Fire Fighter in the Sky

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By:

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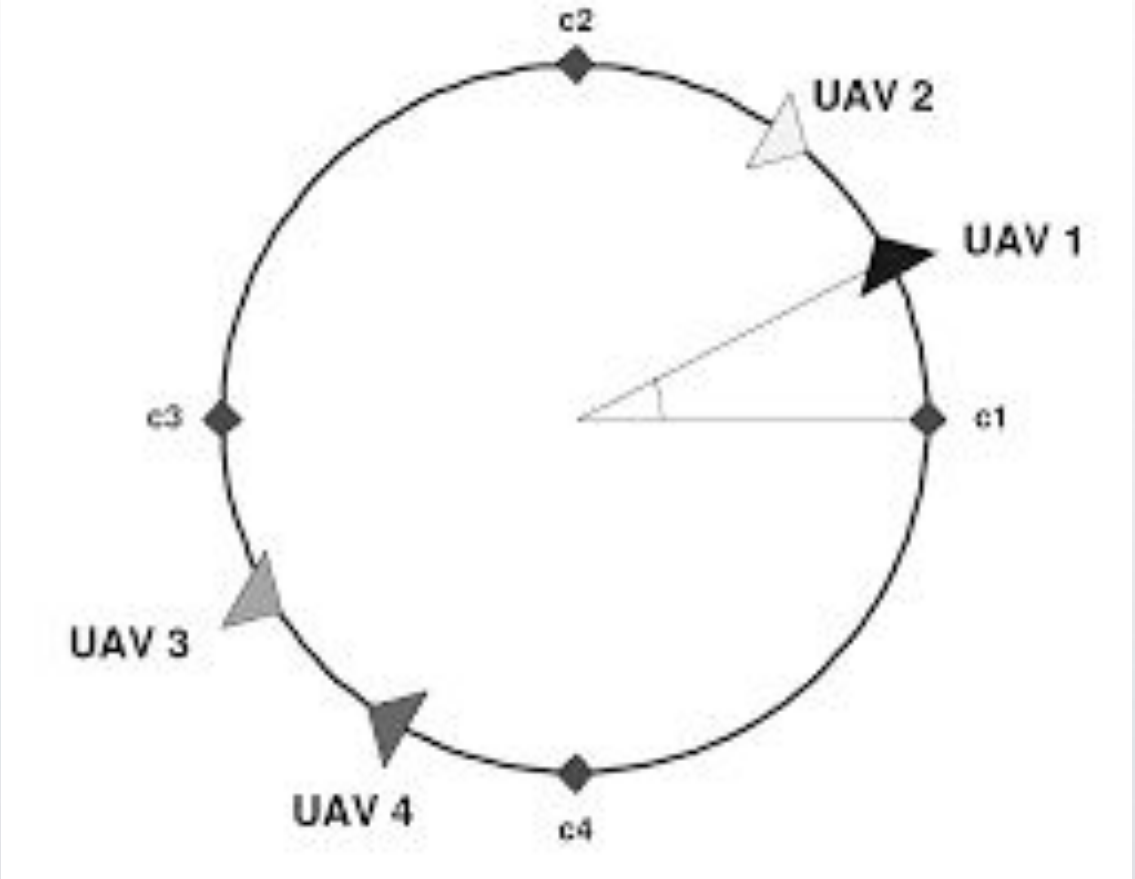
OUR PROJECT

- An autonomous drone that provides additional aid to firefighter
- Controlled by Raspberry Pi, and a flight controller
- Object Detection using a PIXY Cam

Background

- Forest fire monitoring with small UAVs
- UAV with Fire extinguishing Grenade
- Semi autonomous indoor firefighting UAV



