RED HORIZON

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The Galaxy Dragons

Introduction

Luis Corona

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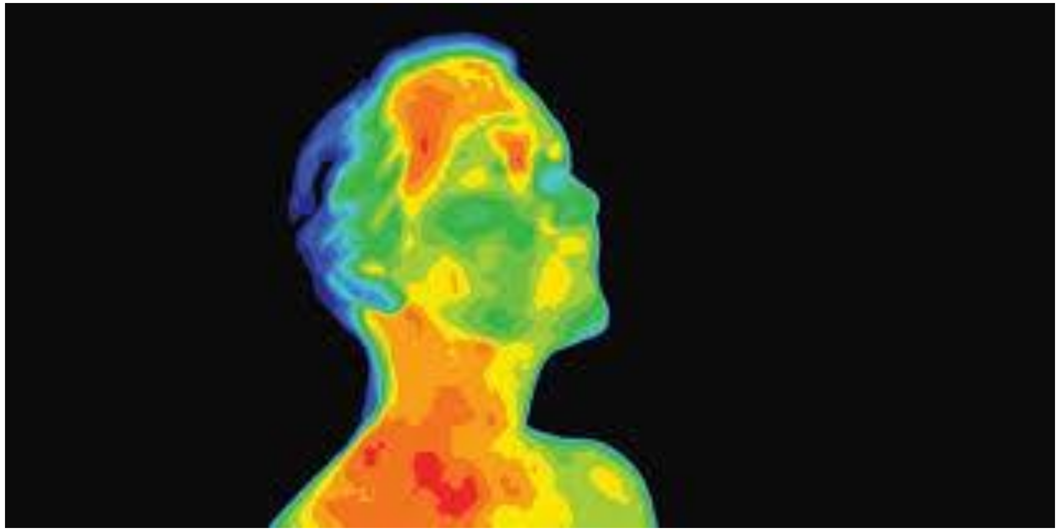
Project Overview

- Main purpose is for search and rescue situations
- Small and easy to transport.
- Cover areas with small amount of manpower
- More cost effective than using other type of equipment (choppers, search crews, etc.)
- Accurate information and data
- Thermal camera makes it easier to find human in large areas

Covid-19 Drone

- Thermal Camera can be fine-tuned to help detect people with Covid-19
- Sanitary
- Can cover large crowds of people
- Can help prevent the spread of the virus



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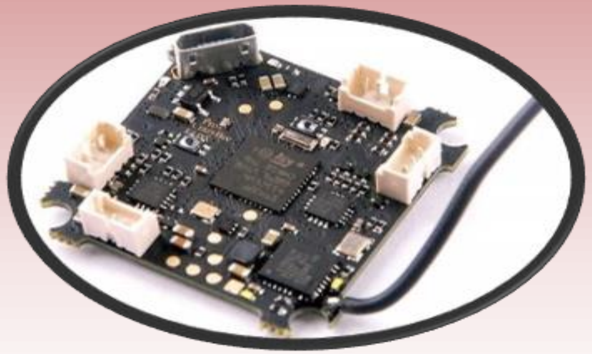
Key Components

- Carbon fiber Frame
- Electronic Speed Controller
- Flight Controller
- Thermal Camera



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Delivery Date

- December-January: Order the parts and test them.
- January-February: Build and test the assembled components
- February-March: Tune the drones flight and mount the camera to the drone.
- March-April: Finalize our hardware and software.
- April: Have completed project.

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New Issues

- S-Bus connection issues
- Motor twitch
- Fail Safe Error

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Solutions to our New Issues

- Originally, we had I-Bus connection but our flight controller was S-Bus
- Solution:

Switched controller and receiver to S-Bus

- Motors would twitch when power was connected
- Solution:

Re-Soldered all motor connections to flight controller to ensure a secure connection

Solutions to our New Issues

- Fail safe error would not let us control our drone via the remote
- Solution:

Once our wires were soldered correctly the drone was able to be taken out of failsafe mode and operated

Basic Aerodynamics of a Quadcopter

Christopher Smith

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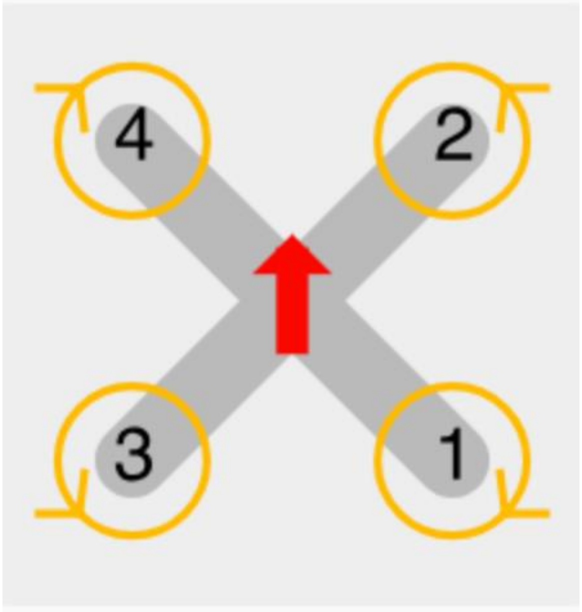
Motor Orientation(Clockwise or Counter Clockwise)

- BOTH!
- The motors that are positioned next to each other should spin in opposite directions while the motors that are diagonal from each other should spin in the same direction.
- This is mandatory, no exceptions.
- If all motors spun in the same direction the quadcopter would keep spinning in that direction.
- Having the motors spin clockwise and counter clockwise allow the net forces to cancel each other out, thereby allowing stability.



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Thrust

- To get your drone to lift off the ground the motors must generate thrust by rotating at fast speeds.
- This act then pulls air downward and raises the quad off the ground. This is called thrust.
- When the motors generate a thrust that is greater than the weight of the drone, the drone will rise upwards .
- A decrease in thrust will cause the drone to lose height.

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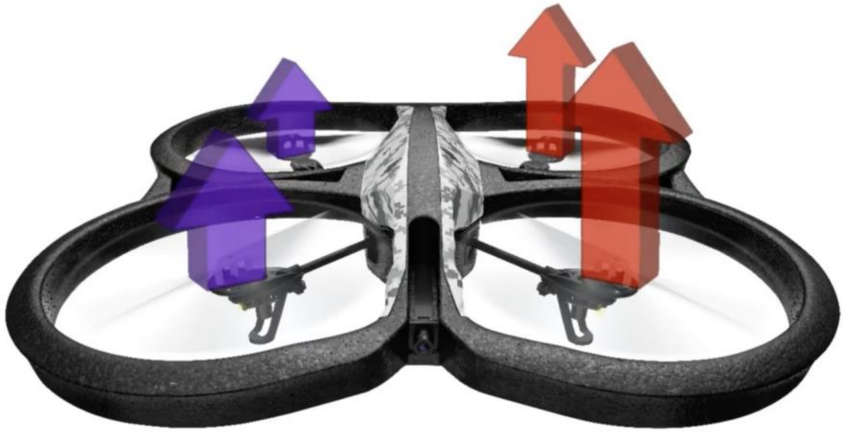
Roll

- Rolls means to move you drone left or right, not to be confused with rotating.
- To roll your drone to the right the thrust is increased on the left while the thrust is decreased on the right.
- The reason you increase one side while decreasing the other is because you still want to keep that net torque at zero.



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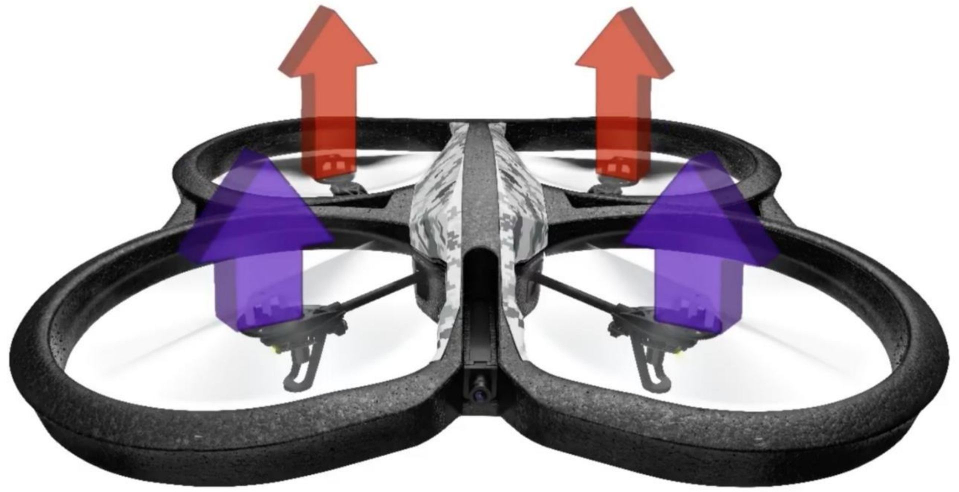
Pitch

- Pitch means to move forward or backwards.
- To move forward, just like roll, we need two motors
  to increase thrust while the other two are decrease.
- To move forward the rear motors increase.
- This causes a net forward force.



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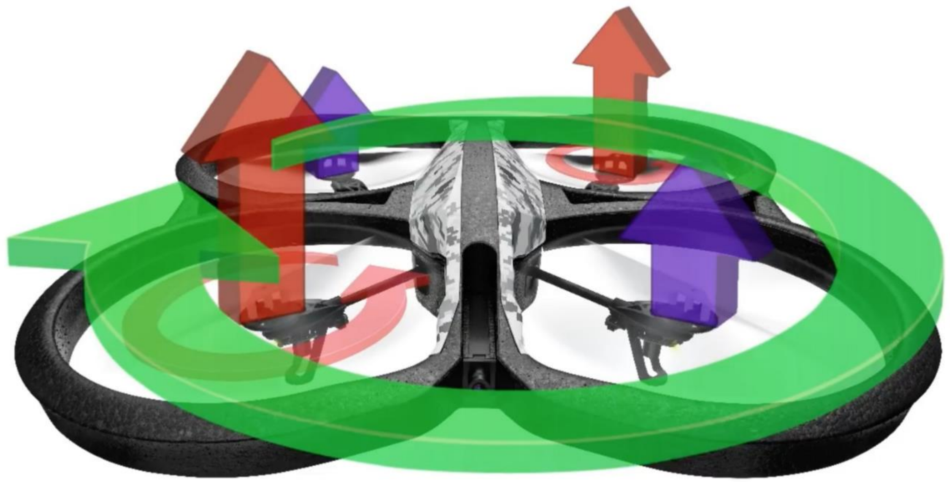
Yaw

- Means to rotate about the center axis.
- To yaw counter clockwise we increase thrust on the opposite clockwise motors while decreasing thrust on the opposite counter clockwise motors.



