EECS C106A Final Project Check-In 1

D.A.R.T (Team 27)

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Original Abstract

Our project aims to develop a transformable robotic vehicle that can transform from a car to a drone. It will achieve this by rotating the wheels 90 degrees and take flight using built-in propellers. It will be equipped with ultrasonic sensors to detect obstacles in its path, and navigate around them, either by maneuvering on the ground or flying over it. This innovative design offers the potential for enhanced mobility and versatility in various applications, such as search and rescue operations, surveillance, and package delivery.

Updates

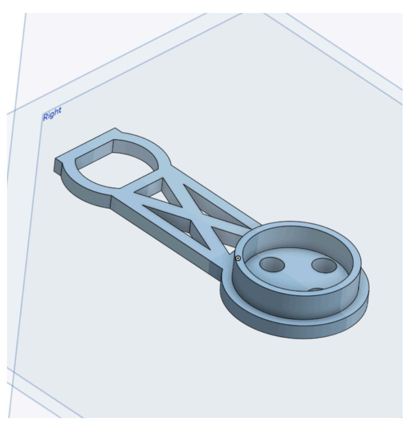
Since receiving feedback on our project design, we have been hard at work prototyping and creating designs for our vehicle. Namely, we have split up the project into three main components: mechanical, electrical, and software. All three have been substantially developed and are on track to be completed by the project deadline.

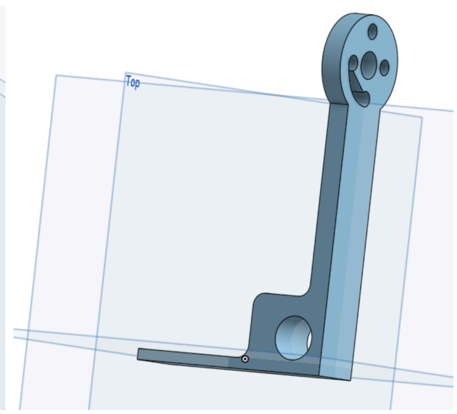
See following pages for more details.

Mechanical

The mechanical portion is the most critical portion to the success of the vehicle, and we have made excellent progress so far. We have prototyped a toroidal propeller design which will enable us to have enough lift to ascend off the ground while still enabling smooth driving. This design has been honed through multiple revisions, utilizing the rapid development capabilities of 3D printing. To test the amount of lift being generated, we have also designed a thrust measurement device which sets up the motor-propeller system to push against a kitchen scale (through an intermediate beam).

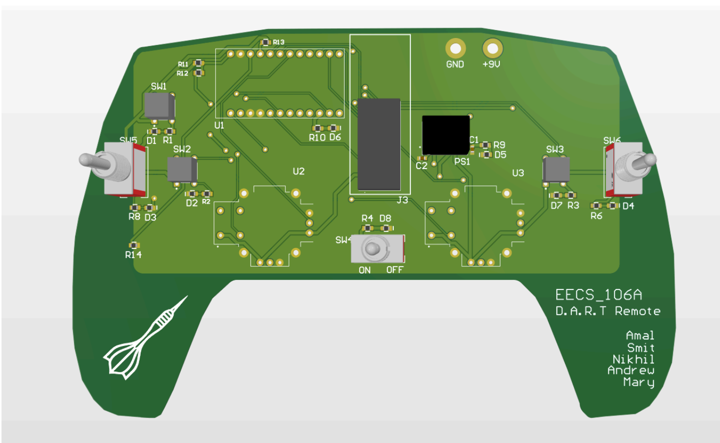
We have also developed a driving gear mechanism which will propel the car whilst on the ground. This includes optimizations for weight savings, as since this is a drone the lighter the craft, the easier it will be to fly. Again, these designs continue to be iterated upon and show promising results in preliminary integration testing. Images of all these developments are shown below.

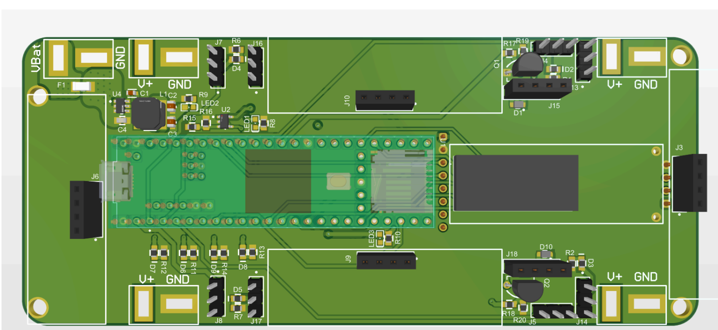




Electrical

To enable the mechanical functions of the vehicle, we have designed two Printed Circuit Boards (PCBs). One will be placed onto the drone and handle all flight (and drive) control logic and be powered by a Teensy 4.1. The other is a remote control which will send signals to the receiver, powered by an Arduino Pro Micro. We have just recently sent these to be manufactured at JLCPCB (this purchase is not covered by the course-provided budget). Images of the completed boards can be seen below.





Software

All flight and drive controller logic has been implemented in C, and is ready to be tested. All code is version-controlled in a private repository. Much of the code borrows from the principles described in dRehmFlight, an open-source flight controller intended to be used with VTOLs.

Much of the software work so far has been to validate functionality of individual components. For example, we are using brushless DC (BLDC) motors, which require special electronic speed controllers (ESCs). These in turn require specific pulse widths to be sent to them in a specific sequence; which itself is poorly documented. We found that a 1.5-2ms pulse is required. Although frequency-independent, a maximum frequency of 490Hz is desired. This is because on Teensy/Arduino, PWM can be driven by an integer value in the range of 0 to 255 (inclusive). At 490Hz, 255 corresponds to maximum power (2ms pulse), thus not requiring additional high-side scaling. The low-side (1.5ms pulse) therefore corresponds to a PWM value of 175, reducing range to 80 integers. This is not specified in any datasheet, and we have had to test these extensively.

We also have tested our ultrasonic sensors and determined that they are quite noisy, especially with soft/ridged surfaces. To mitigate this, we tested different digital filtering methods and settled on a moving average filter. Pictures of this testing can be seen below.