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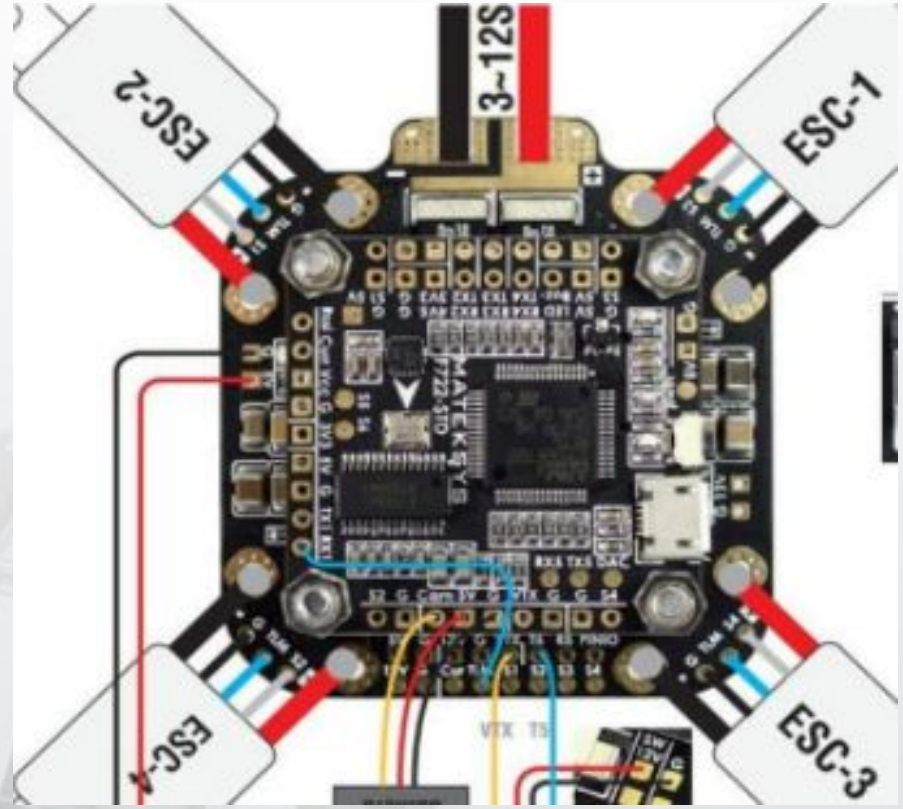
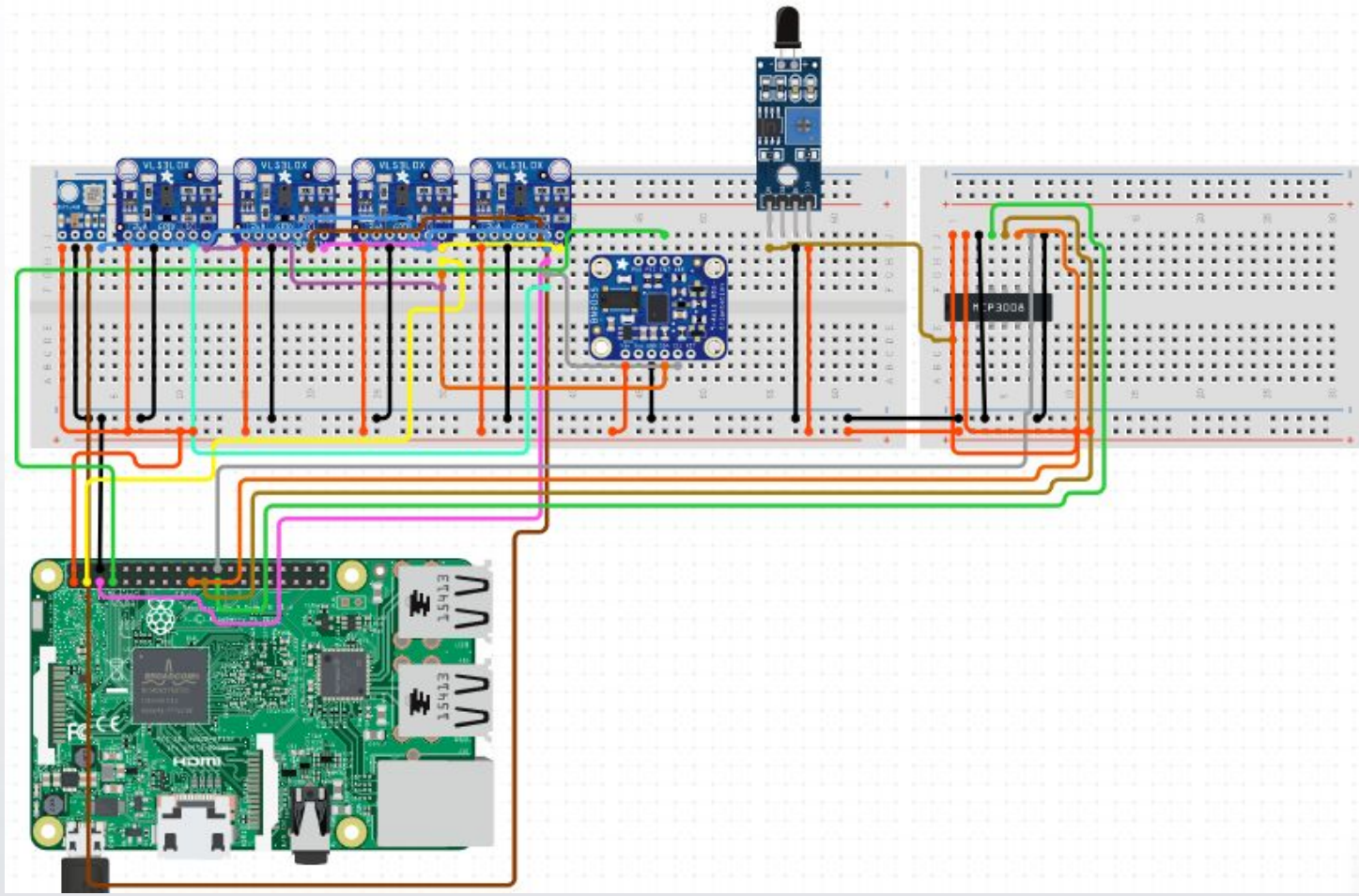
Main Components

- 1x Raspberry PI 3 Model B
- 1x 9-Axis Absolute Orientation Sensor (BNO055)
- 4x Lidar Sensor (VL53L0x)
- 1x Pixy Cam 2
- 1x IR sensor
- 1x Barometer (BMP085)
- 4x 950 kV BLDC
- 4x Sg90 micro servo
- 1x First Alert EZ fire spray
- 1x Matek X class 12S PDB
- 4x 35A 2S-6S ESC
- 4x 10x4.7 Propeller

Circuit





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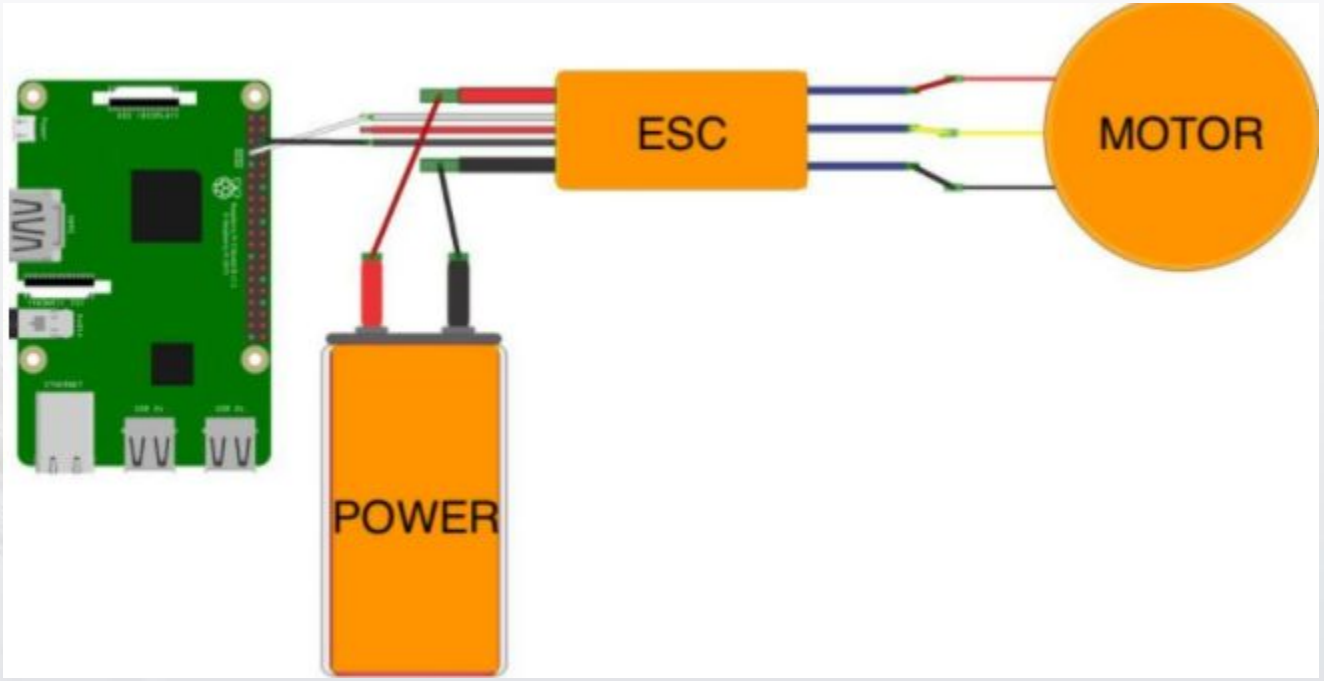
Circuit



