EECS C106A Final Project Check-In 2
D.A.R.T (Team 27)
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Original Abstract

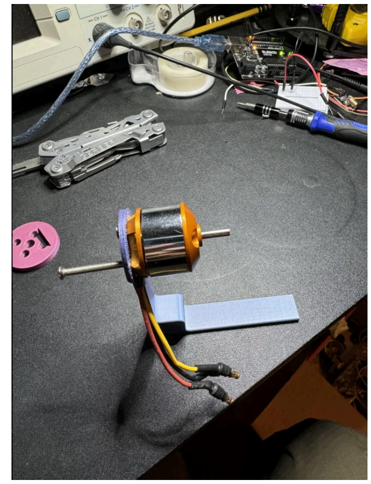
Our project aims to develop a transformable robotic vehicle that can transform from a car to a drone. It will achieve this by rotating the wheels 90 degrees and take flight using built-in propellers. It will be equipped with ultrasonic sensors to detect obstacles in its path, and navigate around them, 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

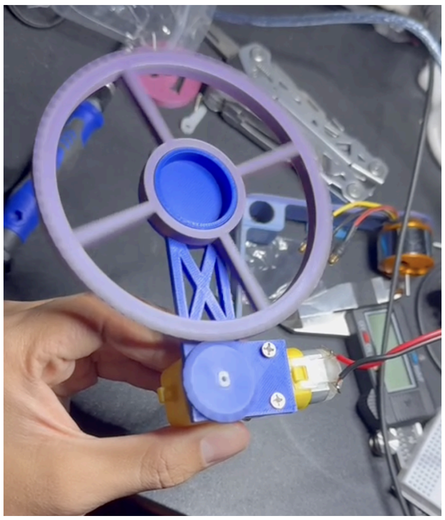
Since check-in 1, we have continued prototyping and adjusting our design depending on various performance tests that we have done. We have made a couple changes to our design, however, we are still working towards the original abstract. Since we had mostly completed firmware and sent out orders for our pcb before check-in 1, we mostly have mechanical updates. We are still on track to be completed by the project deadline.

See following pages for more details.

Mechanical

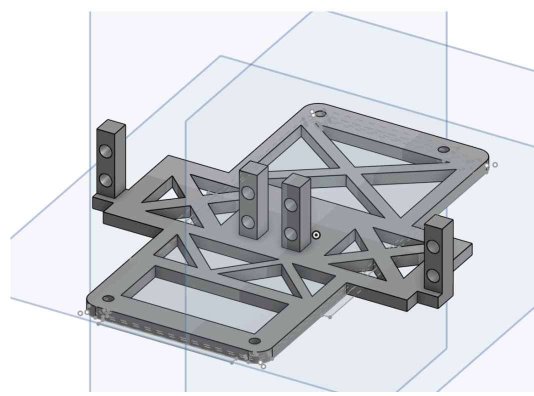


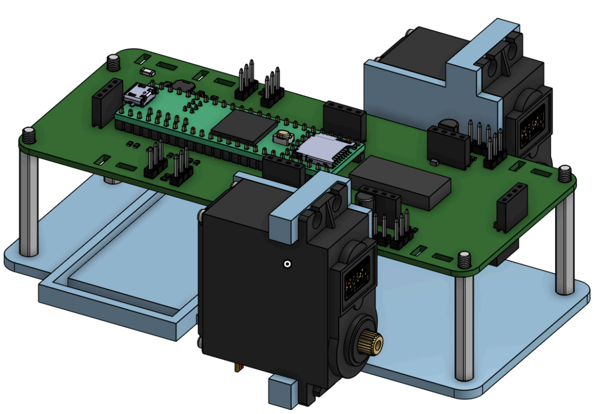
Thrust Testing:
We printed the thrust tester that we designed and conducted initial tests with smaller propellers.
At maximum power, the system generated approximately 110 grams of thrust at an angle. After correcting for the angle, we estimated the thrust to be around 150 grams.