Advance Aerodynamics of a Quadcopter

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New Challenges for Flight

- Drone flight produces new areas of difficulty for engineers such as
  1. Six degrees of freedom
  2. Low Reynolds Number
  3. Close proximity motors

  to name a few.

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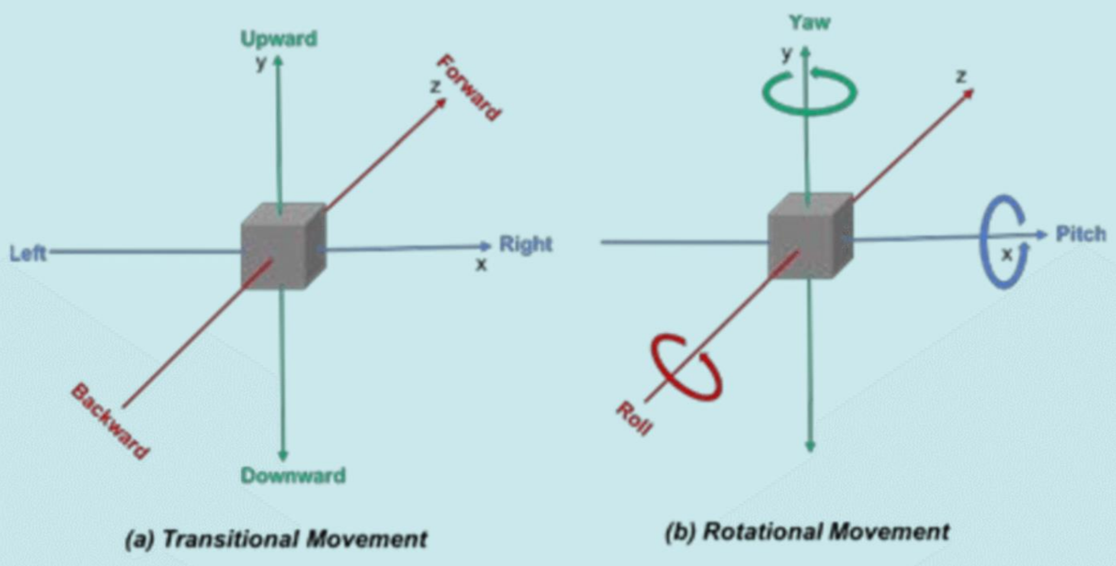
Dynamics

- There are two coordinate frames that drones use. 1) The inertial frame 2) The body frame.
- The position and velocity of the drone lie in the inertial frame
- Whereas the roll, pitch, and yaw angles lie in the body frame
- These frames describe the six degrees of freedom(translational and rotational motions). This makes drone flight extremely difficult to calculate especially once coupling with aerodynamic effects.



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Motors

- The torque produced by brushless motors is given by the equation

$$\tau = k_t(I - I_0)$$

- Voltage that is measured across the motor is given by the equation

$$V = IR_m + K_v\omega$$

- The power the motor consumes is given by

$$P = IV = \frac{(\tau + K_t I_0)(K_t I_0 R_m + \tau R_m + K_t K_v \omega)}{K_t^2}$$

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Forces

- Power is also equal to the (thrust x air velocity)

$$P = TV_h$$

- Air velocity when the drone is hovering

$$P = \frac{T^{\frac{3}{2}}}{\sqrt{2\rho A}}$$

- Thrust

$$T = \left(\frac{k_v K_\tau \sqrt{2\rho A}}{k_t}\omega\right)^2$$

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Improvements for Next Version

- Blades below frame to subtract downward forces on drone.
- More precise choice of propeller blades to maximize efficiency.
- Shell to make drone more aerodynamic.

Building Process

Luis Rocha

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Assembling

- Connecting Receiver
- Soldering Receiver
- Charging Battery
- Connecting Top Frame

Testing

- Tuning Remote with Drone
- 1st Flight Test

Camera

- Programming Camera
- Making it work wirelessly
- Mounting Camera to drone

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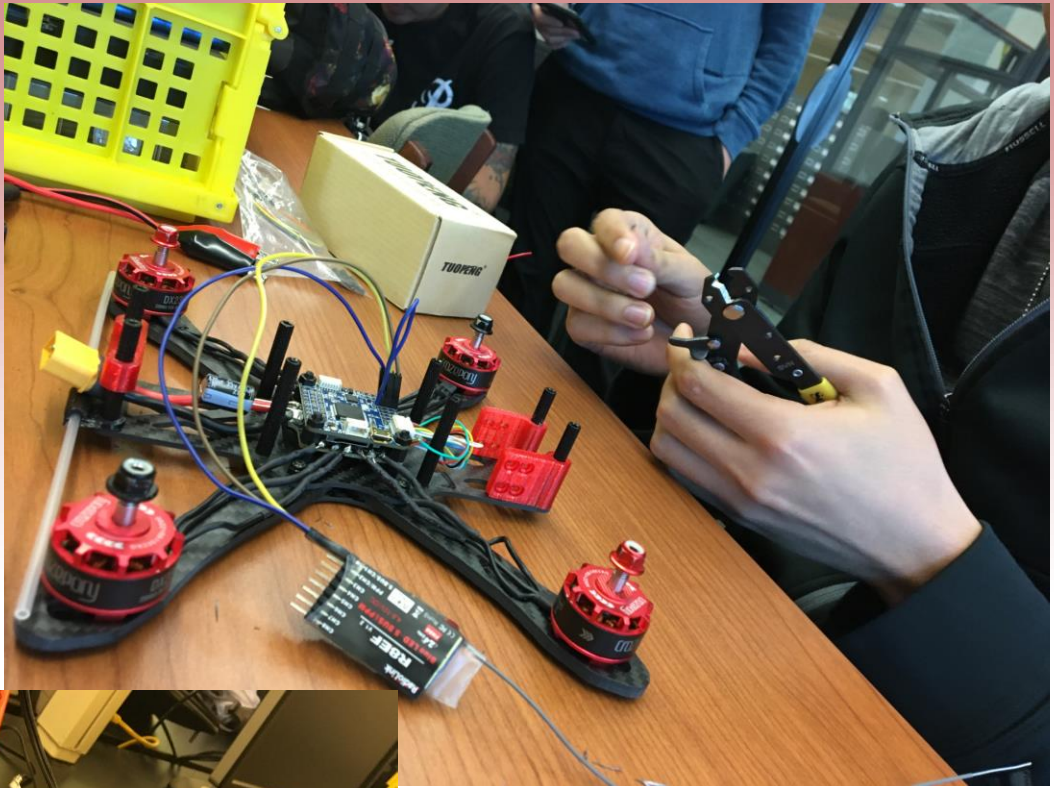
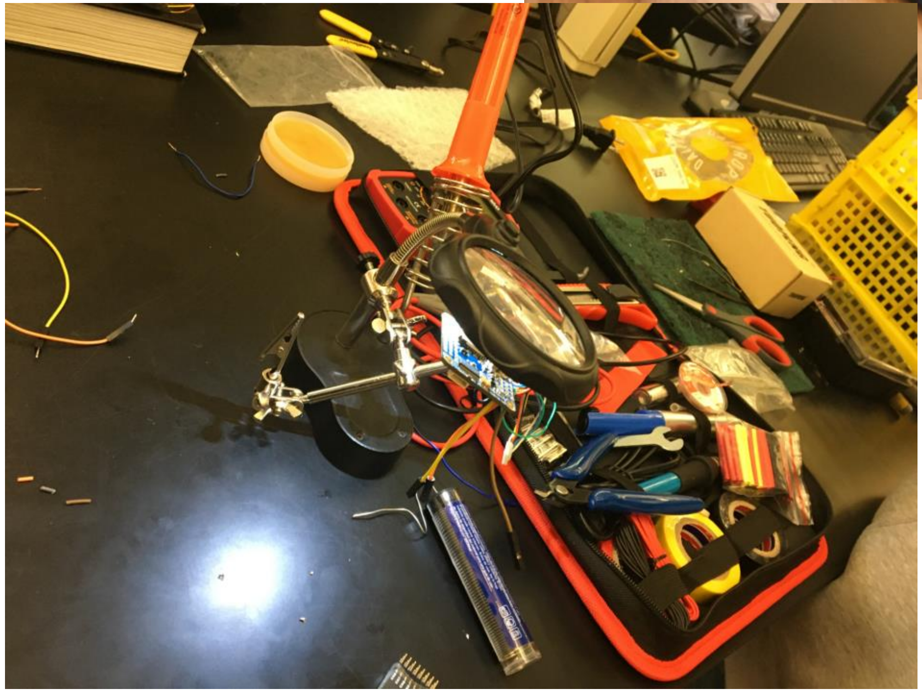
- Connecting Receiver

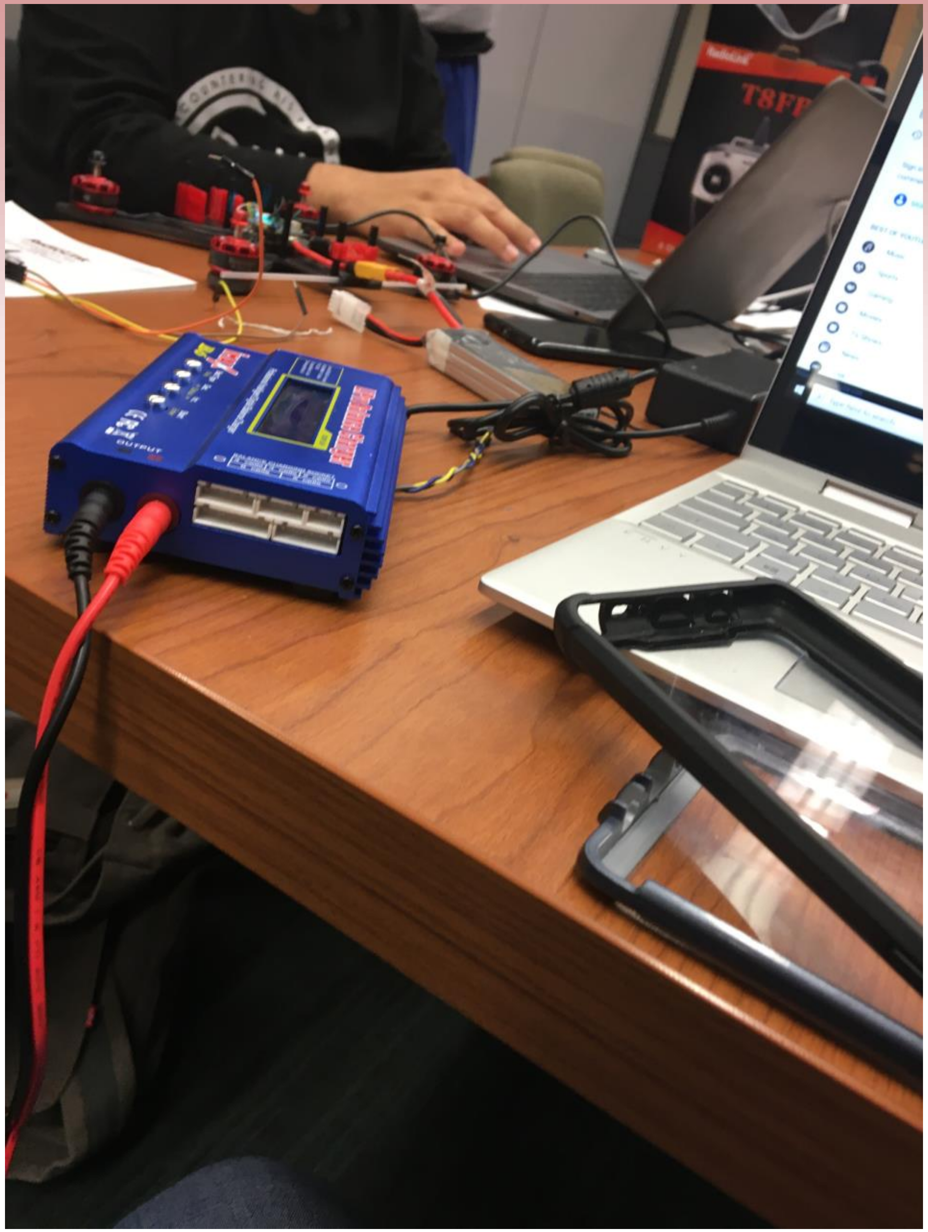
We make sure that every wire was connected to the right input in the flight controller.