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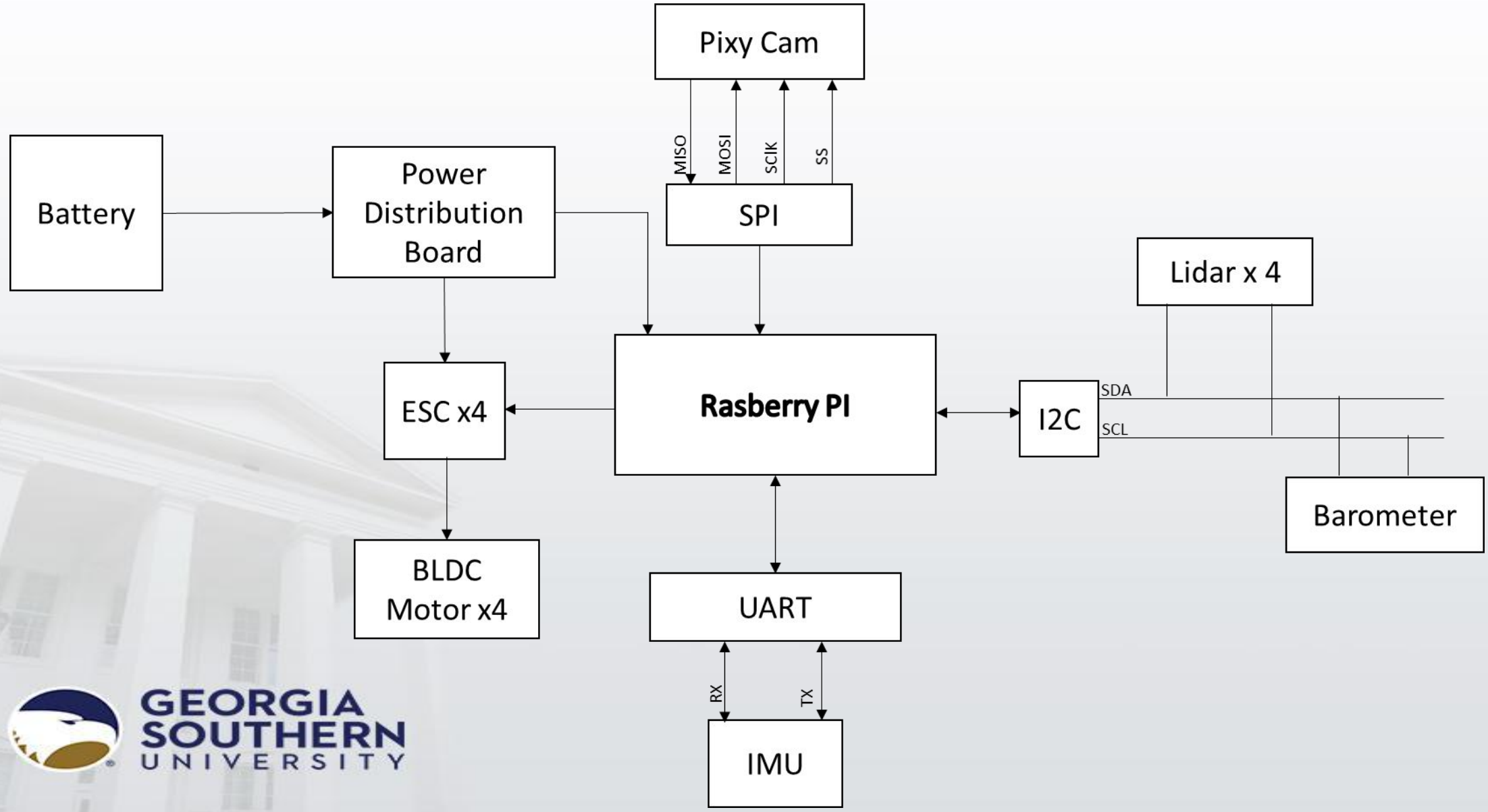
Block Diagram



