EE344 : ELECTRONIC DESIGN LAB

WINDOW CLEANING DRONE

TEAM ID : MON-13

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MILESTONE 3

FEEDBACK FROM MILESTONE 2

1. Integrating SMPS into the drone would have issues with scalability as it might pose safety challenges while traversing higher floors.
2. Keep an on-board tank instead of a ground motor for similar reasons.
3. Attaching any kind of wire/pipe would limit the drone’s range while also make it difficult to reach certain inaccessible areas of buildings.
4. Ensure proper insulation and isolation of electrical components from the water pump to prevent unexpected short circuits which could be very harmful given the amount of current which will be flowing through the wires.

MILESTONE 2 ACTIONS

- Using an on-board battery and a water tank for the power and water supply respectively.
- Using XT60 connectors for all on-board connections to prevent unexpected short circuits due to improper soldering or stray wires.
- The XT60 connectors also reduce the need to solder-desolder wires every time to test.

PROOF OF CONCEPT

PROOF OF CONCEPT - DRONE WORKING

This is the reaction testing of the drone wherein we provide RC inputs to the drone and check if the drone reacts accordingly. In this video, we have tested the Arming input, Roll input in either direction, Pitch input in either direction and Throttle.

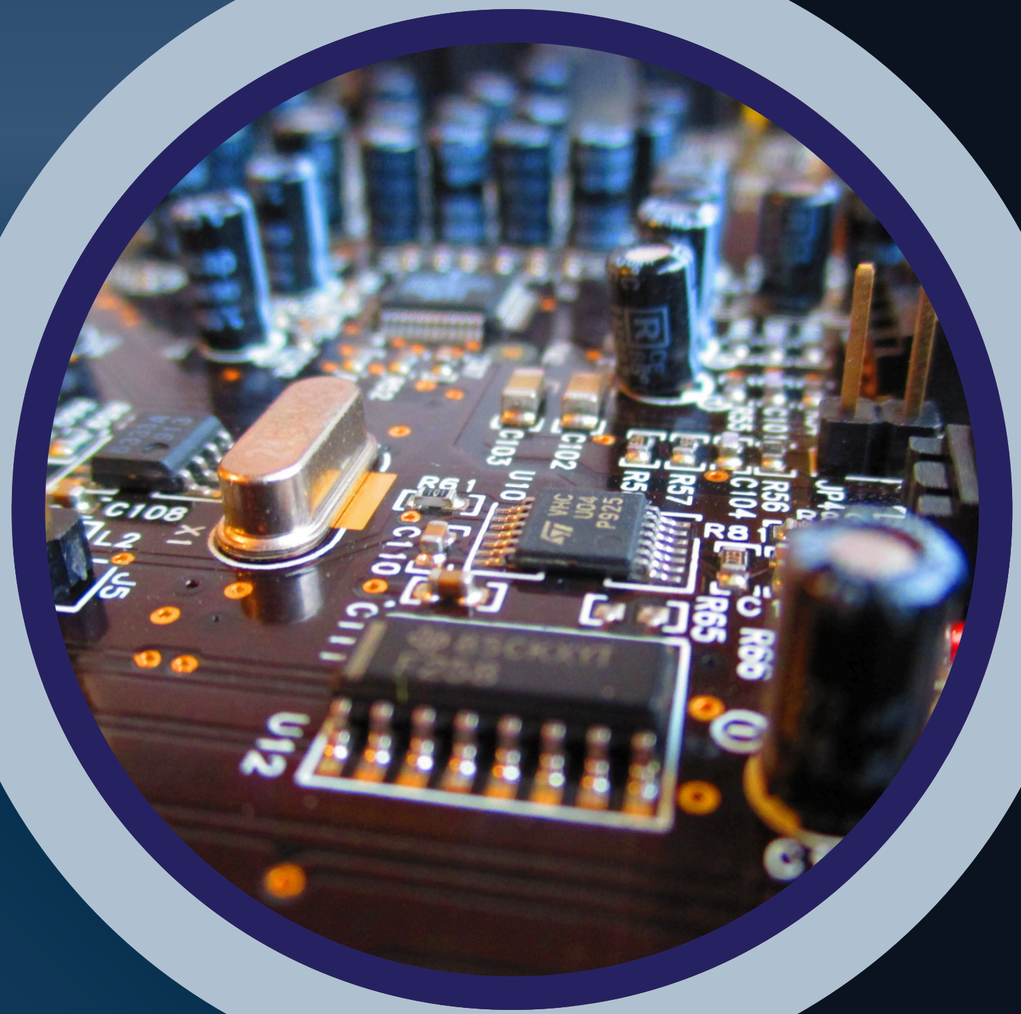
Link

PROOF OF CONCEPT - PUMP WORKING

Here we are testing the variation of motor working with different PWM values which are transmitted using the RC transmitter which is what will be used in the final demo.