- Soldering Receiver

Easy process since we soldered the previous wires to the speed controller.





- Charging the Battery

For our battery, we are using an ImaxB6 mini Lipo battery charger, which is a high-performance, micro-processor controlled charge/discharge station with battery management suitable for use with all current battery types, with integral equalizer for six-cell Lithium- Polymer (LiPo), Lithium High Volage(LiHV),Lithium-Ferrum (LiFe) and Lithium-Ion (LiIon) batteries; maximum 6A charge current and 60W charge power. We had to plug both red and blakc wire to the battery terminals, as well as the special connector.

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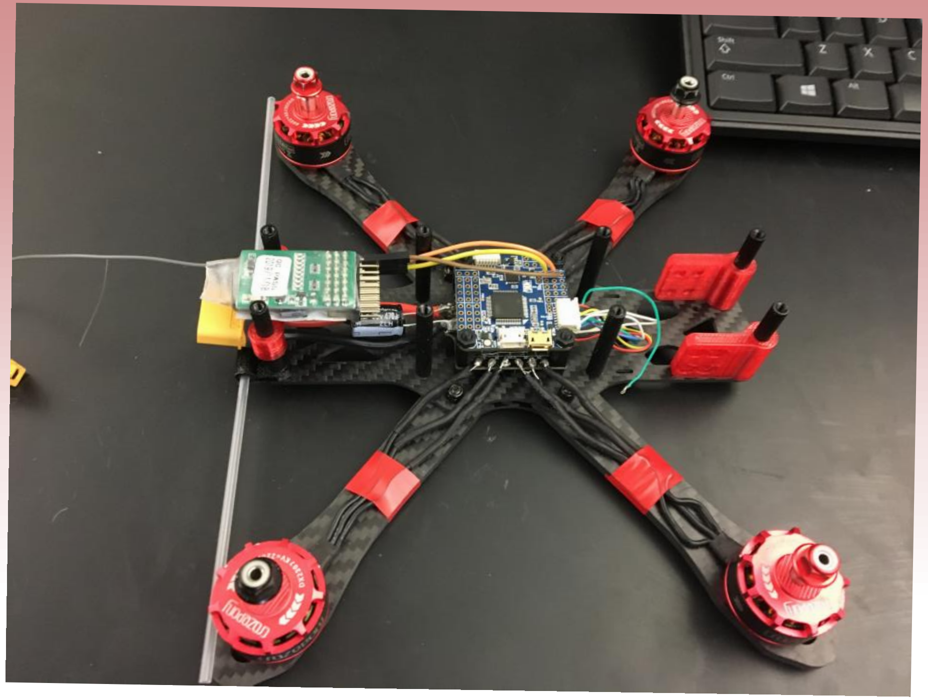
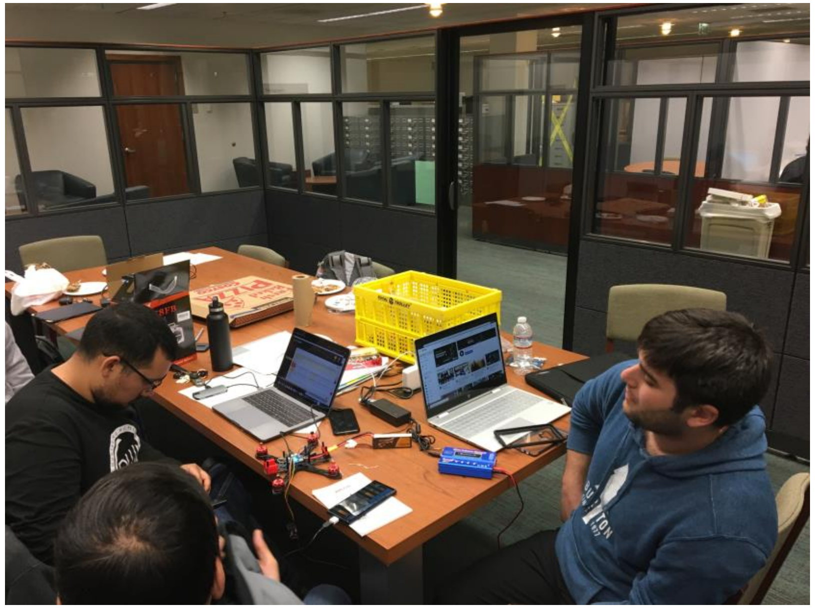
Connecting Top Frame

We just put the top frame in our drone since we are not going to need it open anymore.



- Tuning Remote Control with Flight Controller

This was the hardest and most complex process so far since we didn't have experience on this. However, we had a little help doing it(see last slides of presentation).



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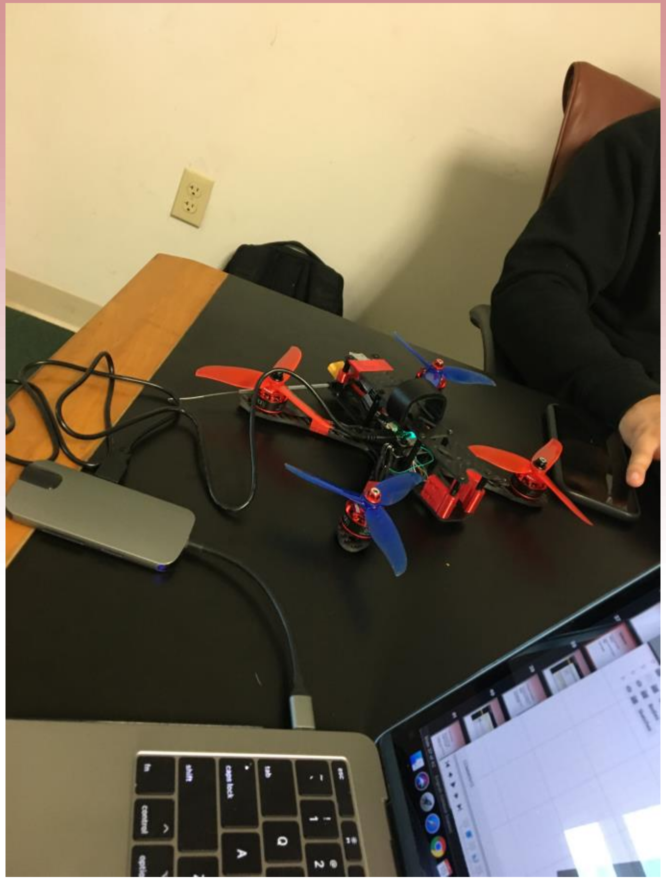
1st Flight Test

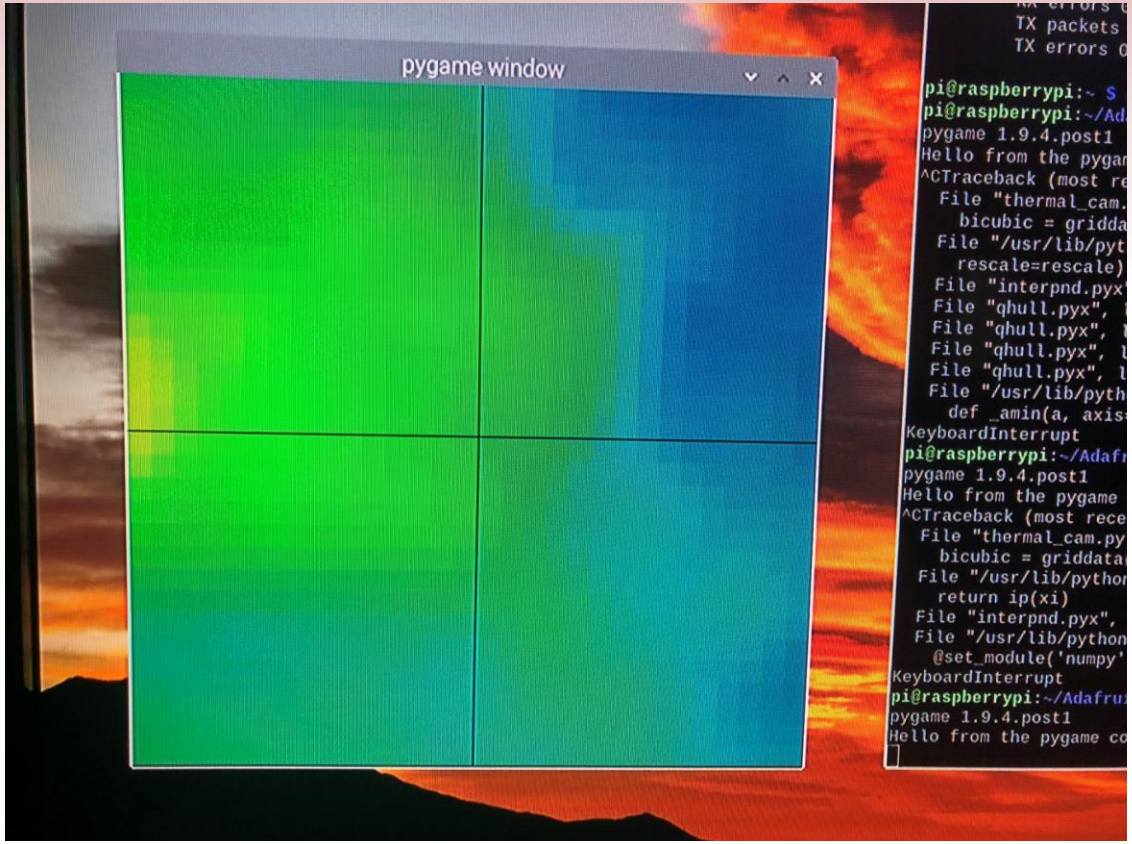
The drone seemed very stable, not problems flying it once we tuned it.