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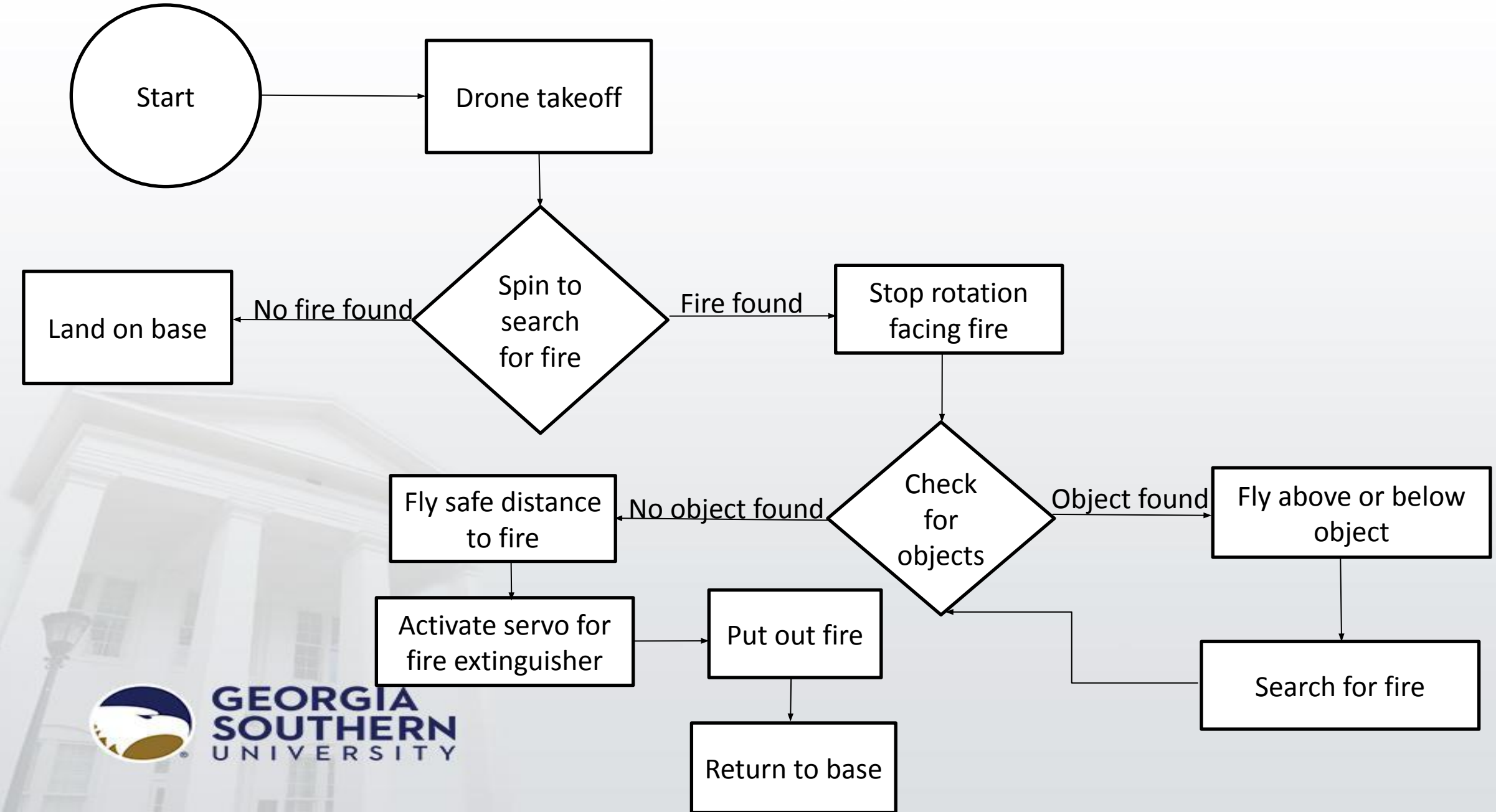

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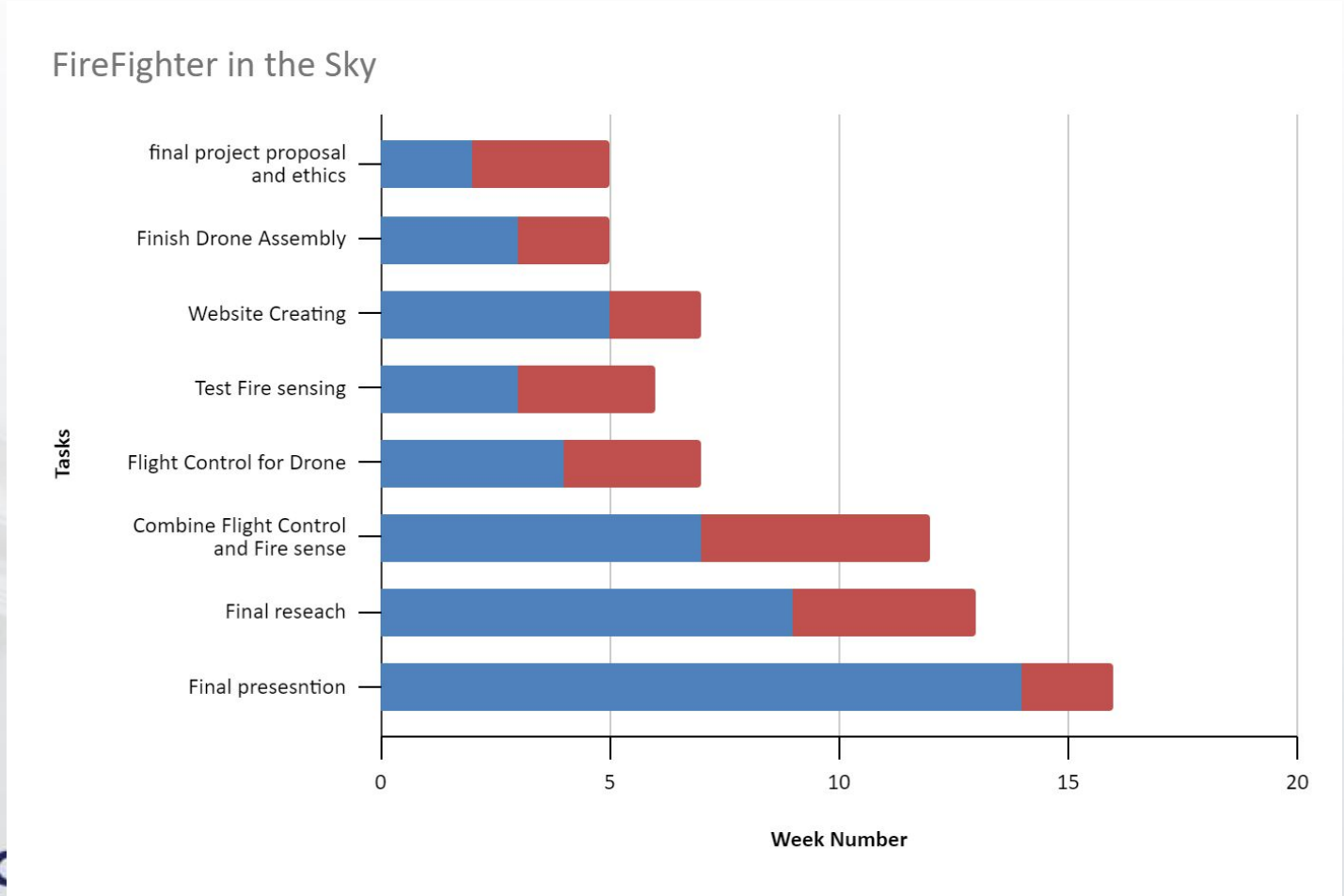
Gantt Chart