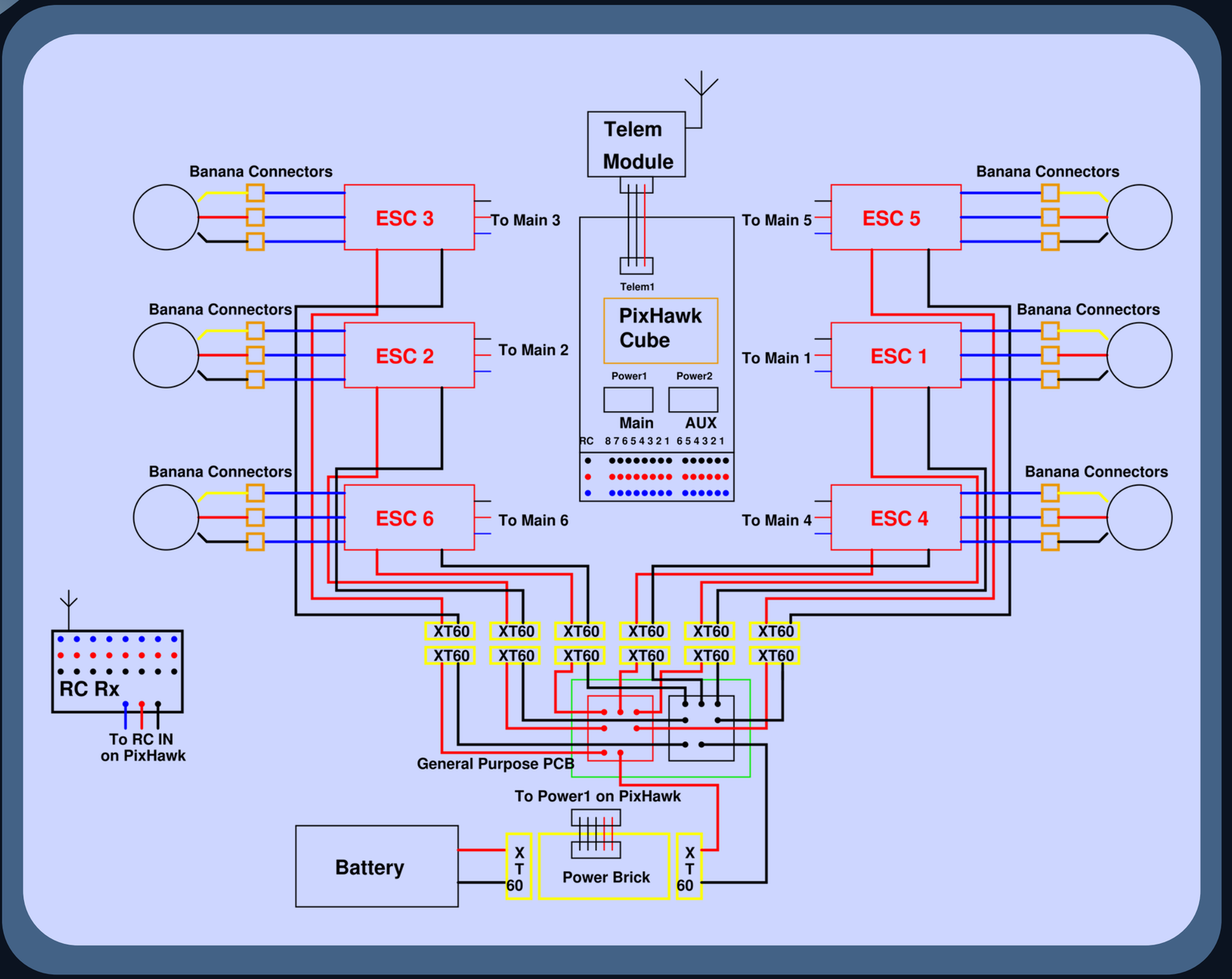
Link

CIRCUIT DIAGRAMS AND FINAL IMPLEMENTATION

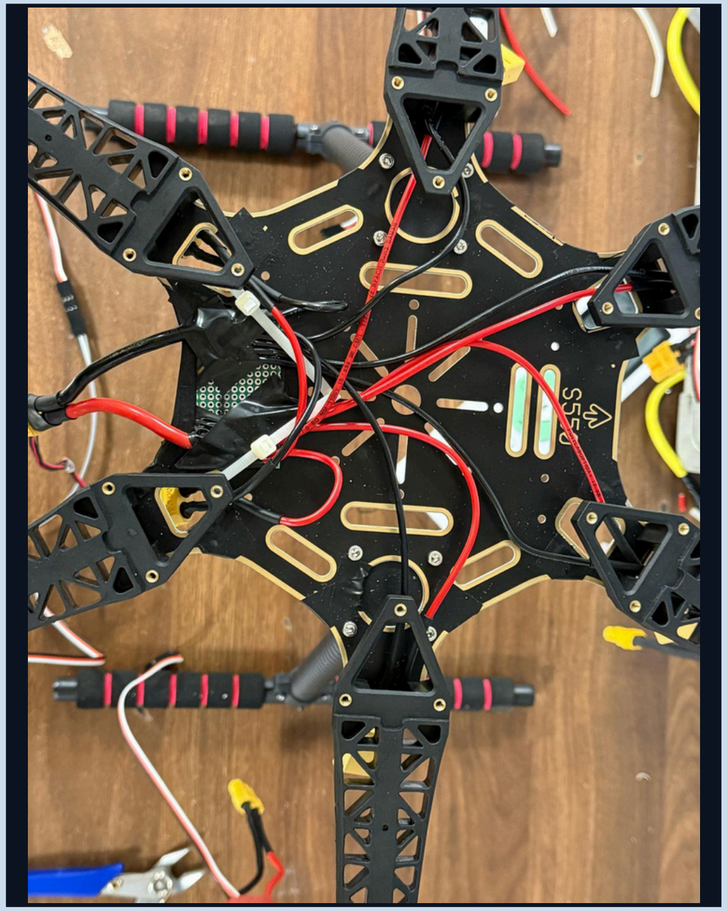


CIRCUIT DIAGRAM

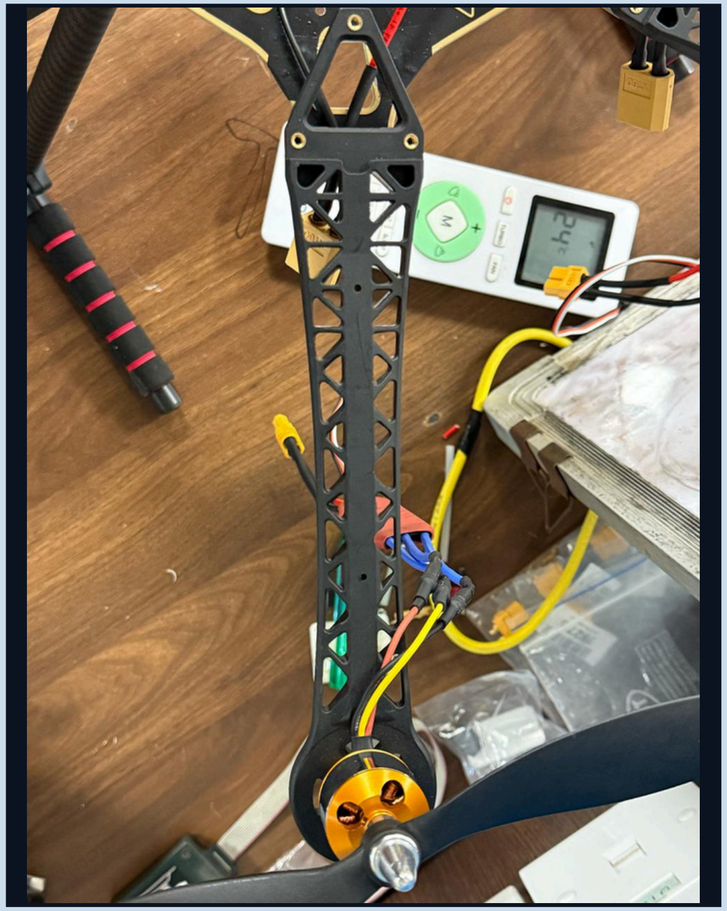
ESC-PIXHAWK-TELEM-RC



CIRCUIT IMPLEMENTATION

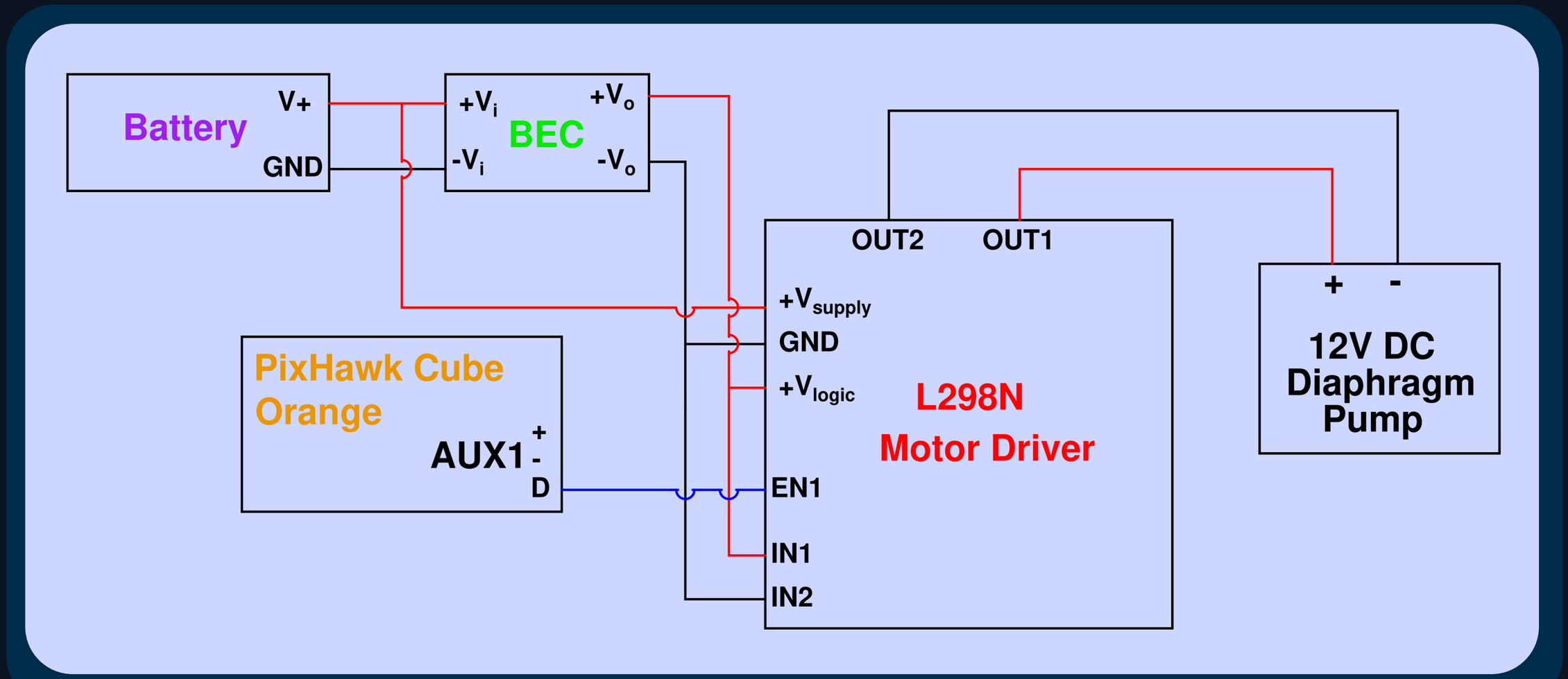


The Power Distribution Board which was given on the Frame was faulty as some ESCs didn't work properly with the board so we made the connections manually on a General Purpose PCB and soldered all connections on it. We created a wire mesh to replace the PDB. The wires in the mesh ended in XT60 connectors to ensure easy usage and a modular circuit.



