Senior Design Proposal: Autonomous Lawnmower

This document describes the contents of the project proposal that our team will submit. There is no required length for this document; it needs to be long enough to contain the required information.

The PowerPoint presentation that will also be part of the proposal will follow the same outline.

1 Introduction

Autonomous devices have gained popularity in recent years, particularly autonomous vacuums. These devices save their clients time from performing tedious and time consuming tasks by handling the process themselves. Mowing a lawn is one of these tasks where an autonomous device would save considerable time, but autonomous lawn mowers have not seen the same popularity as some of these other devices. This project seeks to create a design which can confidently mow a lawn on its own, navigate difficult terrain, and include a remote control option. We hope to make an autonomous lawn mower that is more appealing and useful than the current market options.

2 Problem Description

Mowing a lawn can be tedious work. In hot, tropical climates, it can even be unbearable at certain points of the day. On the other hand, on days of heavy rain, one is also deterred from mowing the lawn. However, by incorporating the proper electrical systems, a lawn mower can become automated as well as remote-controlled, making the task much more relieving and time-saving, and may include proper water-proof housing to encase the electronics, making it available for use in rain. These electrical systems will include a control module and an RF wireless system that interface with the motors. The control module will consist of a microcontroller that receives and processes programmed commands that outline a pattern for the lawnmower to follow, thus automating it. Additionally, it will be carefully designed with the appropriate sensors to ensure it doesn't come in collision with any objects of the environment. This will solve the issue of many DIY lawn mower projects that break down upon impact with environmental obstacles. Lastly, the RF wireless system would consist of a transceiver integrated with the microcontroller circuit board to provide manual control for any additional complicated obstacles, such as hills or sharp turns, as well as providing a solution for the assumed instance of the automated programs failing to function properly all the time.

3 Proposed Solution

Our proposed solution includes 5 main functions:

1. Battery operated motors
2. GPS locating and navigation
    a. Obstacle avoidance
3. Remote Control through RF
4. Built in Programs for Automation
    a. Cutting Grass
    b. Pattern/Route of mowing
    c. Safety Features
        i. Stop blade when picked up
        ii. E-stop button
5. Overall durability of electronics/housing

Firstly, we intend to utilize motors that are powered by battery. We decided on using batteries to avoid the costs of gas and the ineffectiveness of a USB (wired) power source. The battery provides the lawn mower with mobility and simplicity.

Second, our lawn mower will have GPS capabilities allowing the mower to report its position within the yard, create an outline of the yard's boundaries, and enable it to avoid large obstacles. We plan to utilize BLE (bluetooth) due to its cheaper costs and easy implementation as this technology has been used in many products and IoT projects. In combination with BLE we will use ultrasonic sensors to try to sense obstacles before contact so that the mower can maneuver around it and report it in its mapping capabilities.

Third, we will also be using BLE to remotely control the lawnmower. Our goal is to develop an app that can record the GPS data and control the lawnmower if a user needs to. The bluetooth module will interface with the motors through a PCB and have direct control. We will use “tank drive” to control the two sides of the mower independently and code in the minimum angle that the mower can be pivoted at the push of a button.

Fourth, automation is the main selling point of this project. We will develop a state machine that will run certain tasks constantly and other tasks when interrupts are thrown. Constant tasks include: reporting mower position, safety features, obstacle avoidance, and managing motor positions. Tasks that will be run when interrupts occur are: GPS mapping of a yard, Cutting the grass, and remote control toggle(if remote control is enabled or not). This will allow the user to get a personalized autonomous experience and also ensures only essential tasks are run constantly and thus conserving power.

The fifth function is in short robustness. Our first prototype will be durable and made of lightweight materials such as wood. The electronics will be housed properly so that damage is minimized.

4 Demonstrated Features

Features we plan to demonstrate:

1. Remote Control Abilities: Lawn mowers can be controlled through an app.
2. Gps Position reporting: Lawn mower can report its position relative to a starting point.
3. Obstacle Navigation: Motor can ‘see’ obstacles and navigate around them
4. Pattern/ Routing: Lawn Mower can mow in set pattern
5. Safety Features: When picked up or tipped over, the blade will stop spinning, and a working E-stop button to power the mower.

5 Available Technologies

This section should have sufficient information to convince me you will be able to do what you are proposing. **Remember that parts availability is still a very big issue.**

- **ESP32**
- **2 x 24V DC Gear Motors (100:1 gear ratio)**
- **1 x Blade Motor**
- **3 x 24V Motor Drivers**
  - **2x L298 Dual full-bridge driver**
- **1 x Blade Motor Driver**
- **24V Lithium-ion Batteries**
  - **8 pack**
- **Battery Charger**
- **DC-DC Step-down converter (24V to 5V)**
  - **LM2596S-ADJ/NOPB**
- **DC-DC Step-down Converter (24V to 3.3V)**
  - **LM2596S-ADJ/NOPB**
- **Ultrasonic Sensors (3)**
  - **HC-SR04**
- **Tilt Sensor**
  - **3-Axis Gyro/Accelerometer IC - MPU-6050**
- **GPS Module (BLE)**
  - **NEO-6**
- **Chassis/frame**
- **Wheels**
- **Blade Assembly and Hub**
- **Emergency Stop Button**
- **Safety Features**

- **Waterproof Enclosure for Electronics**

6 Engineering Content

There are two halves to the engineering that must be done to complete our project: hardware and software. For hardware we need to design a pcb and a physical lawn mower. For software, we have to initialize all the sensors, MCU, and communications. Also, we have to develop an app that receives this data and presents it to the user while also being able to send data back to the lawn mower. Below are specifications of the roles and tasks split among the team members. It is important to note that we all will be working together, but have specific responsibilities to make sure certain functions are completely made.

Team Members (Name)	**Hardware Role**	**Software Role**
Ryan Murray	Assemble Body, wheels, battery, sensors & Wires,E-stop	App-Remote Control, Driving and displaying information, Getting info from MCU wirelessly
George Loayza-Renzo	Transceiver Circuits and Antenna for BLE/GPS, PCB	Transceiver Programs, ADC and DAC initializing & processing, APP
James Boumalhab	Assemble Body, wheels, battery, sensors & Wires,E-stop	Get GPS data and perform navigation processes with sensors. Autonomous abilities (driving)
Tamrah Hughes	PCB Design for MCU(usb–c) & all sensor interfaces,	Initialize MCU. App-Remote Control, Driving and displaying information, Getting info from MCU wirelessly

7 Conclusions

This design will create an autonomous lawnmower with integrated sensors to detect collisions and with RF equipment to include the option for remote control. The design will be battery powered and will have a protective casing. The sensors will determine when the lawnmower is about to or is colliding with an object, preventing the lawnmower from getting stuck or to tell the lawnmower to adjust its path to continue mowing. The remote control aspect of the lawnmower allows the client to still use the mower when the terrain may be too complicated for the autonomous programming. Without the remote control, the lawnmower may be useless for parts of the client's lawn, requiring them to buy another mower. The autonomous option for the lawnmower makes the product attractive, saving the clients time and requiring little supervision. The battery power allows for replacing the power source in case the batteries are damaged and standardizes power distribution across the design, not requiring other power sources. The protective casing is for the longevity of the design, so that a client can have a long lasting, reliable product despite wet or other challenging conditions.