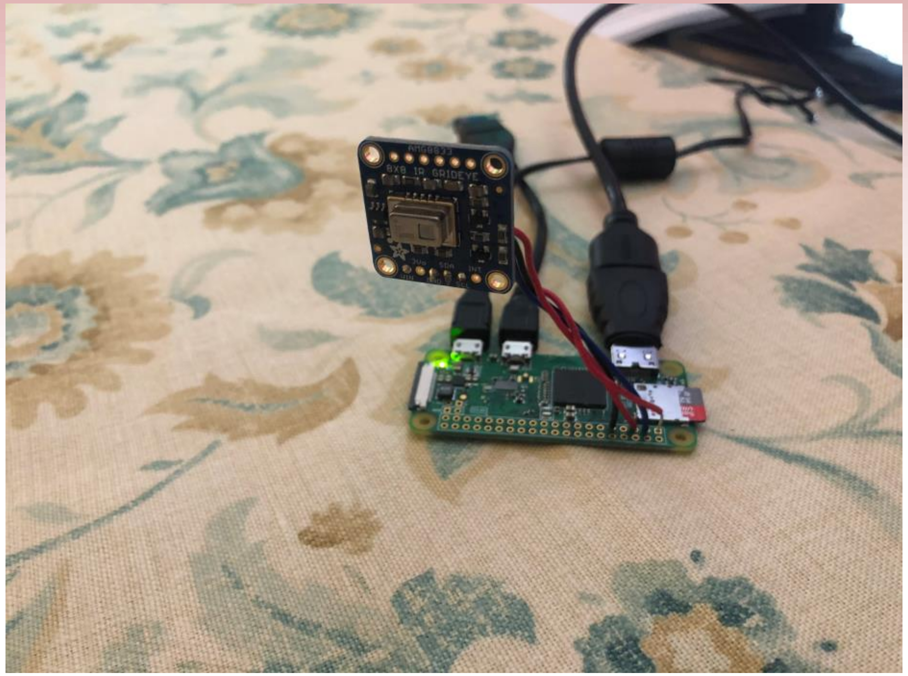


Programming Camera

We are using Raspberry Pi as the interface between the drone and the camera; however, we have a lot to learn before we want to even connect the camera.

This is how the camera works using the Raspberry pi interface with python language.





We still need to:

Make it work wirelessly

Mount it to the drone

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Things we can do better as a team for next project:

- Meetings more often and better planned.
- No pandemic.
- Try assigning individual work.
- Order parts ahead of time.
- Do not focus our attention in the costs only.
- Do not depend on school facilities/supplies only.

Thermal Camera

Sergio Olivarez

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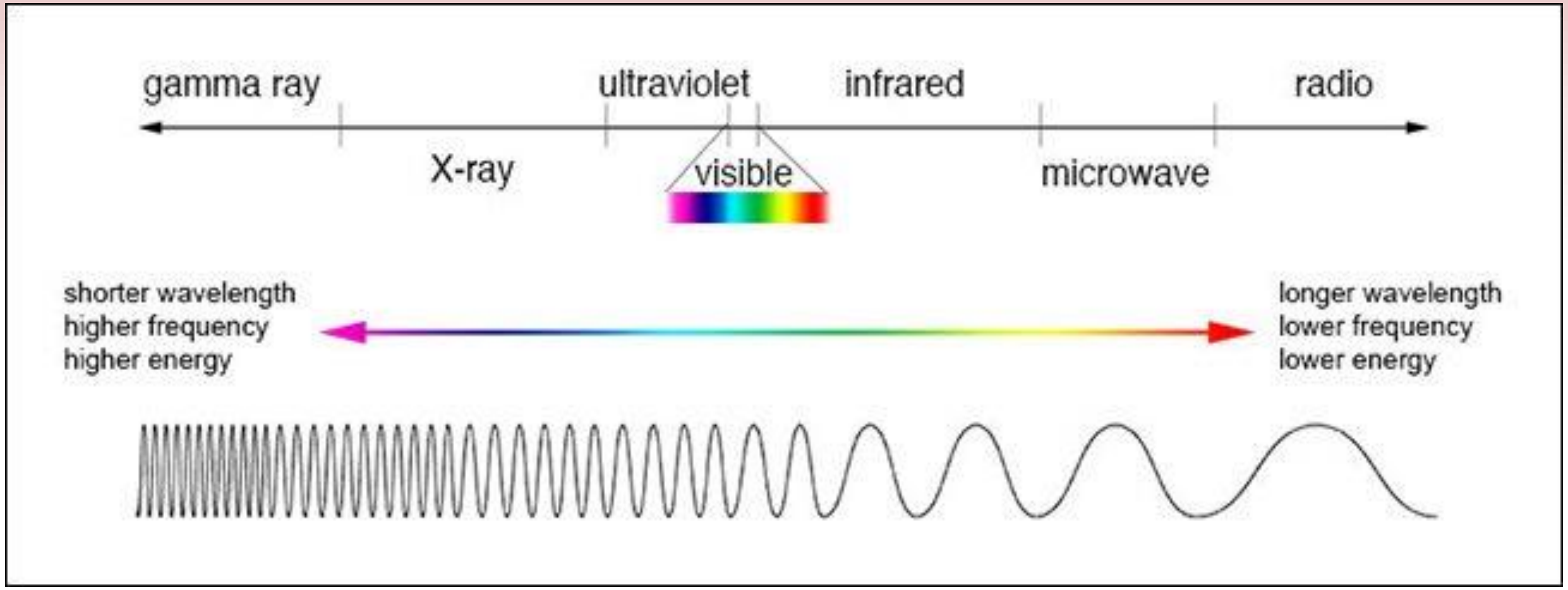
Thermal Camera

How does it work:

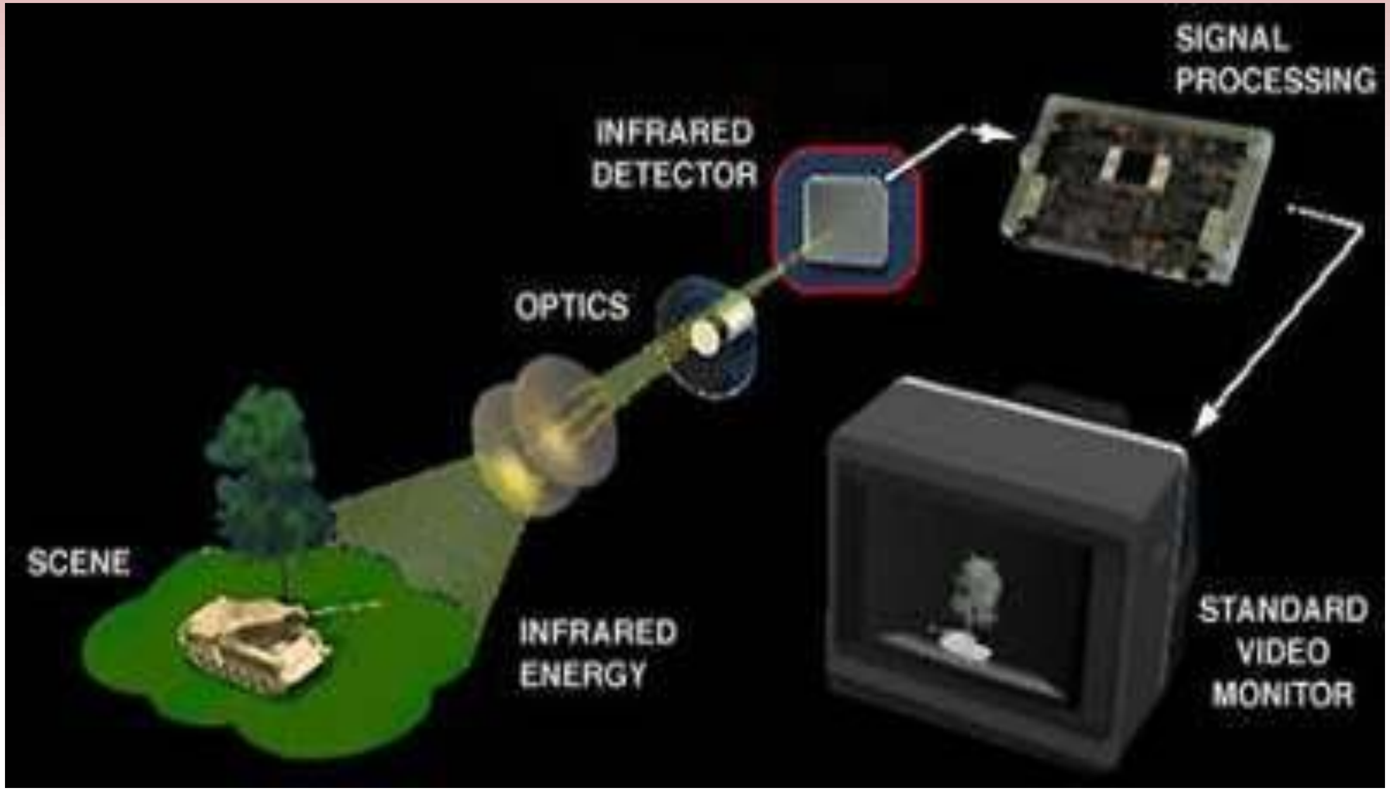
- All objects emit infrared radiation.
- The more heat an object has, the more infrared radiation it produces.
- Thermal cameras record the intensity of infrared radiation and assign a value for each intensity.



Thermal Camera

<u>How does it work:</u>

- A lens focuses the infrared light emitted by all the objects.
- The infrared detector creates a temperature pattern called a thermogram.
- The thermogram is translated into electric impulses.
- The impulses are sent to the signal processing-unit, which translates the impulses into data.



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Thermal Camera

Our Camera:

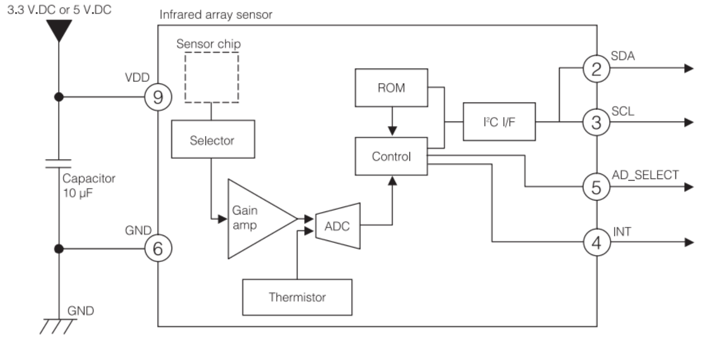
- AMG8833
  - Captures temperature ranges from -4 degrees to 176 degrees Fahrenheit.
  - 10Hz framerate
  - Easy compatibility with raspberry pi.