CIRCUIT DIAGRAM

WATER PUMP

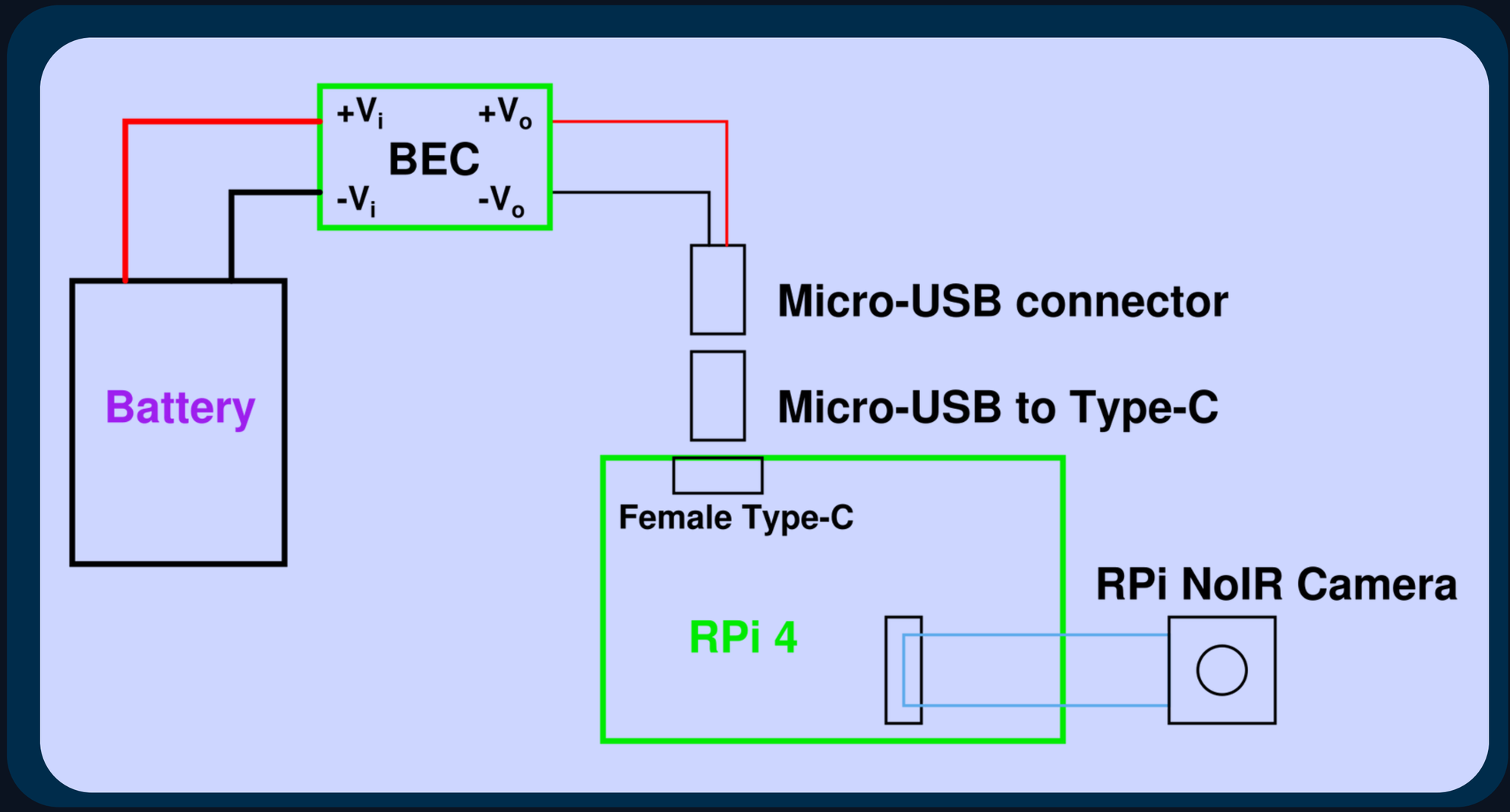


CIRCUIT IMPLEMENTATION

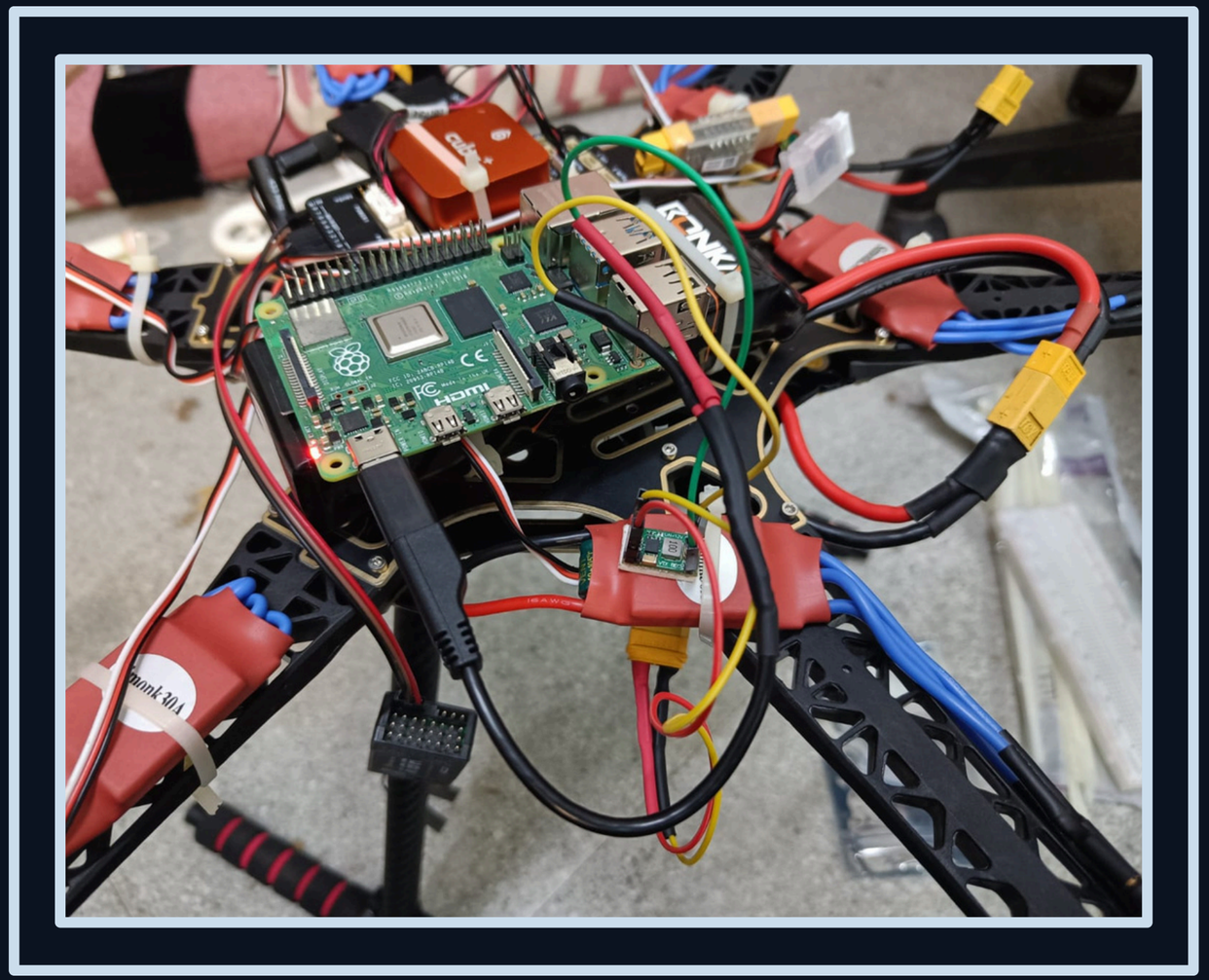
Currently a Breadboard was used to make the connections. The connections will be finalised using connectors in subsequent days.