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Team Breakdown

Member	Team Role
John Bailey	Team Leader ; Design and fabrication of UAV
Maria Gonzalez Bocanegra	Programming and Neural Network
Camiya Felton	Electric circuit design
Jamison Golson	Programming and Flight Control

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Initial Project Design

- Design changes
  - Three tier body to one tier cockpit
  - Ultrasonic sensors to lidar sensors
    - Difficult to detect fast moving objects
  - ESCs connected in parallel to using a power distribution board
    - All four motors were not receiving power
  - 3s lipo battery to 4s lipo battery
    - 3s battery does not provide enough thrust
  - Switched ESC from 30A to 35A
    - We are looking at upgrading the battery to 5s
  - Switched from a bucket to extinguisher spray can
    - Easier to aim for fire extinguishing

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Calculations

$$Power = Prop\ Const * rpm^{Power\ factor} \quad (1)$$

Calculate Thrust Total

2 x [Weight of Drone + Weight of Carried Object]

+

[Total from above x .20]

/

Number of Motors Needed

$$T = \frac{\pi}{4} D^2 \rho v \Delta v \quad (2)$$

T=thrust [N]
D=propeller diameter [m]
v=velocity of air at the propeller [m/s]
Δv=velocity of air accelerated by propeller [m/s]
ρ = density of air [1.225 kg/m³]

- 950 kV BLDC
- 3s battery = 11.1 V
- Spins at 10,545 rpm
- 955 g of T/BDLC
- 4s Battery = 14.4
- 13680 rpm
- 1049 g of T/BLDC
- Drone mass = 1909.6

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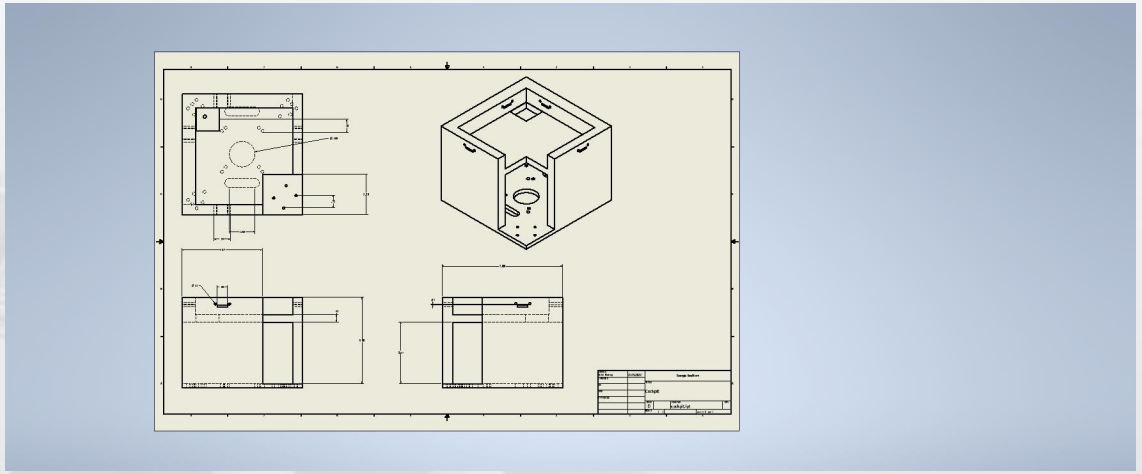
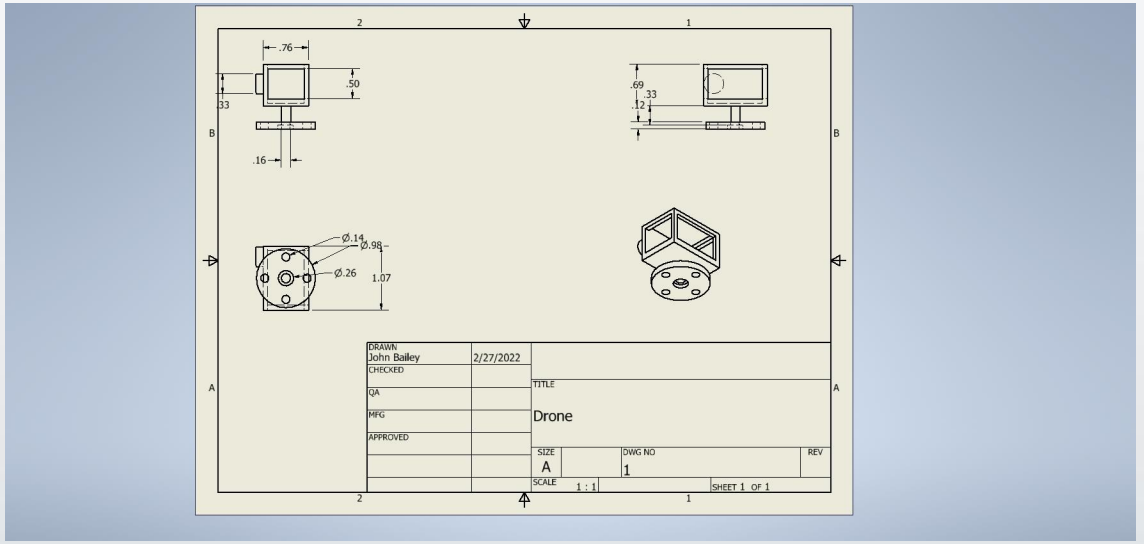
CAD design





