intended (blade motors, wheel motors).
    a. Each individual major subsystem would work even as a combination of smaller interconnections.
4. Put effort into refining the autonomous algorithms, so that it lawns the way we want to lawn and move autonomously.