CIRCUIT DIAGRAM

RASPBERRY PI AND NOIR CAMERA



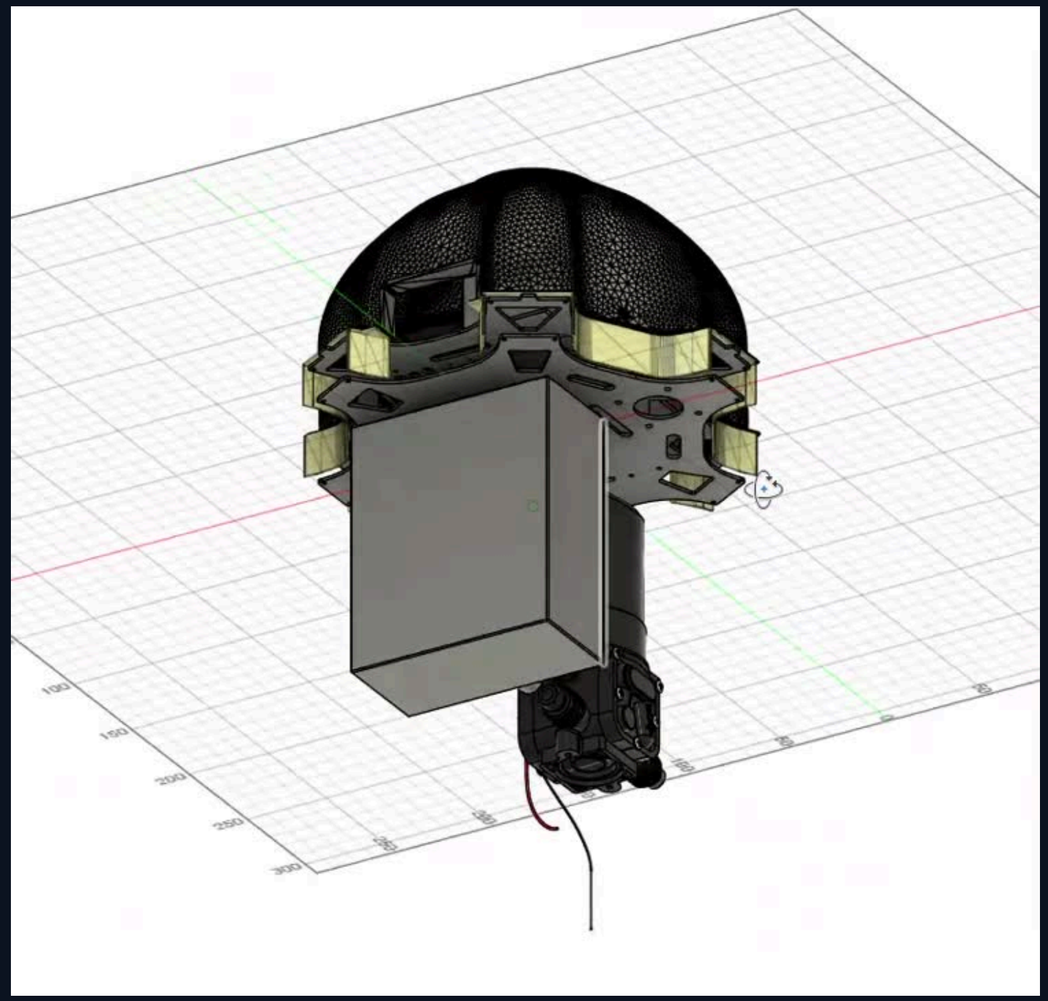
CIRCUIT IMPLEMENTATION



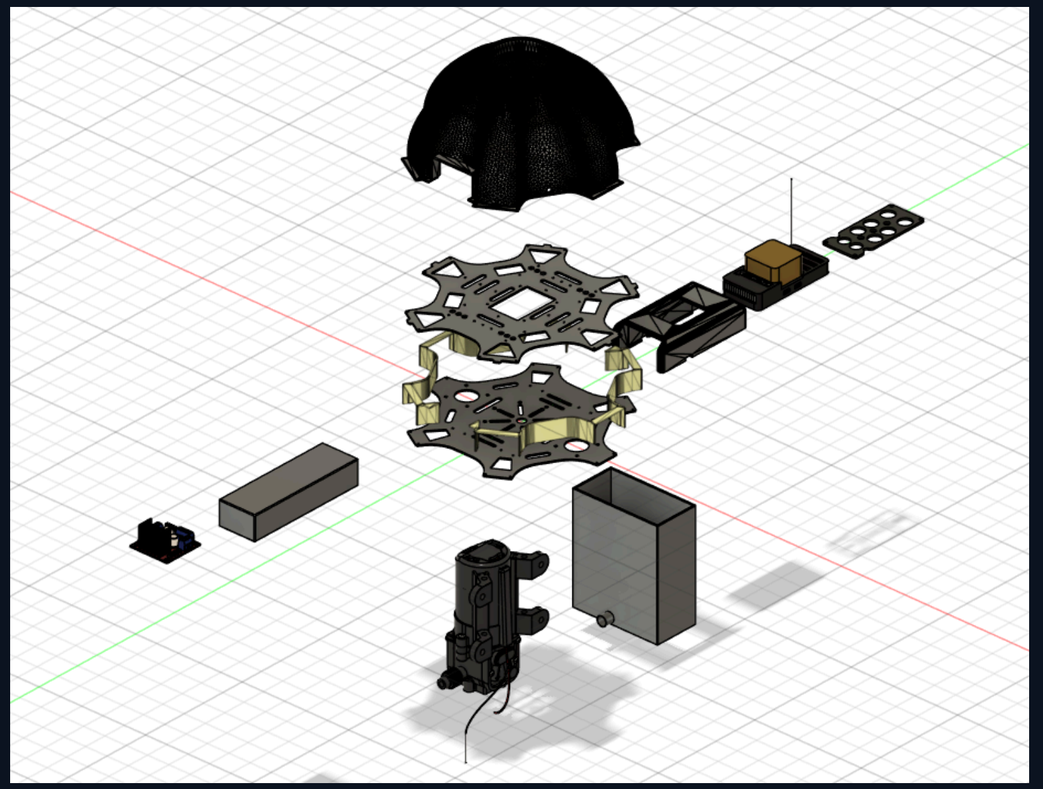
We didn’t have a direct Male Type-C connector so we used the Micro-USB connector and Micro-USB to Type-C converter we got with the Telemetry module to make a Type-C connector to power the Raspberry Pi 4