Performance

Item	Performance
Number of pixel	64 (Vertical 8 × Horizontal 8 Matrix)
External interface	I^2C (fast mode)
Frame rate	Typical 10 frames/sec or 1 frame/sec
Operating mode *1	Normal Sleep Stand-by (10 sec or 60 sec intermittence)
Output mode	Temperature output
Calculate mode	No moving average or Twice moving average
Temperature output resolution	0.25 °C
Number of sensor address	2 (I^2C slave address)
Thermistor output temperature range	−20 °C to 80 °C −4 °F to +176 °F
Thermistor output resolution	0.0625 °C

Note: *1 Normal Mode : normal operation mode; Sleep Mode: detection is off (output and data reading not possible); Standby Mode: 1 frame measuring intermittently every 10 or 60 sec.

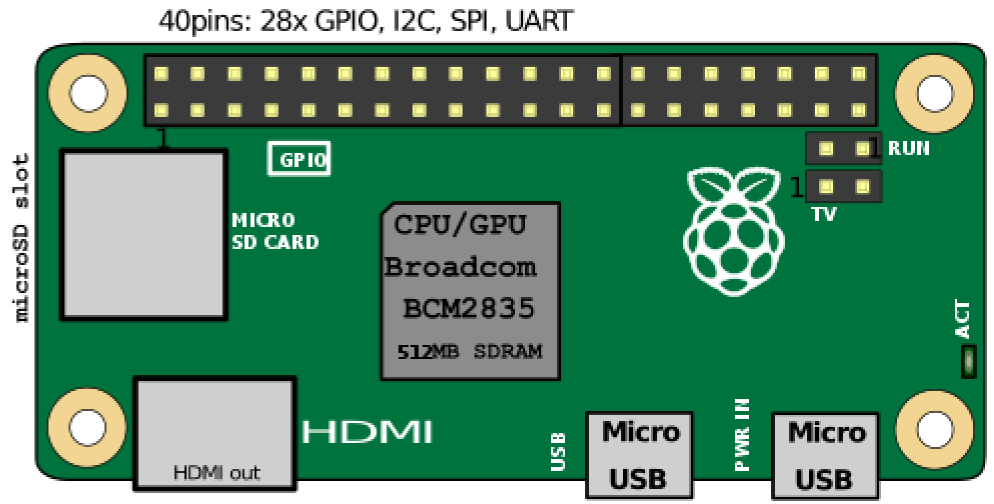
Internal Circuit



Raspberry Pi

<u>Raspberry Pi Zero W:</u>

- Raspberry Pi is a single board computer that runs Linux.
- The GPIO (general purpose input/output) pins allow users to control electronic components for physical computing.
- The Raspberry Pi Zero will allow us to send our thermal video over wifi.



Thermal Camera (Coding)

Fadi Attar

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Thermal Camera Code

- We are using pseudo code that is provided in one of the websites.

```
# pylint: disable=invalid-slice-index
points = [(math.floor(ix / 8), (ix % 8)) for ix in range(0, 64)]
grid_x, grid_y = np.mgrid[0:7:32j, 0:7:32j]
# pylint: enable=invalid-slice-index

#sensor is an 8x8 grid so lets do a square
height = 240
width = 240

#the list of colors we can choose from
blue = Color("indigo")
colors = list(blue.range_to(Color("red"), COLORDEPTH))

#create the array of colors
colors = [(int(c.red * 255), int(c.green * 255), int(c.blue * 255)) for c in colors]

displayPixelWidth = width / 30
displayPixelHeight = height / 30

lcd = pygame.display.set_mode((width, height))

lcd.fill((255, 0, 0))

pygame.display.update()
pygame.mouse.set_visible(False)

lcd.fill((0, 0, 0))
pygame.display.update()
```

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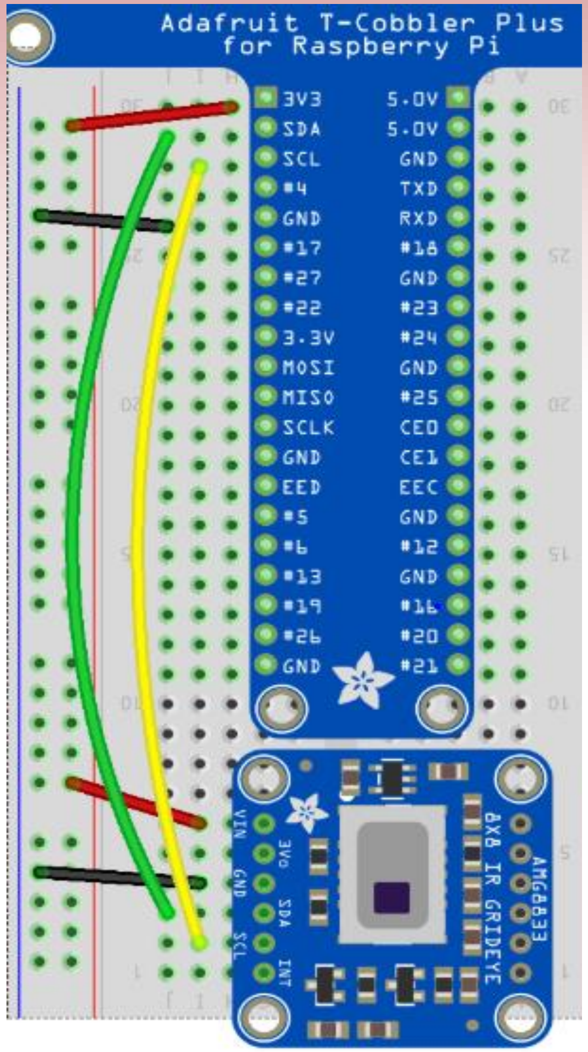
Thermal Camera code

```
#some utility functions
def constrain(val, min_val, max_val):
    return min(max_val, max(min_val, val))

def map_value(x, in_min, in_max, out_min, out_max):
    return (x - in_min) * (out_max - out_min) / (in_max - in_min) + out_min

#let the sensor initialize
time.sleep(.1)

while True:

    #read the pixels
    pixels = []
    for row in sensor.pixels:
        pixels = pixels + row
    pixels = [map_value(p, MINTEMP, MAXTEMP, 0, COLORDEPTH - 1) for p in pixels]

    #perform interpolation
    bicubic = griddata(points, pixels, (grid_x, grid_y), method='cubic')

```



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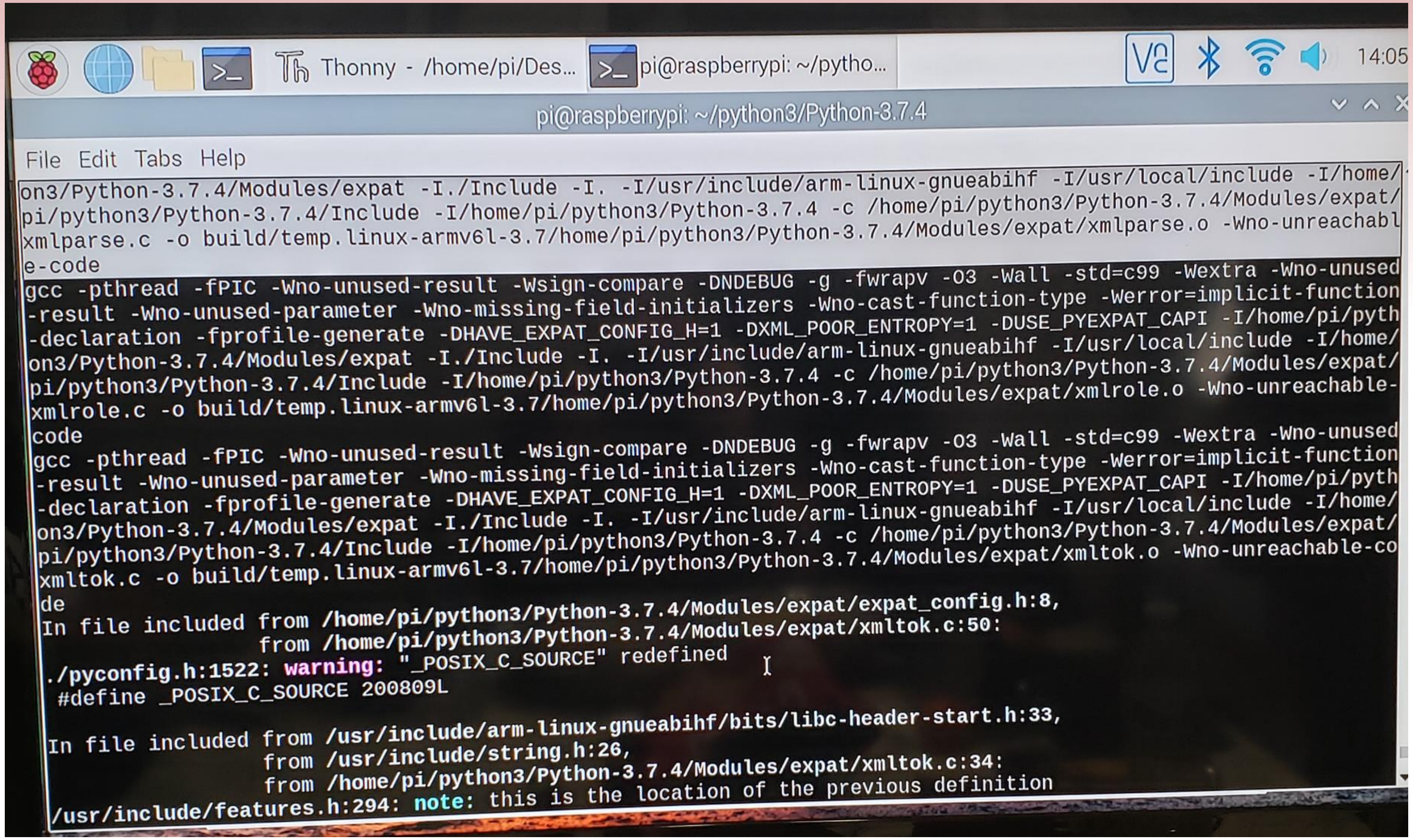
Thermal Camera code



- Using Raspberry Pi.
- Upgrading the Pi.
- The thermal camera Needs python 3.4+ on the Raspbian to work.
- Implemented the camera libraries and functions on the pi.
- Send the feed on a local network.