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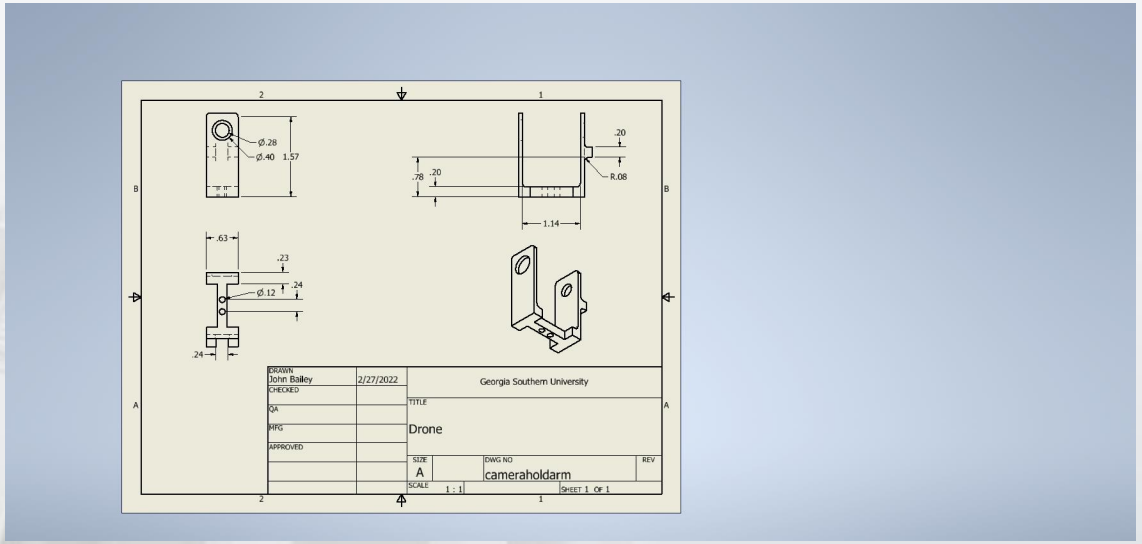
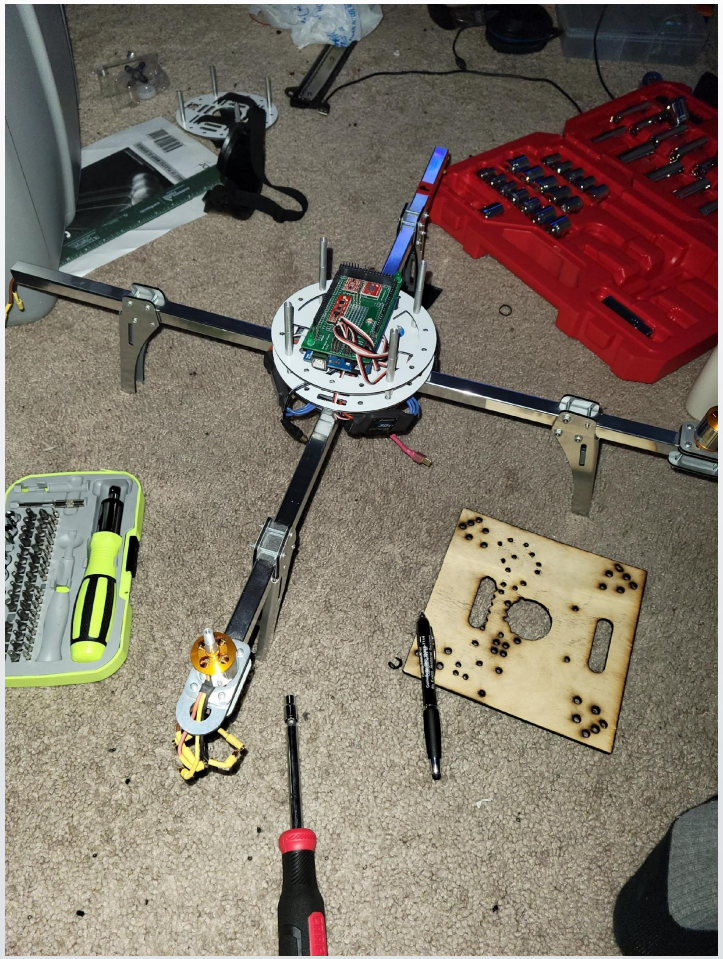
CAD Design