CAD DESIGNS

CAD FOR THE ASSEMBLY



EXPLODED VIEW



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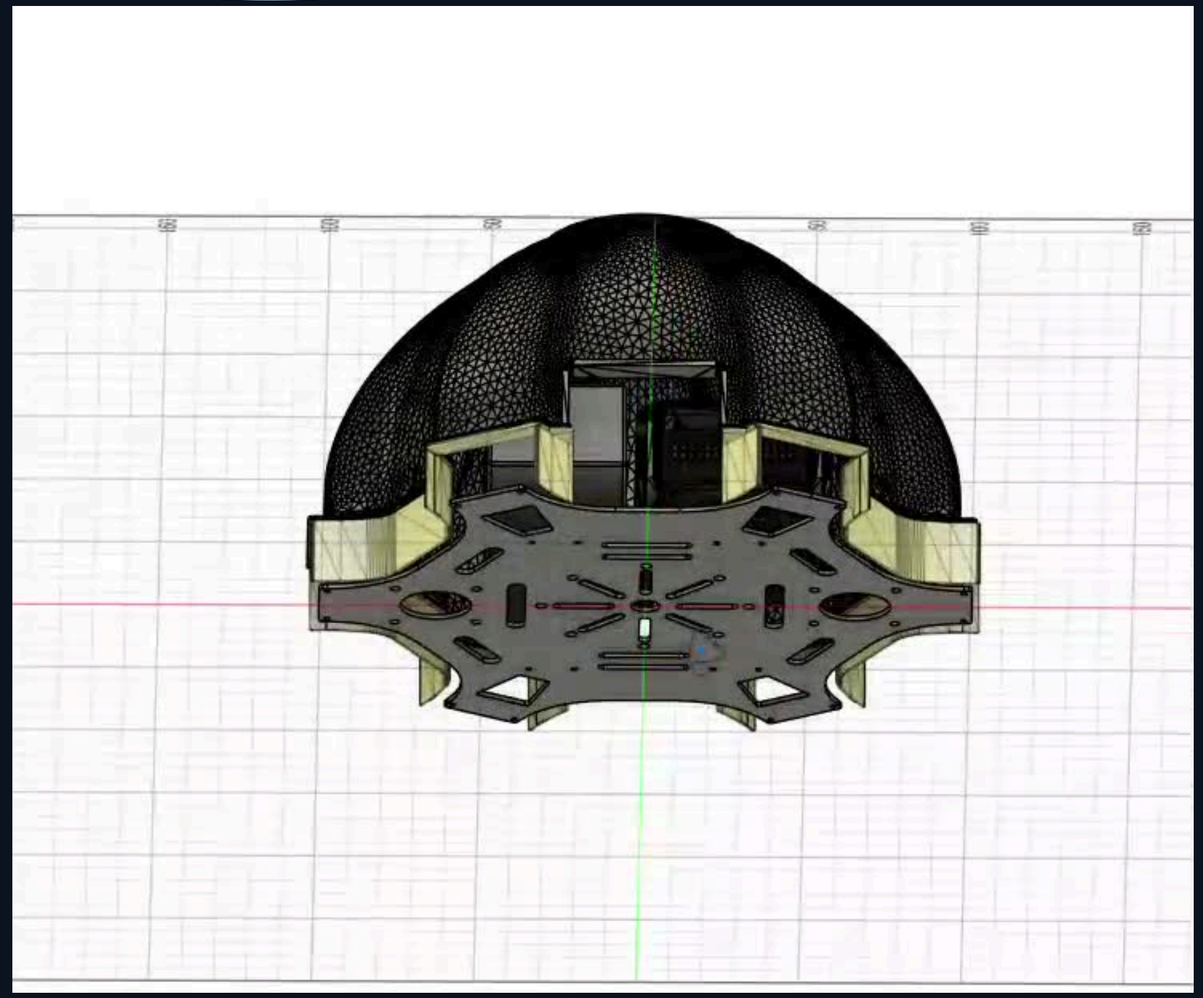
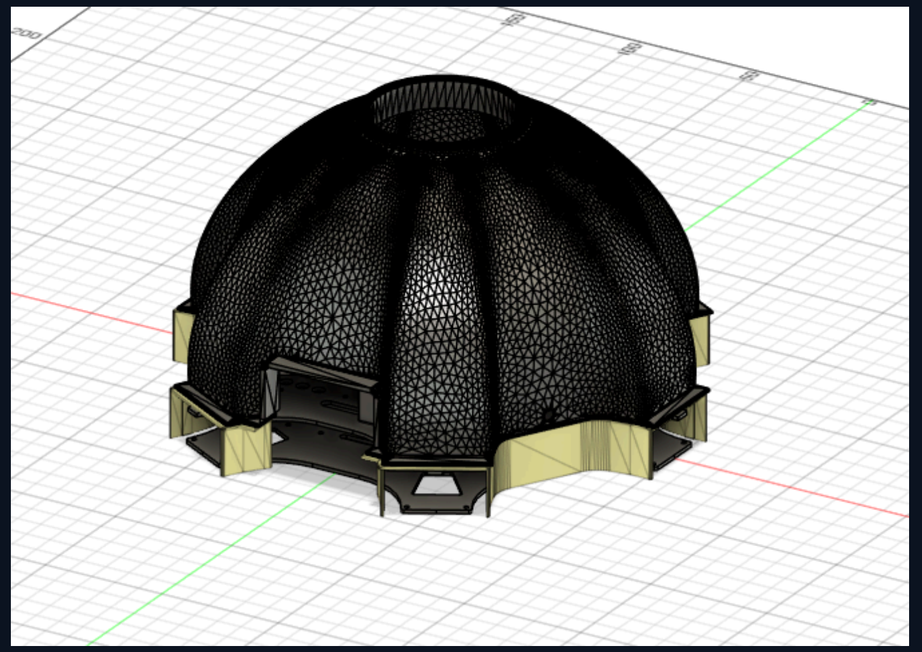
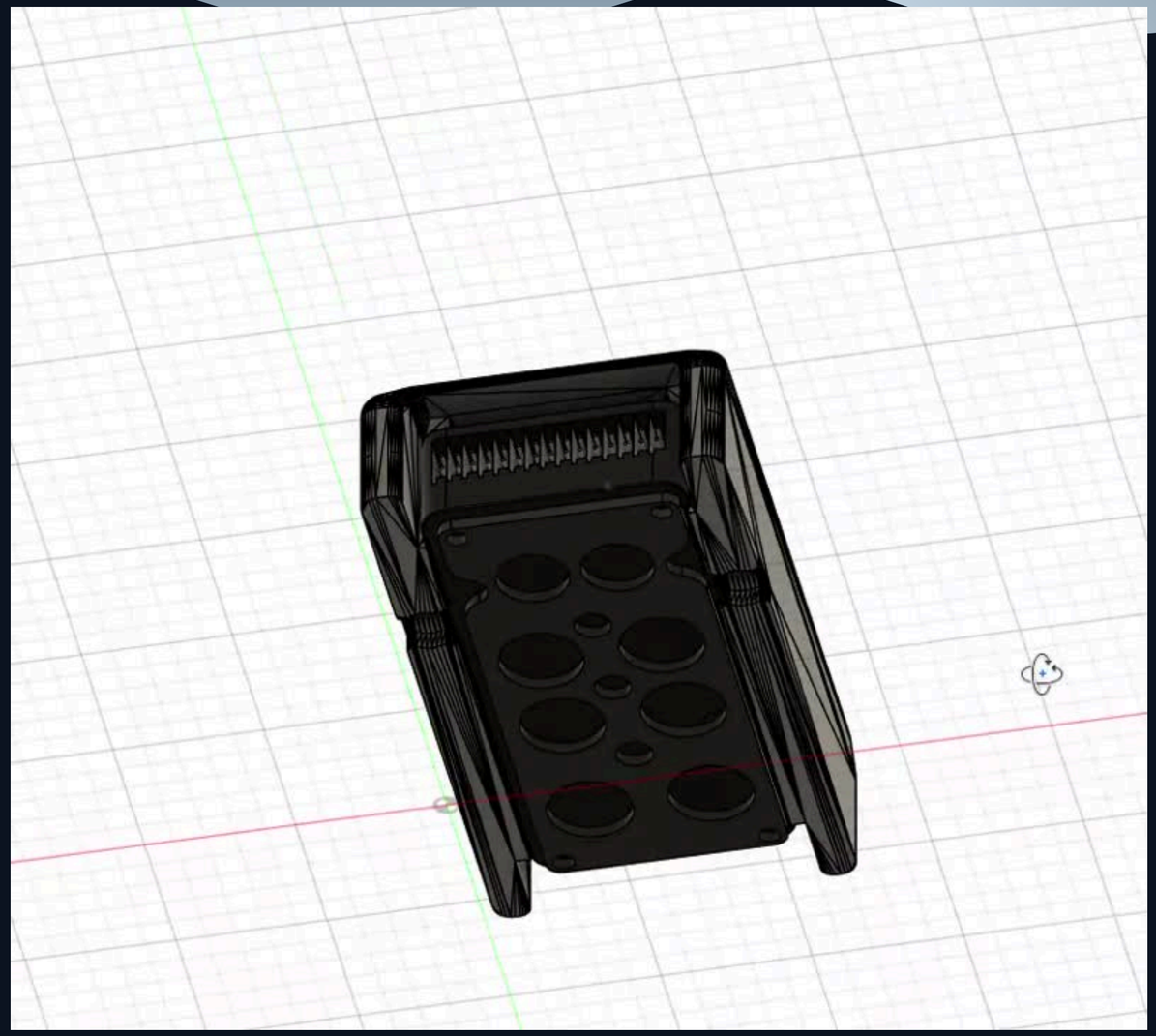
CAD FOR THE CANOPY