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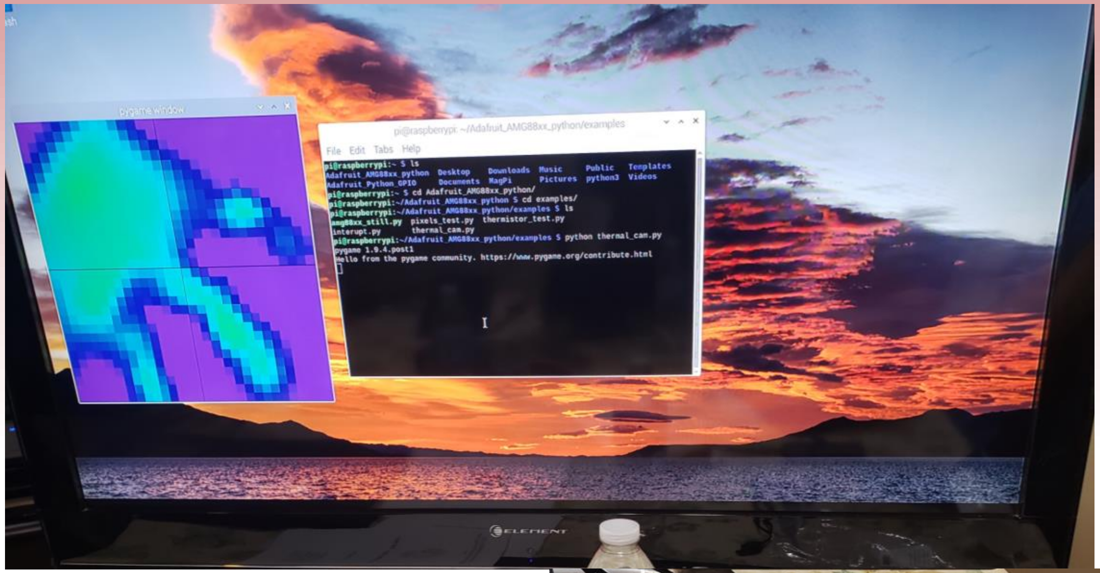
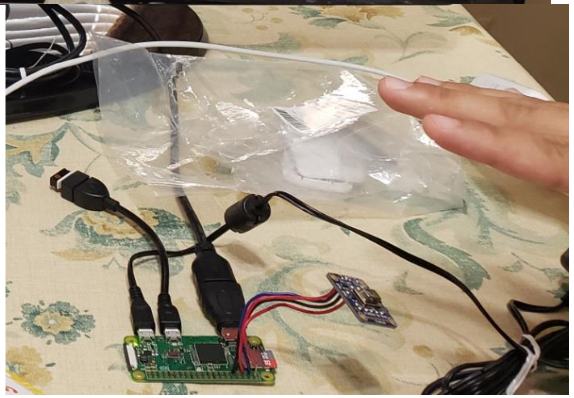
Thermal camera

- Get the camera streaming.
- Mount it on the drone.
- Send the signal through Wifi.
- Interpret the data.
- Show the data either online or on a separate screen.





Flight Tuning & 3D Printing

Joshua Hinojos

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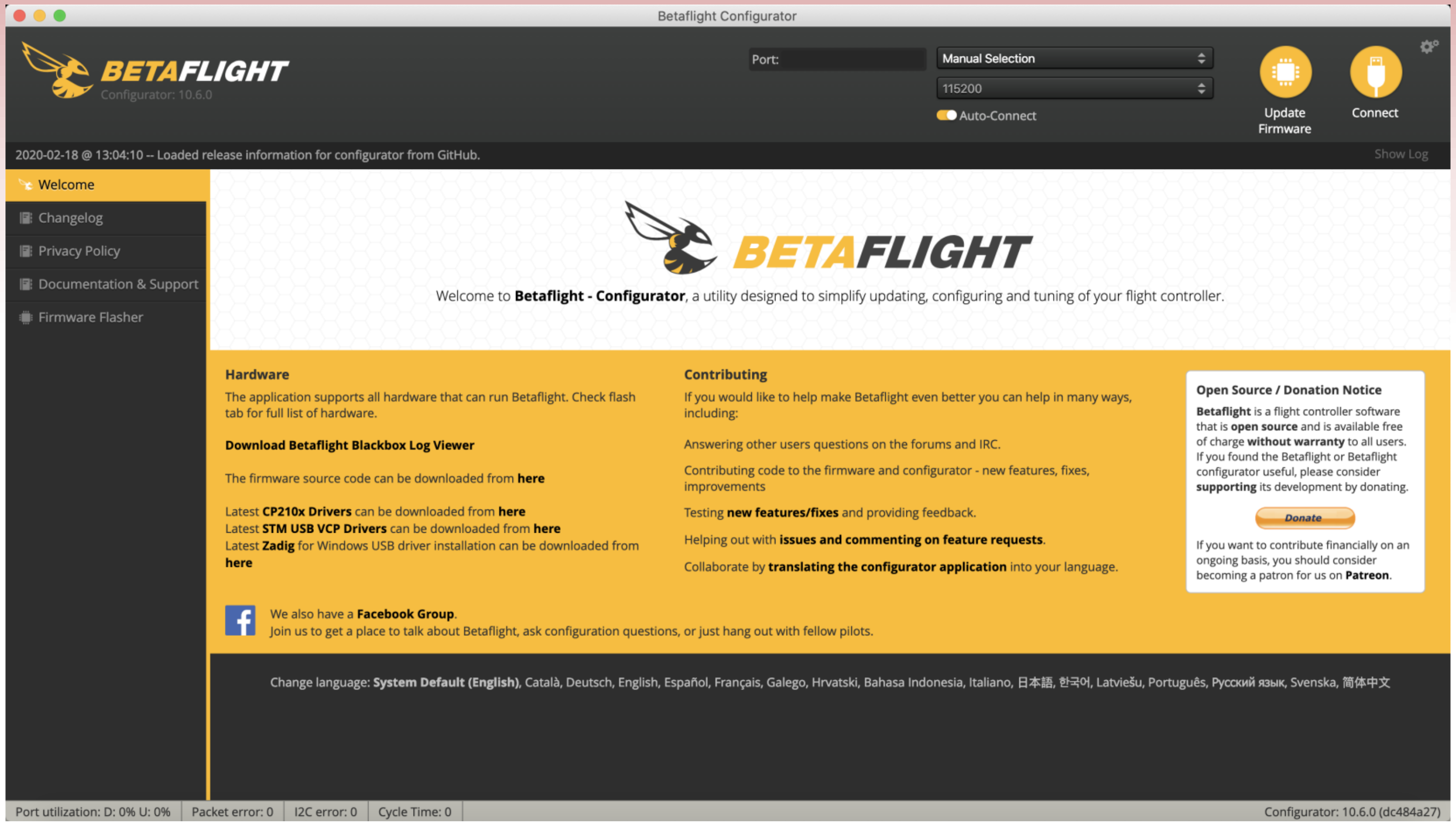
Flight Tuning

COMPLETED

Flight Tuning

<u>Previously Stated:</u>

- Our choice of flight turning software is Betaflight.
- Using the software we were able to:
  - Test the motor connections.
  - Test the flight controller’s gyroscope.



Source: https://betaflight.com

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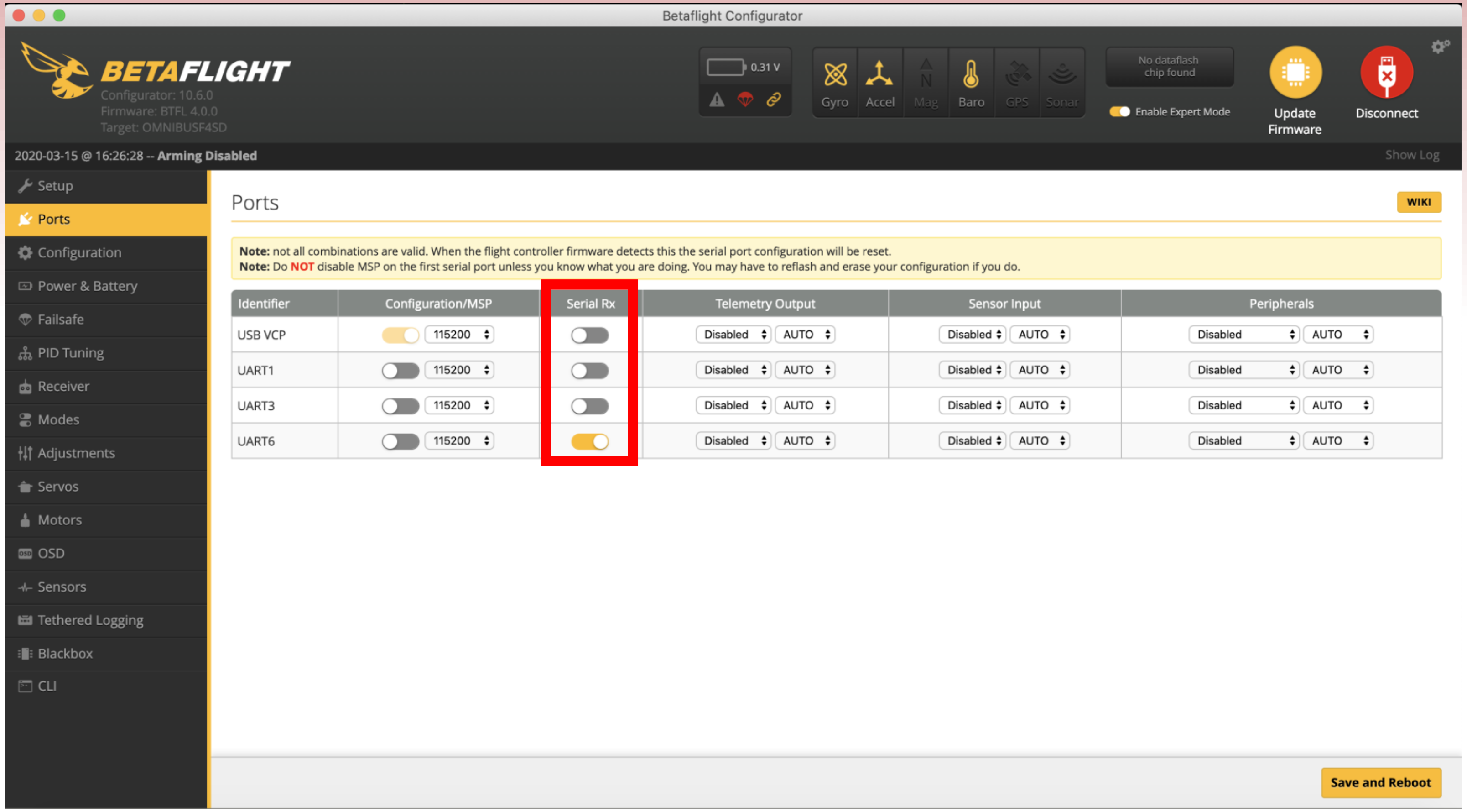
Connecting the Receiver.