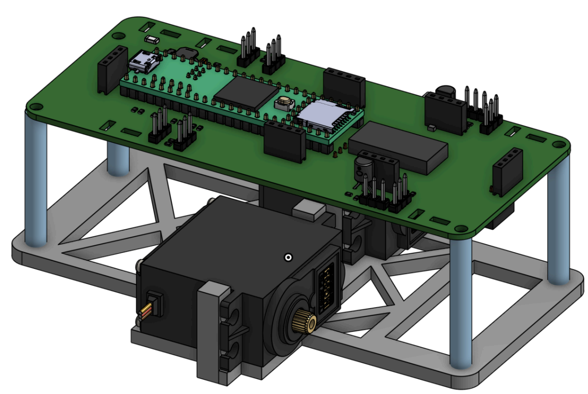


Wheel Speed Testing:
We finalized gears connecting the motor to our wheel/propeller. We printed out the components and have since tested the wheel speed with the motor and determined that the maximum speed is approximately 0.5 meters per second. These results allowed us to adjust our firmware accordingly to account for the real expected speed of the motor.

Servo Integration
Our servos have arrived, however, they are heavier than anticipated. To optimize weight and performance, we decided to use two servos instead of four. We redesigned the arm system to incorporate one servo on each side of the body, creating a functional joint mechanism connected to the servos. After simulating multiple servo configurations, we selected the most efficient setup for the body and proceeded to print the PCB frame and main body components.
Finalized version is shown on the right, although updates are still being made as we continue testing.

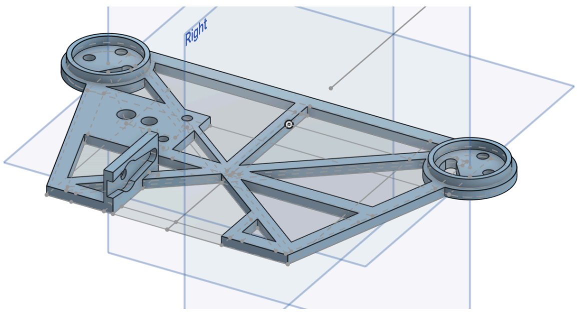


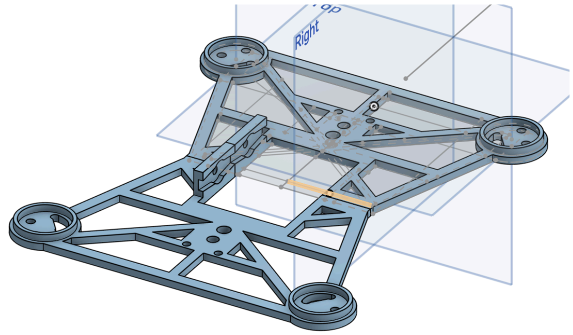




Arm Design

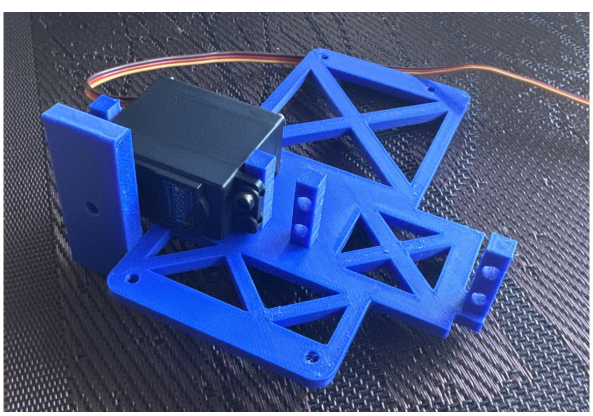
We designed an arm system tailored to accommodate both the previously developed wheel and propeller assemblies. The design connects to the PCB frame while supporting the servo configuration we selected after simulations. Through iteration, we mitigated the moment of inertia of each side to reduce load on the servos. Similarly, we've aimed to balance the vehicle as best as possible around its 3 principal axes. We determined that indenting the servo horn directly into the arm provided the most secure and precise connection.