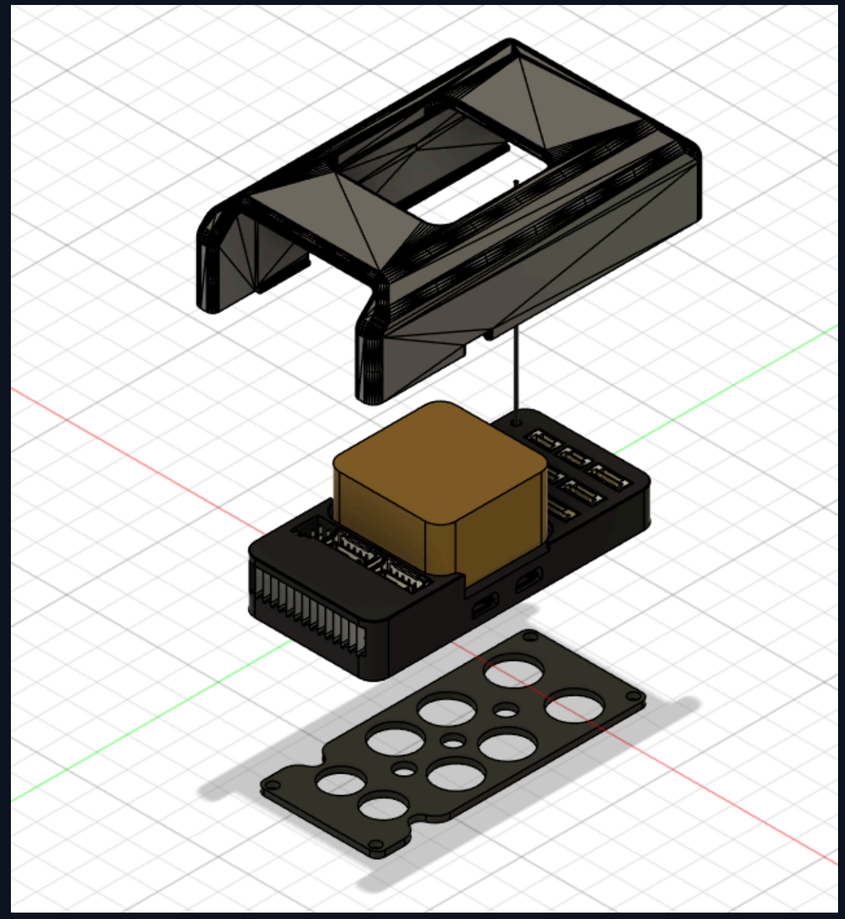




Link

CAD FOR THE PIXHAWK CASING





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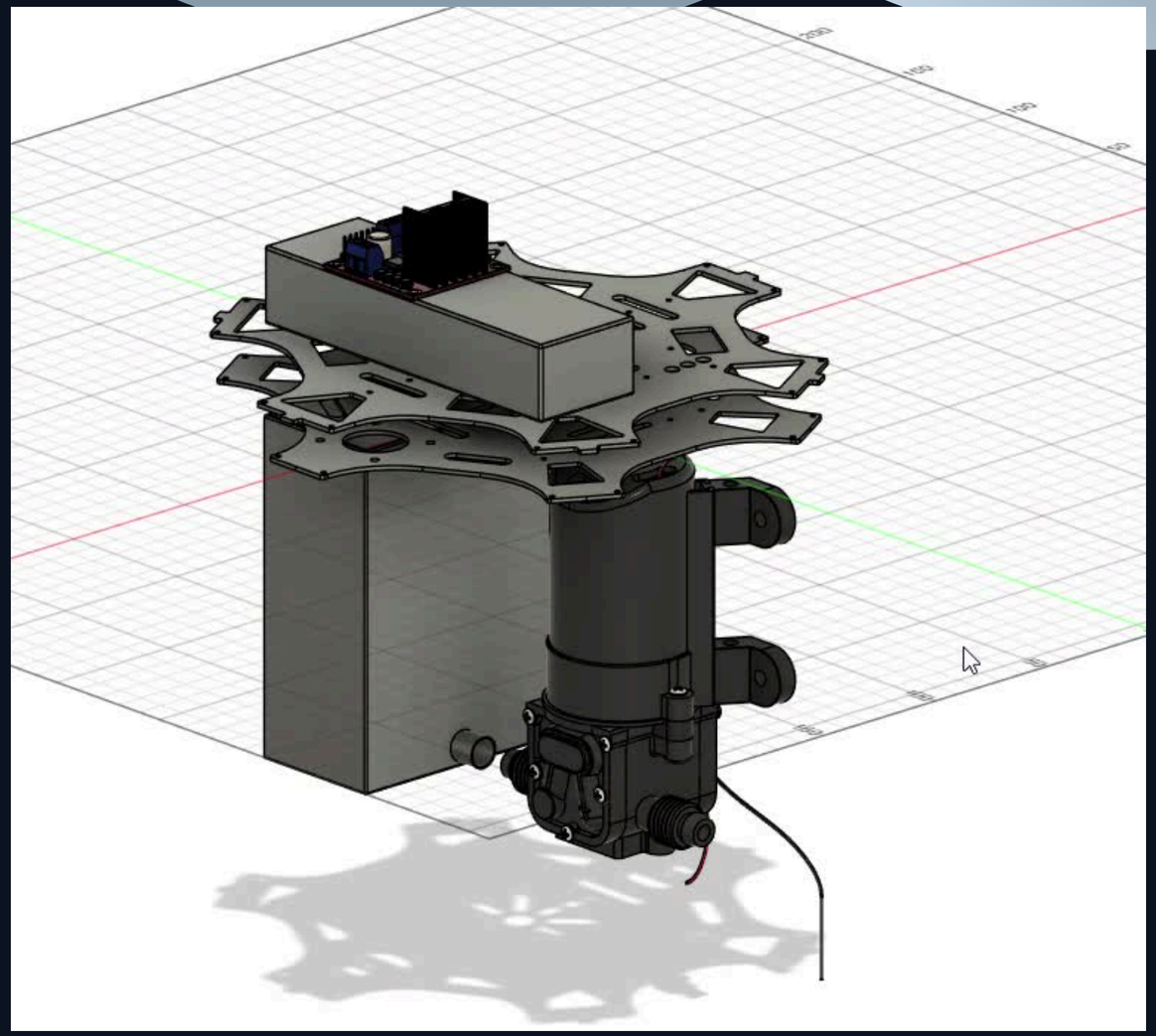
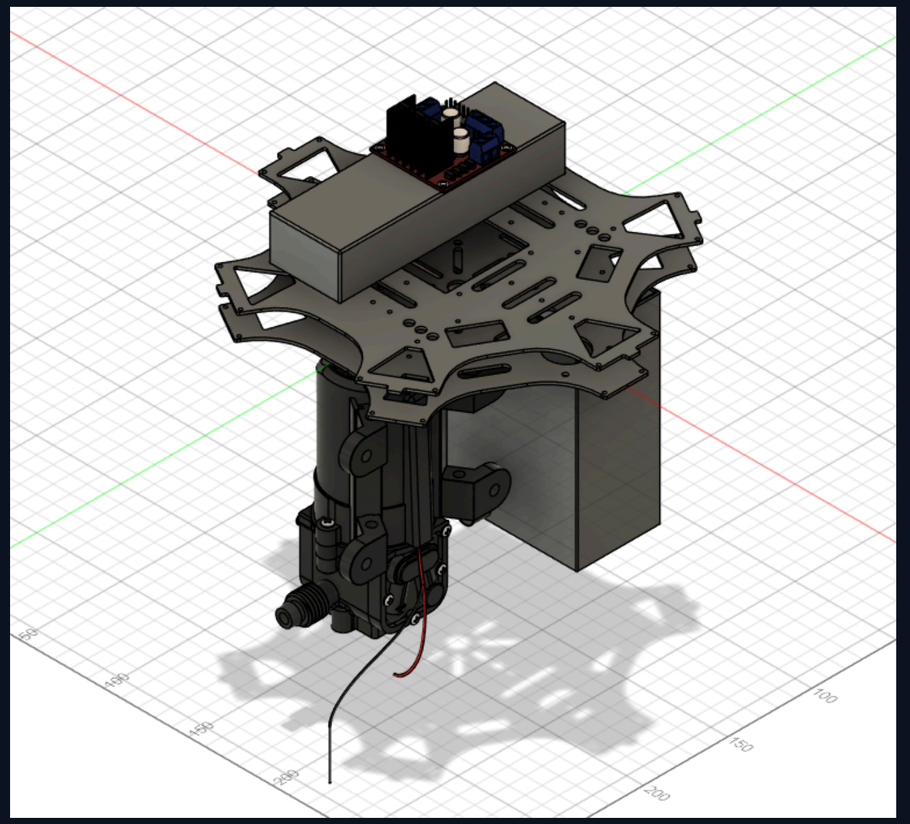
CAD FOR THE WATER MECHANISM





Link

CRITICAL PENDING TASKS

1. Flight test of the drone
2. Integrating the water spraying mechanism
3. Water-proofing of the complete drone and its electrical components using casings and insulating adhesives/tapes.