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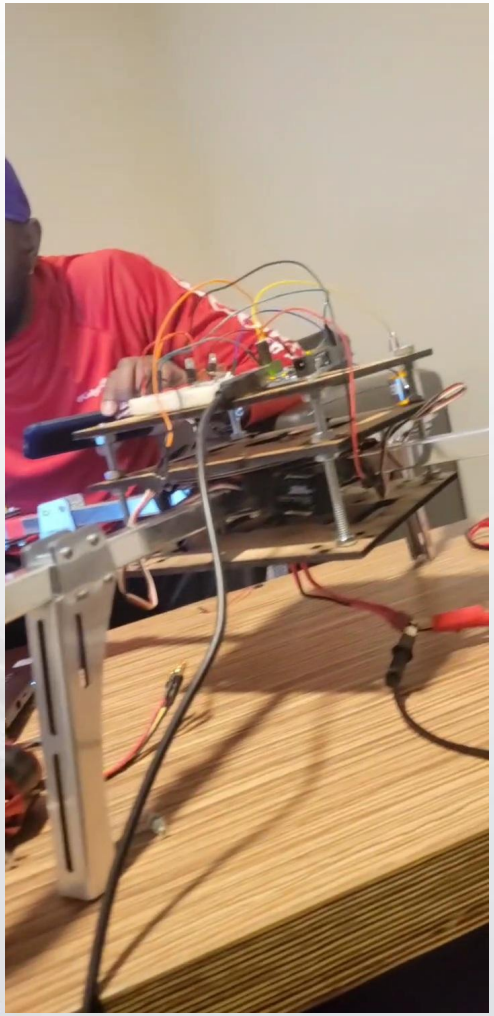
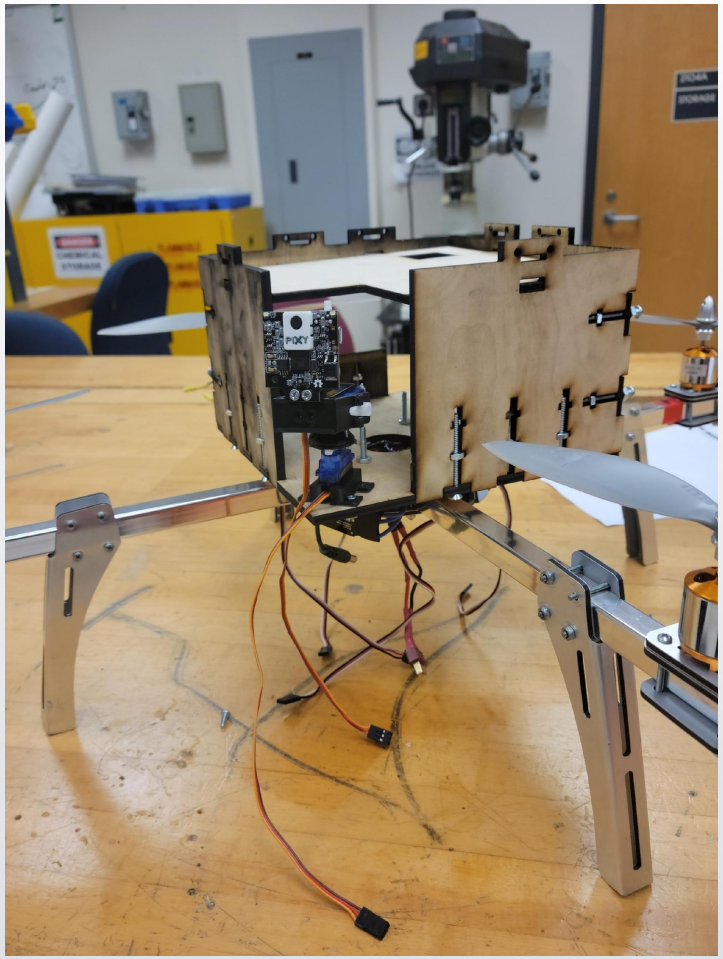
Prototypes





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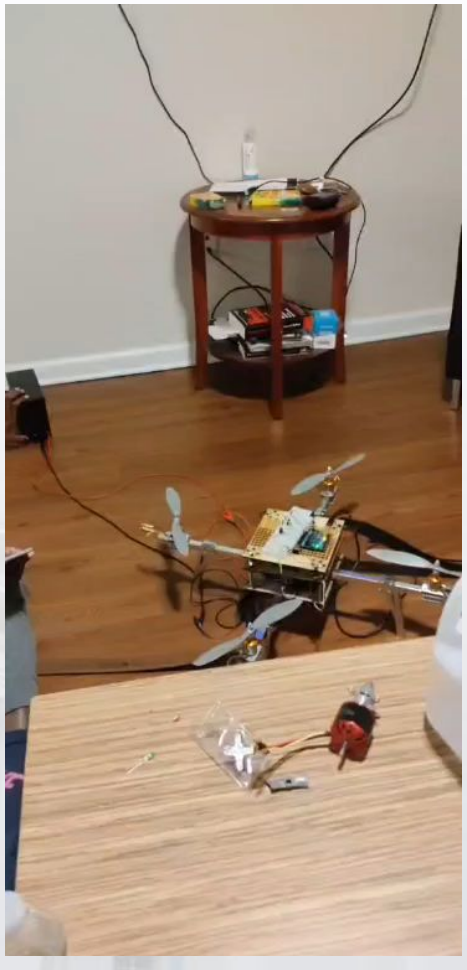
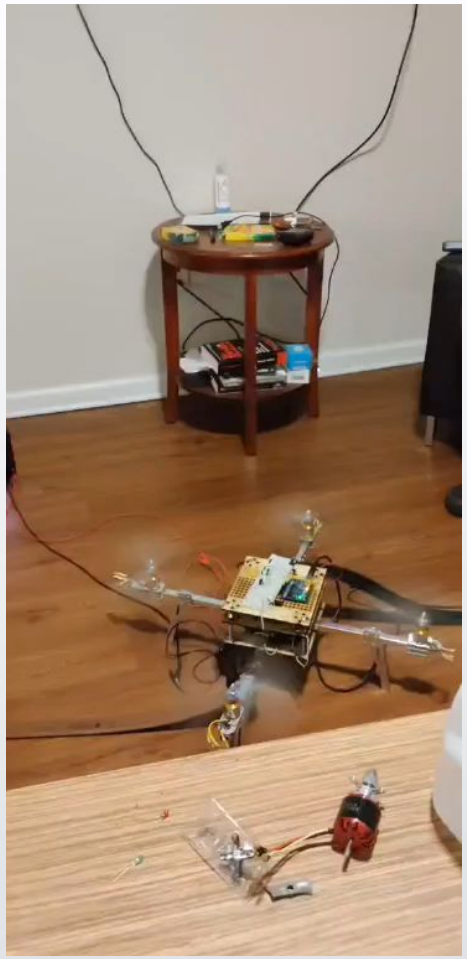
Project Results





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Computer Vision

- Use of Convolutional Neural Networks (CNNs) to identify in real-time a fire.
- Python implementation due to the flexibility incorporate several different libraries and packages.
  - Tensorflow: machine learning and AI library
  - Numpy: library for mathematical support and for large, multi-dimensional arrays and matrices.
  - OpenCV: library that provides a real-time optimized Computer Vision library, tools, and hardware.

