Design Review 1

1. Major Subsystems

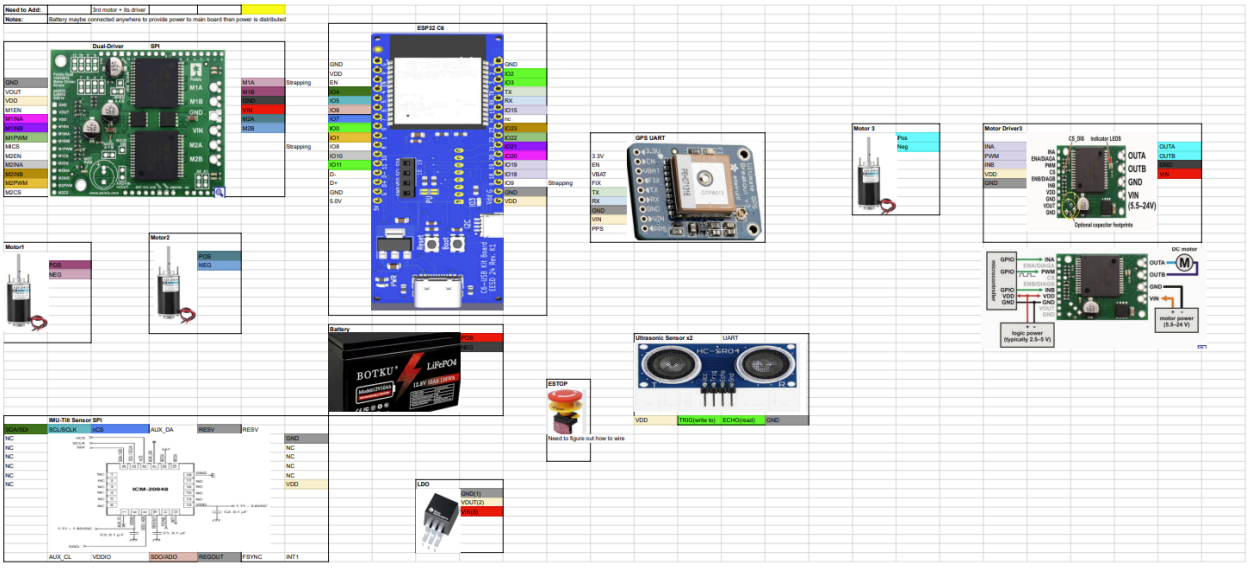

Figure 1. System layout

1.1. Power Management

The power management will consist of the 3 motors, using one dual driver for the wheel motors and one single driver for the blade motor. The motors are permanent magnet motors, which were chosen for the ease of use, only using two terminal connections. The speed of the motor is controlled with a driver, the speed controlled with a PWM signal and two IO pins to determine the direction of rotation of each motor. The motors require 12 V.

With the motors requiring 12 V, we chose a rechargeable 12 V battery to power the mower. The chosen battery is rated for 10 Ah, which will supply enough power for the maximum current draw of the motors to meet the 45 minute battery life requirement. To distribute power to multiple terminals, we will use a screw hole power hub on the mower.

To power other systems on the mower, we will use an LDO to convert the 12 V to 3.3 V.

For the mower, we chose the ESP32 C6 since it meets our needs for the system without using excessive specs. The ESP32 C6 has sufficient GPIOs with 22 GPIO pins and has Bluetooth 5 for our remote control system.

1.2. Physical

The physical body will be a wooden board with the electronics mounted on top of the board and wheels at the corners to drive the mower. A wooden board will provide a simple and inexpensive setup to the mower. The wheels were chosen since they are for a standard push mower, allowing

our design to remain a similar size to a push mower. These wheels, being built for a mower, will have adequate tread to navigate a lawn.

- Weight:
    - Battery: 1.2 kg
    - Motors: 1.44 kg (3*480)
    - Wire Blade: +- 0.35 kg
    - Sensors & PCB: +- 0.3 kg
    - Wooden housing: +- 5 kg
    - 3D Printed Motor mounts: +-2 kg
    - **Total Weight = 1.2 kg + 1.44 kg + 0.35 kg + 0.3 kg + 5 kg +2 kg = 10.29 kg**

1.3. Navigation

For navigation we are using the Adafruit Ultimate GPS module since it has a standard positional accuracy for a GPS system and it is available to us now, instead of having to purchase another module. The module accepts a 3.3 to 5 V input and uses UART to communicate with the ESP32. Using the GPS data, the ESP32 will record points which the mower will then find when it is mowing the grass. This way, the mower will cover the area that the user determines.
A part of the navigation subsystem is avoiding obstacles. To detect obstacles, the mower will use ultrasonic sensors. The ultrasonic sensors we will use are the Gravity Ultrasonic Sensor (V2.0). These sensors can detect objects from 2 cm to 500 cm where the mower should be able to detect objects up to about 1 meter away to give it sufficient time to turn away from the obstacle. These sensors use I2C communication and require a 3.3 V input.

1.4. Remote Control via BLE and App

We will use the built in bluetooth on the ESP32 to transmit data to an app. The app will act as a user interface for controlling the autonomous lawnmower remotely. Through the app, the mower will receive commands and send status updates. Using the onboard bluetooth, we will not have to add external components to the ESP32 to send information.

1.5. Safety

The safety system involves emergency stops from exceeding an angle threshold and a stop with a manual switch. We will use the ICM-20948 IMU as a tilt sensor. This IMU was chosen since it can detect the 35^{o} which we will use as a threshold. The IMU communicates with SPI and requires a 3.3 V input. The ESP32 will monitor the angle of the mower using the IMU, and if the angle exceeds 35^{o}, the ESP32 will stop the motors.

The emergency stop switch will be a mechanical switch which cuts stops the motors by opening the circuit to the motors. This way, the stop will be immediate and will not rely on the ESP32 to stop the motors.

2. Demonstration Plan

For Design Review 2, the working subsystems will be demonstrated with the kit boards. The power subsystem will be demonstrating that the motors can be run from the battery and ESP32 without unexpected large current draw, where the motors make up the majority of the power usage on the mower. The physical system will be shown by having the wooden board with wheels and motors attached. We will be able to show that the mower can effectively drive when the motors are attached. The navigation system will show that we can record points and then the ESP32 can determine where it needs to go to find those points later and that the ESP32 can detect when it is going to hit an obstacle and it can send information to the motors to avoid it. The bluetooth will be demonstrated by having an app that interacts with the ESP32. This will involve basic remote control and information on the mower's location. Safety will be demonstrated with receiving data on the IMU and showing that the emergency stop switch cuts power to the motors.