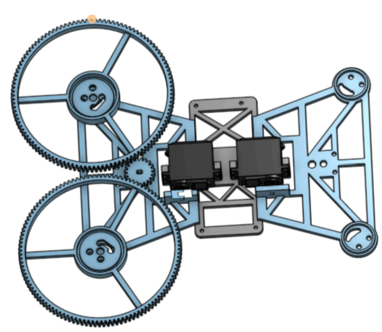


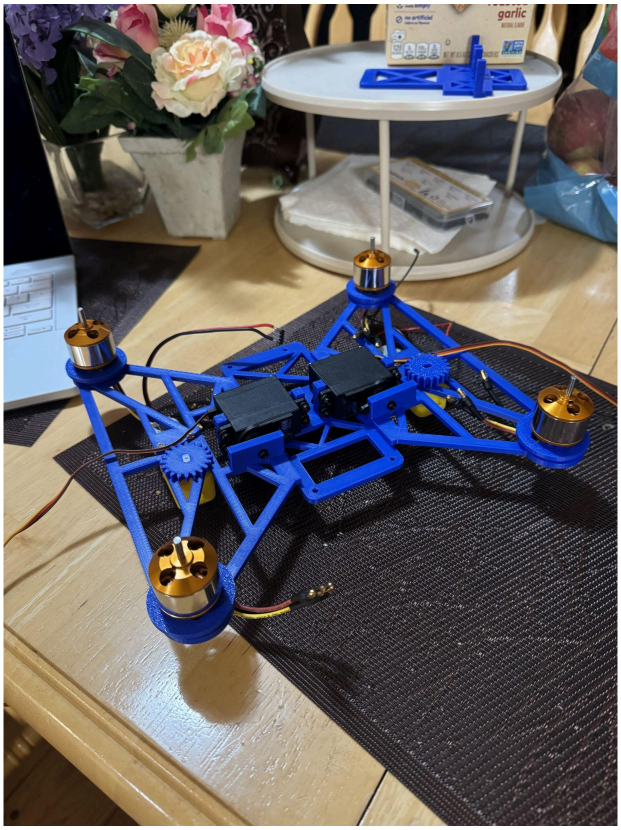


Assembly and Functionality Testing

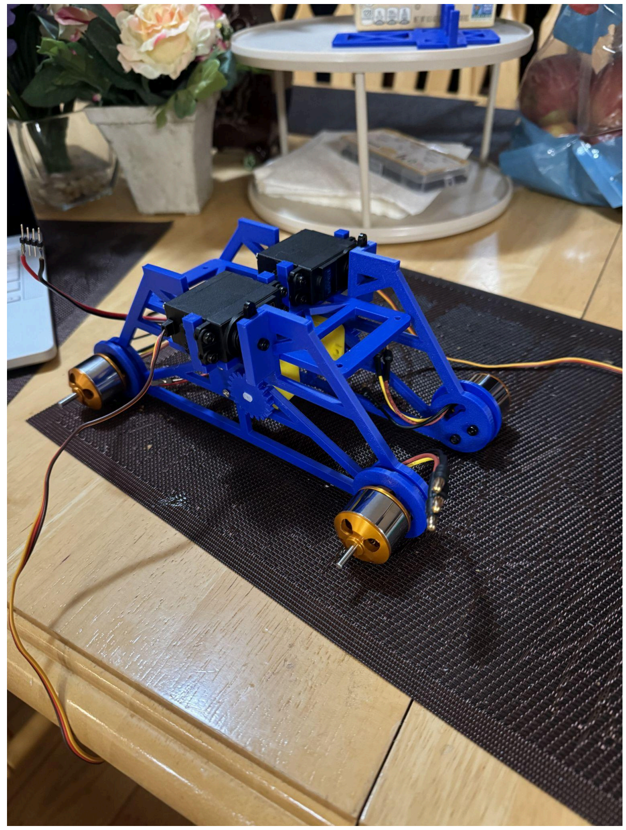
We have assembled the frame and arms to test their functionality with the servos and motors. Following the initial assembly, we identified several areas that required refinement. The orientation of the servos was readjusted to improve alignment and minimize mechanical stress during actuation. Additionally, dedicated mounting spaces were created for the ultrasonic sensor and battery to optimize weight distribution and ensure secure placement. To further enhance the robot's stability, we designed and integrated landing gear, which provides additional support during operation.