KEY RISKS

1. Water leakage from the tank or pipes or any part of the water
2. The thrust from the motors on arming the drone is very high, the drone could go out of control if not tuned properly

INTERMEDIATE TESTING

TEST- AUTOPILOT LOADING AND TELEMETRY TEST

- Flashed PX4 Autopilot on Pixhawk flight controller.
- Connected Pixhawk to PC using micro-usb cable and verified interfacing using QGroundControl software
- Connected Telemetry module on PC and to Pixhawk and tested connection.
- Performed sensor caliberation- accelerometer, gyroscope, magnetometer and level horizon

TEST- INDIVIDUAL ESC+MOTOR

- Powered up a single ESC using Lipo battery
- Assign a channel to the ESC on the Pixhawk
- Connect a BLDC motor to the terminals of the Speed Controller
- The RPM output of the Motor is tested for varying values of the input PWM signal to the Pixhawk. This was controlled using the QGC interface

TEST - ALL ESCS+MOTOR

- Connected the power supply and ESCs to the PDB, assigned channels to all motors
- Performed ESC caliberation
- Varied PWM input to the ESCs and verified operation of all Motor + ESC pair.

Note : After this testing, we found a few ESCs did not operate as expected despite appropriate voltage levels. We identified an issue with the off-the-shelf PDB
At this stage we designed our own PDB on a general purpose board, and tested again
All ESCs functioned properly and we also noted Current vs PWM output vs RPM vs Voltage output at motor pins for an ESC

TEST- RADIO RECEIVER-TRANSMITTER TEST

- Performed receiver-transmitter binding.
- Connected the receiver to Pixhawk and calibrated transmitter ports for roll, pitch, yaw and throttle
- The responses of the ports was tested and verified on the QGC Interface

TEST- CHANNEL MAPPING OF ALL MOTORS AND RADIO TEST

- Mapped each motor to respective channels on Pixhawk.
- Controlled motor rotation using transmitter and observed its response
- All motors were tested in no-load condition and the response was as expected

TESTING PUMP MOTOR AND MOTOR DRIVER TESTS

- Powered up L298N motor driver using Lipo battery and tested voltage levels at output using a fixed voltage input from a power supply.
- Powered up the 12V DC Diaphragm Pump directly by the battery and observed the volume flow rate by connecting its inlet to a water container.

CONTROLLING PUMP MOTOR USING RC

- Assigned an auxiliary channel of Pixhawk for pump operation, and set relevant PX4 parameters for binding RC ports to the channel.
- Verified it’s operation by first observing voltage levels at the output pins of Pixhawk. The channel used had only 2 operating levels, half PWM and full PWN
- Connected the motor driver setup to Pixhawk and validated operation of pump using Radio Control

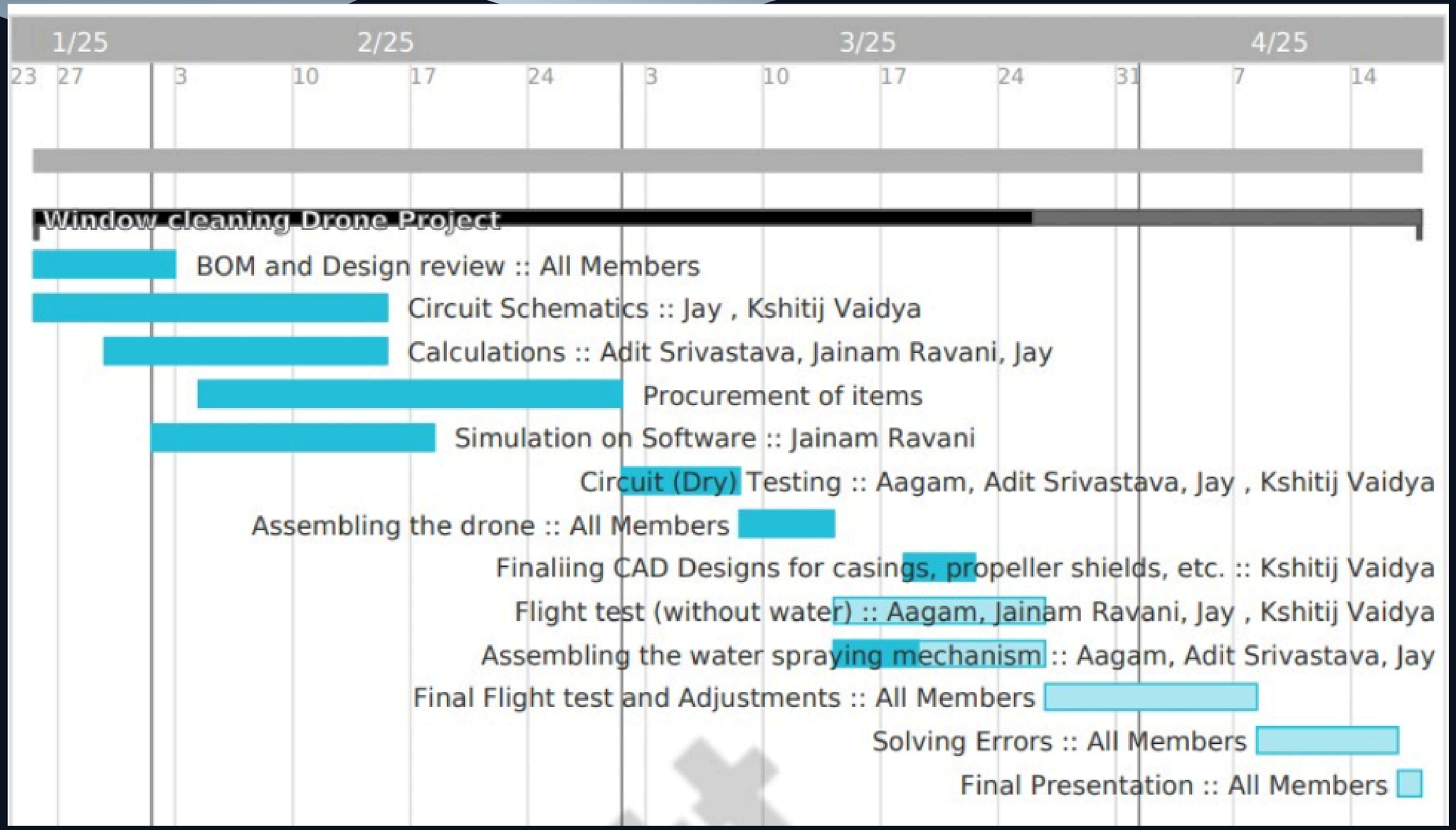
RESPONSE TESTING OF DRONE

- Installed all propellers in place and physically held the drone overhead to check its response
- Throttle, Roll, Pitch and Yaw channels of the Radio Control were triggered and the response of the drone was verified.

All testing videos can be accessed through the following link: Link

TASK MANAGEMENT

UPDATED GANTT CHART



WORK DISTRIBUTION UNTIL FINAL DEMO

- Assembly of water spraying mechanism - Adit, Aagam
- Design of mounts for PixHawk, RPi and other components - Jay, Kshitij
- Making the drone ready to fly - Jainam
- Flight Test without water - Everyone
- Adding the RPi and Camera on-board - Jainam, Aagam, Adit
- Ensuring proper water proofing of the drone - Jay, Kshitij
- Integration of water mechanism on drone - Everyone
- Final Flight Test - Everyone

THANK YOU !