- To connect the receive to the flight controller, we cycled through the Serial Rx switches until it was properly connected.

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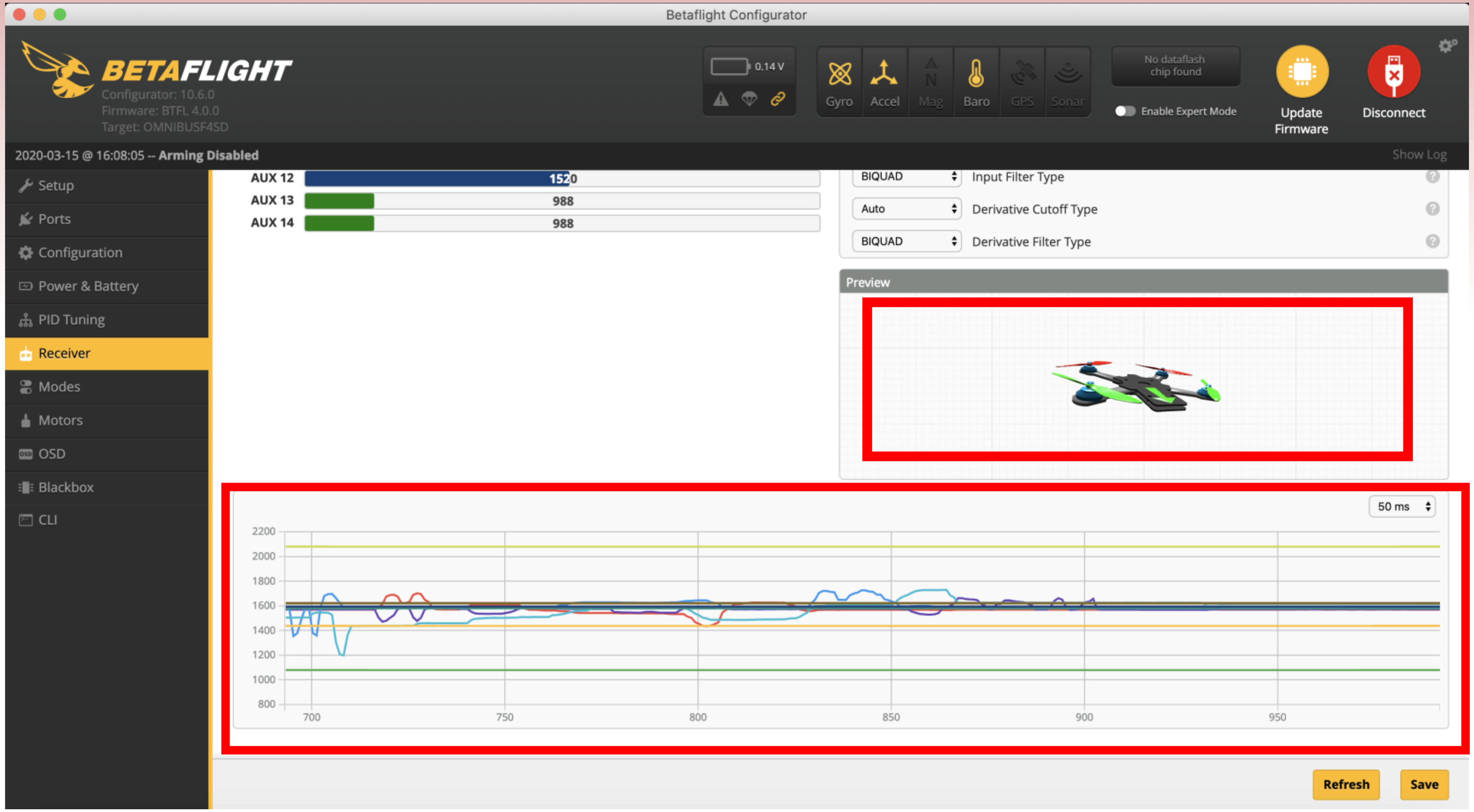
Connecting the Receiver.

- Once connected, we can see how the controls from the remote responded on the graph show.

- It also would move the simulation of our drone



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- Before flying the drone, we had to tune the pitch and yaw using the simulation that was previously shown.
- Before tuning, the simulation was spinning out of control, but using the highlighted buttons, we were able push them and adjust the controls until the simulation was stable.
- Next thing we did was learn to arm and disarm our drone, which is done by the highlighted switch and throttle control.

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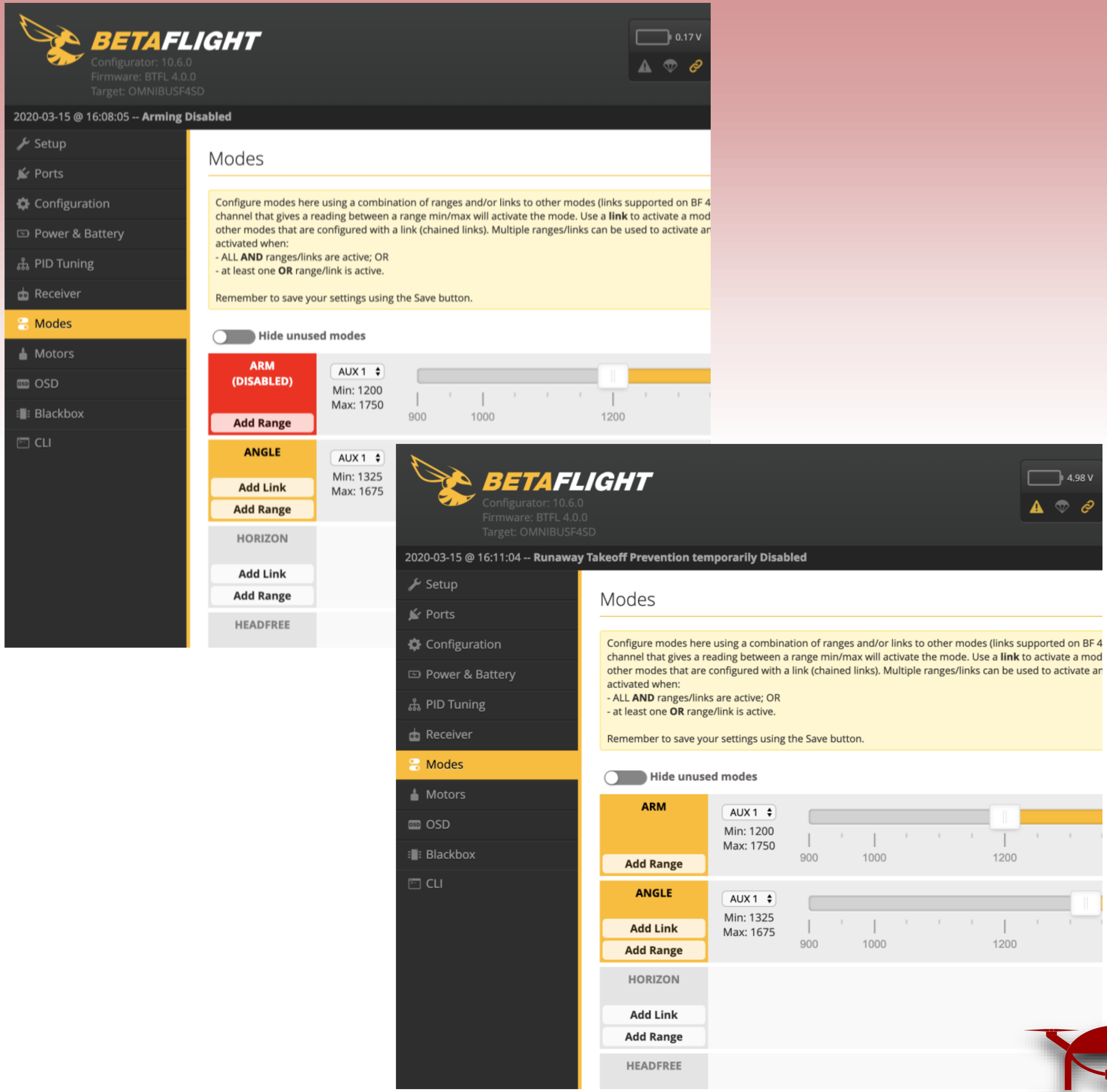
Flight Tuning

SAFETY FEATURES

- Disarming our drone can act as a safety feature incase one of our controls do not respond properly.
- Disarming stops the drone from receiving controls from the receiver.
- Arming allows the drone to start receiving controls from the receiver.
- If the flight controller senses that something is not working right with the receiver, it will not arm the drone.



Flight Tuning

INCOMPLETED

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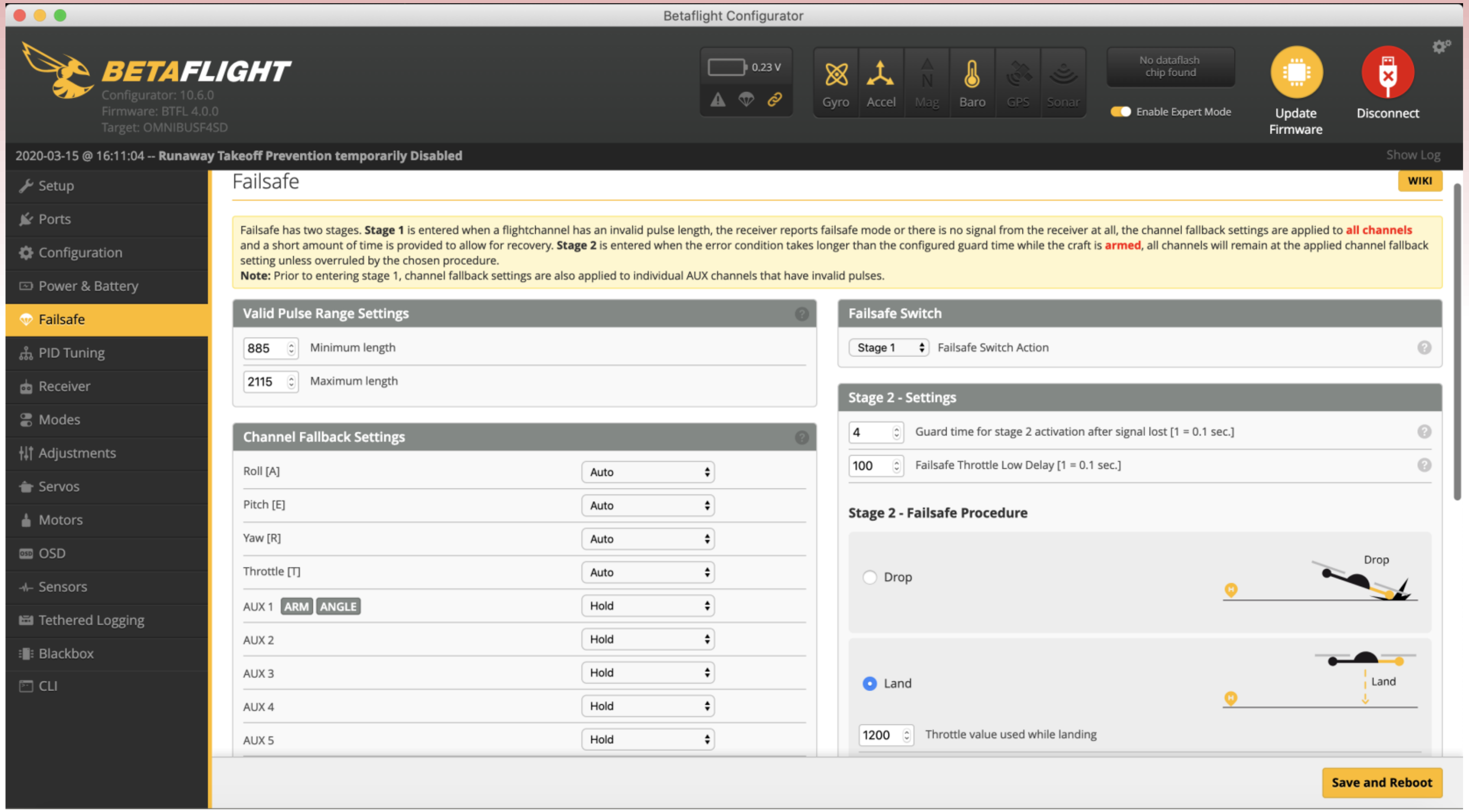