Flight Mode



Drive Mode

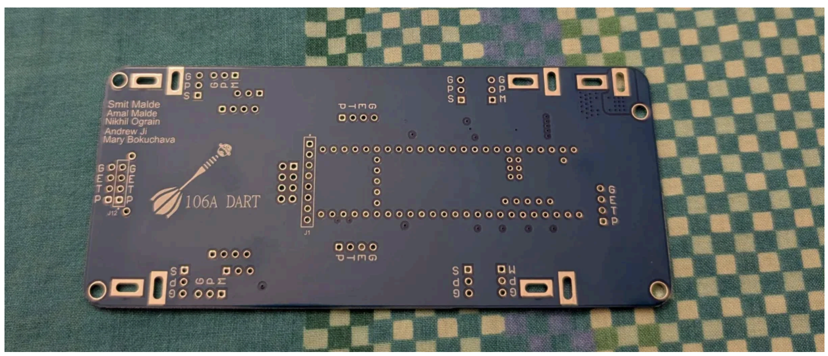
After we completed assembly of the frame and the arms, as shown above, we tested the joint movements, and ensured that there were no obstacles in the 2 possible system positions: drive and flight mode.

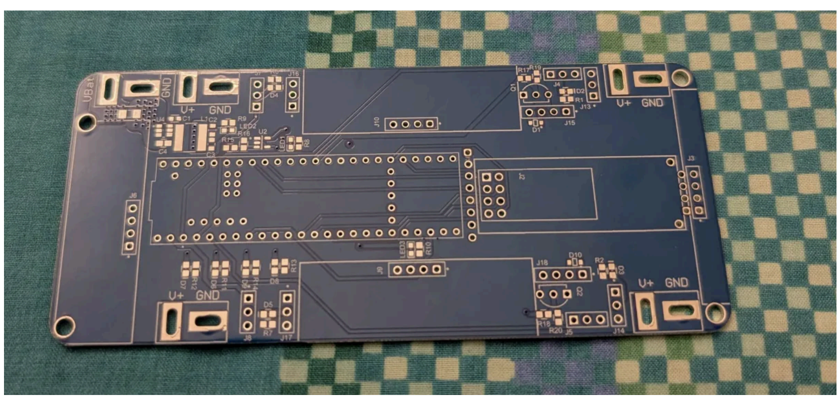
<u>Additional Support Components</u>

We are continuously printing additional support materials, including servo horns, spacers, and landing gear, to enhance the structural stability and overall functionality of the system. As we continue to update features and tweak our design, we also have been creating other supporting components to accommodate for these changes.

Electrical

PCBs were delivered and we soldered all components onto the boards to enable their functionality.





Software

We have finalized the firmware and are now awaiting the complete assembly of the robot to proceed with full testing. One of the key updates on the software side was editing the radio packet structure to optimize packet delivery between the remote control and the robot body. This modification improves the reliability and efficiency of communication, ensuring smooth operation and responsiveness.

```c
typedef struct {
    uint16_t leftJoystickX:10;
    uint16_t leftJoystickY:10;
    uint8_t leftJoystickSelect:1;

    uint16_t rightJoystickX:10;
    uint16_t rightJoystickY:10;
    uint8_t rightJoystickSelect:1;

    uint8_t isFlightMode:1;
    uint8_t isAutoMode:1;
    uint8_t buttonOne:1;
    uint8_t buttonTwo:1;
    uint8_t buttonThree:1;
} RadioPacket;
```

In terms of software, there haven't been many new updates since the firmware is already complete. The firmware has been thoroughly tested and verified in earlier stages of the project. Once the full assembly is complete, we will conduct comprehensive system testing to ensure seamless integration between the hardware and software components.