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Computer Vision Cont…

- `Visualize detected bounding boxes (30% Certainty)`
- Dataset Implemented in Demo
  - COCO Dataset: large-scale object detection, segmentation, and captioning dataset. COCO has several features

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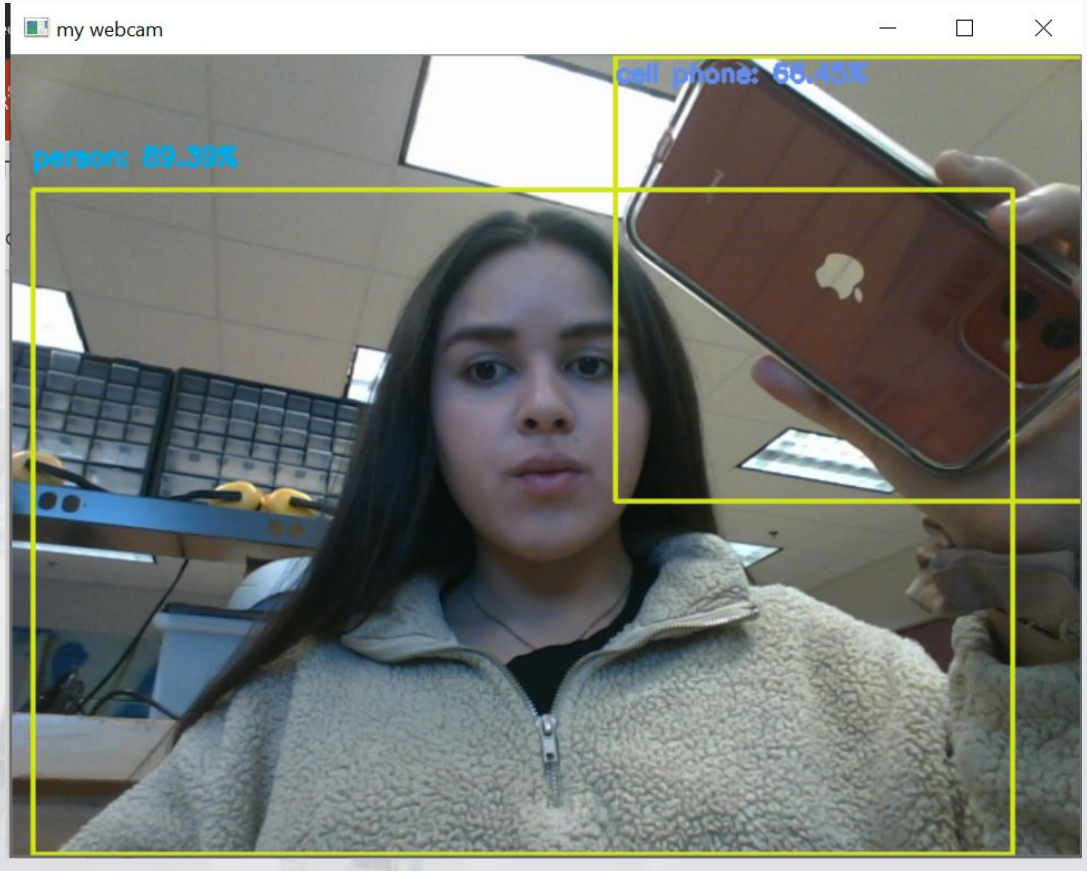
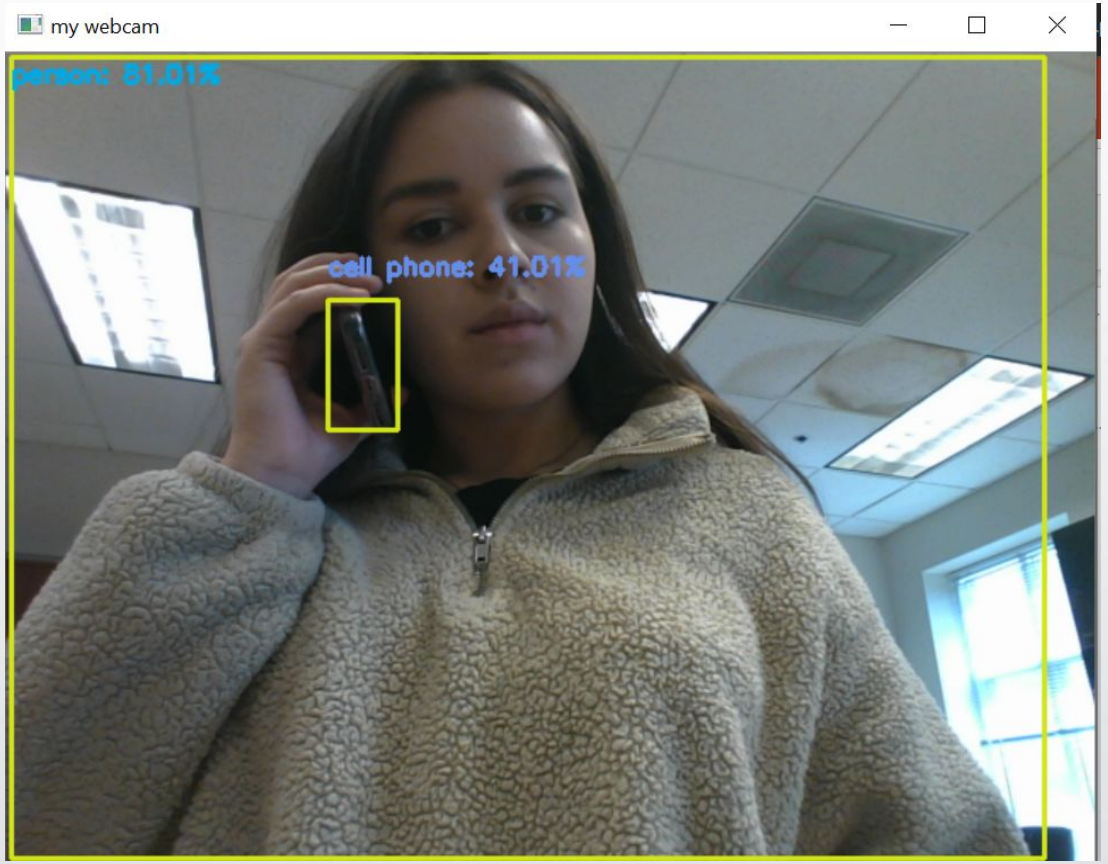
Object Recognition Examples





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Conclusions

- Potential new changes to drone
  - Implement air stair for fire extinguisher to allow different angles of extinguishing
  - Switch BNO055 sensor from using UART to I2C for faster data transfer speeds
  - Add servo driver for fire extinguisher
  - Develop AWS stream service to conduct object-recognition offboard (Amazon Recognition).

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QUESTIONS?

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References

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