Reasons for incompletion of failsafe setup:

- Stay at home orders.
- Need space to test this feature.

3D Printing

INCOMPLETED

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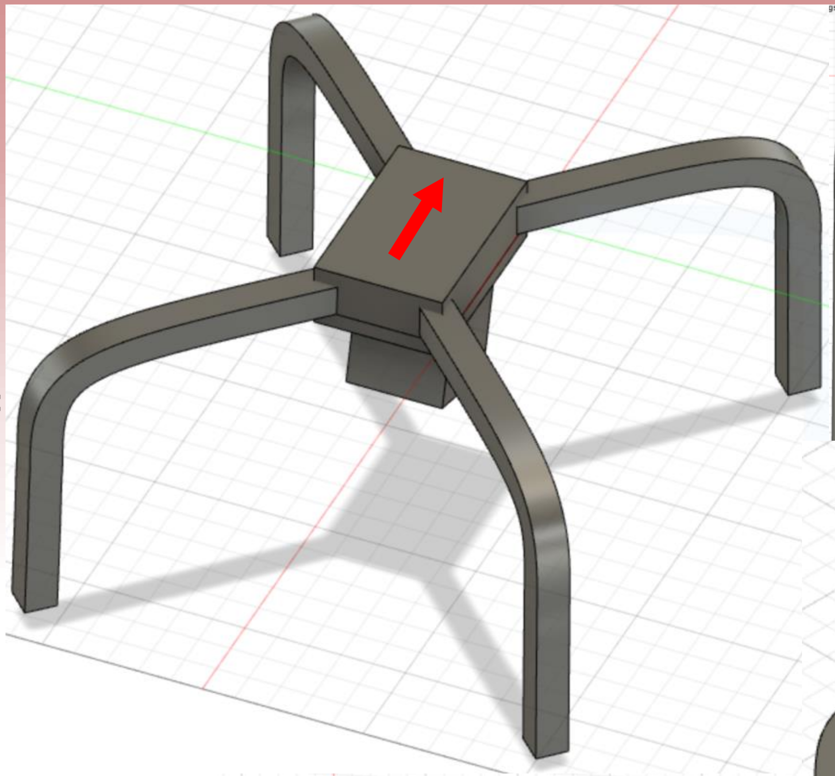
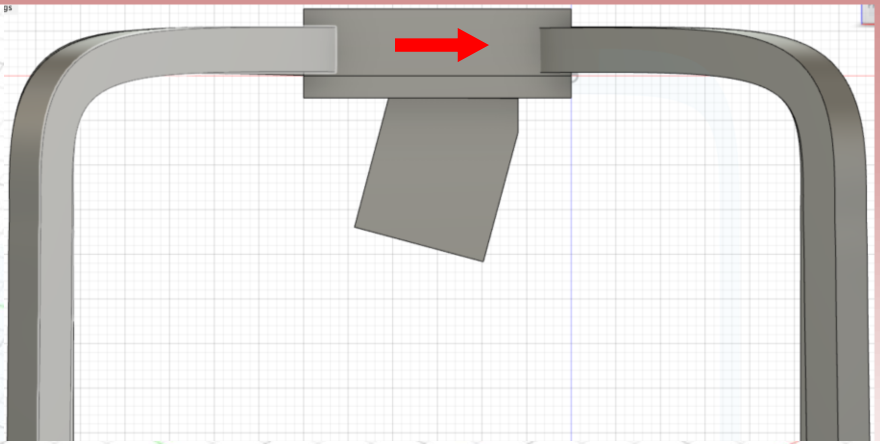
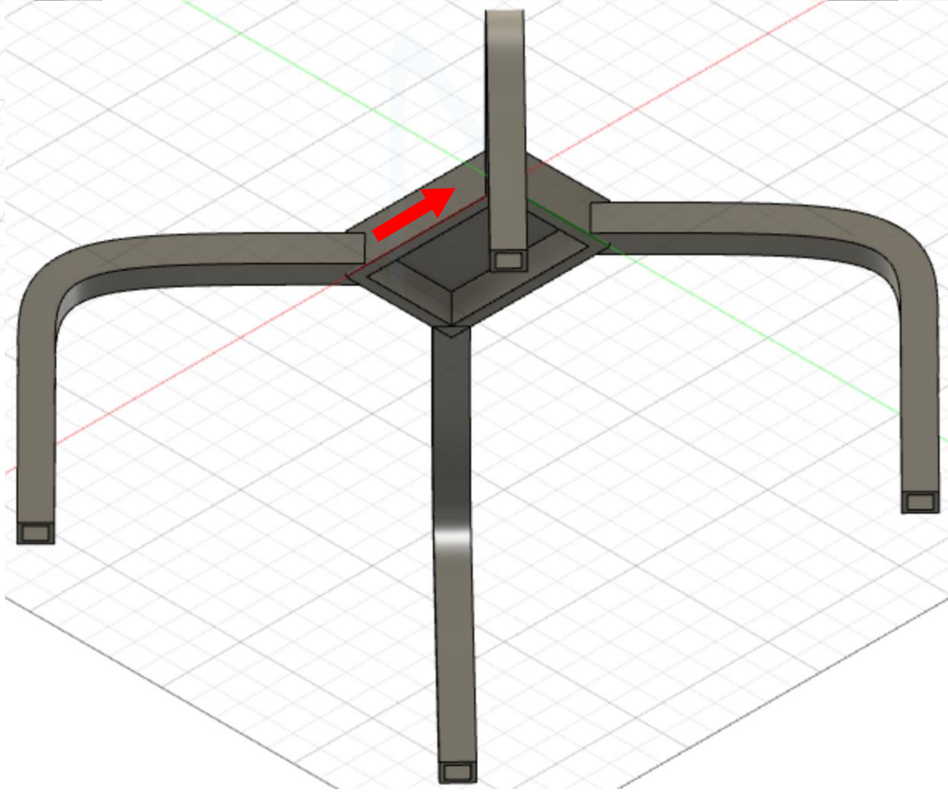
Reasons for incompletion of 3D printing:

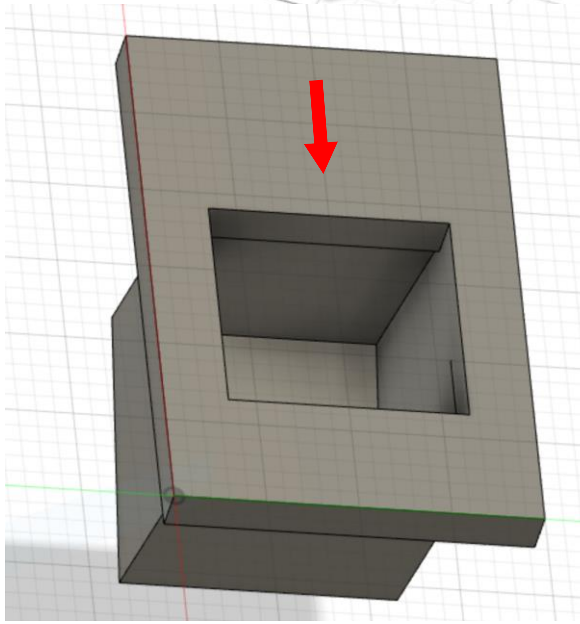
- Again, stay at home orders.

- Not having access to the Fablab’s 3D printers.

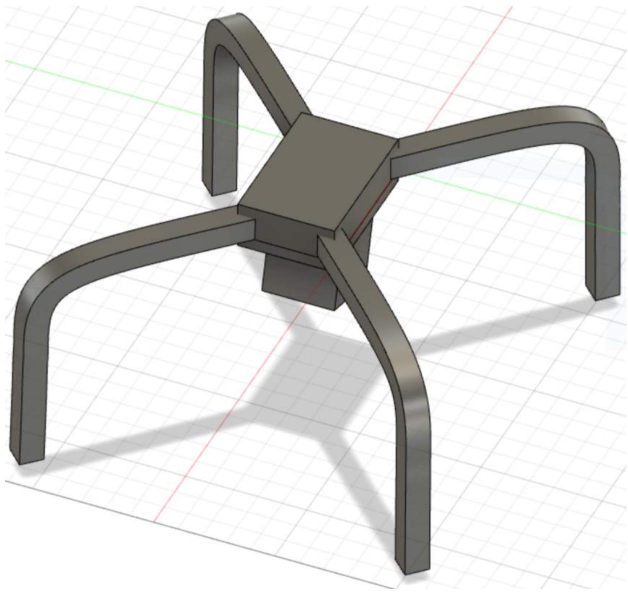








FUTURE IMPROVEMENTS FOR FLIGHT TUNING & 3D PRINTING



- First: Remote
  - Although this remote serves its purpose, there are definitely others that are better.
    - Possibly better range with another remote.
    - More accurate flight tuning from the remote.
- Second: 3D Printing
  - Have multiple models of the legs and camera house printed to fit the frame and check for durability.
  - Possibly print our own frame to help decrease the drone’s weight.

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