Design Review 5
Emergency Management Drone
Team 307

Team Introduction

Haley Barrett
Project Manager

Matthew Roberts
ECE Lead

Kody Koch
ME Lead

Josh Reid
Design/Aerodynamic Engineer

Juan Patino
Test Engineer

Francisco Silva
Programmer

Haley Barrett

Sponsor

Florida State University
Emergency Management and Homeland Security Program

- David Merrick, Director

Haley Barrett

Project Background

- Purpose
  - ➢ Design a drone capable of assisting search and rescue teams in finding targets
- Requirements
  - ➢ Range of at least 1 km with an ideal range of 2km
  - ➢ Flight time greater than 20 minutes
  - ➢ Stabilization of the camera
  - ➢ Object detection
    - ▪ An automatic filter that detects targets on the ground
  - ➢ Weight constraint of 2kg

Haley Barrett

Fall Semester Recap

- Accomplished
  - Final design chosen to be a fixed winged drone
  - Wireless Personal Area Network (WPAN) network design over WiFi/Satellite
  - Power converter chosen for power management
  - Estimated flight time and flight range
  - Analyzed and tested previous image processing system

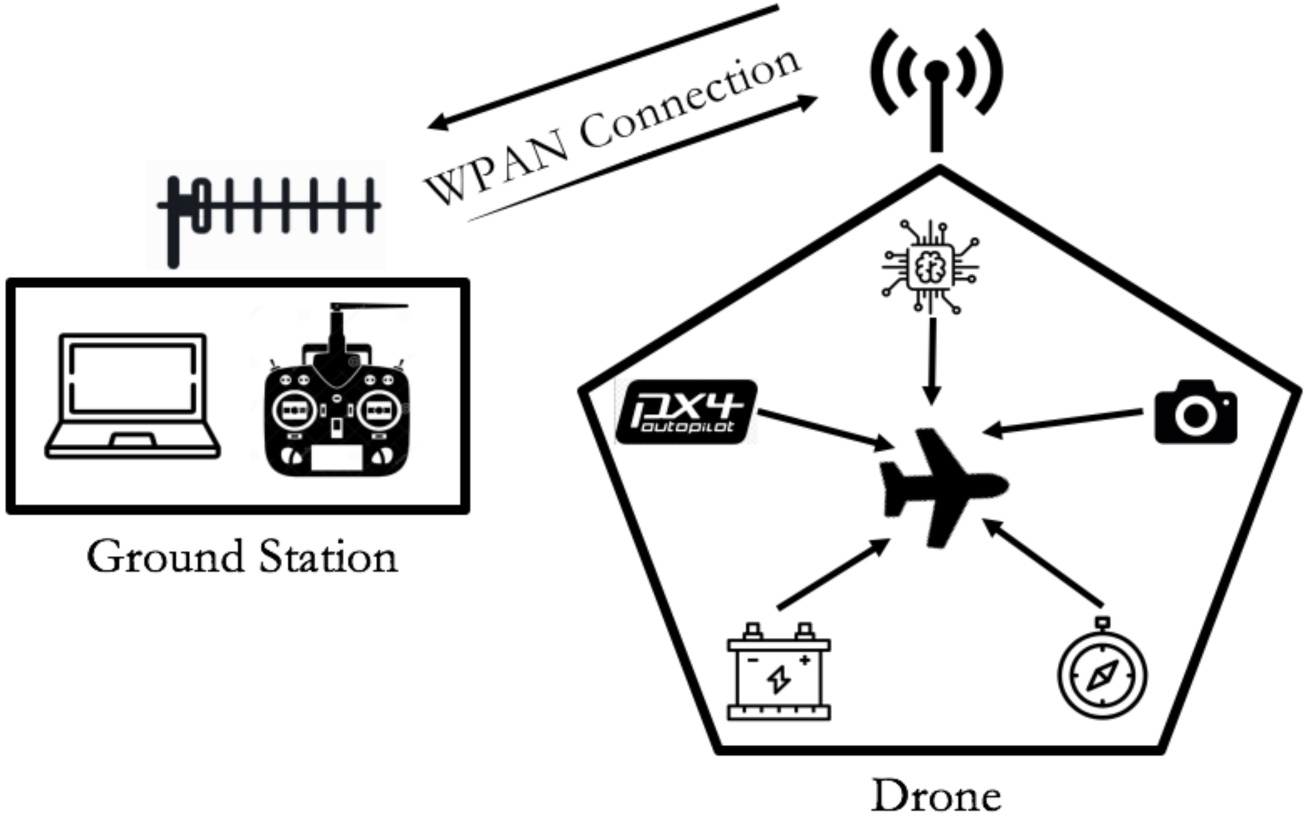
Haley Barrett

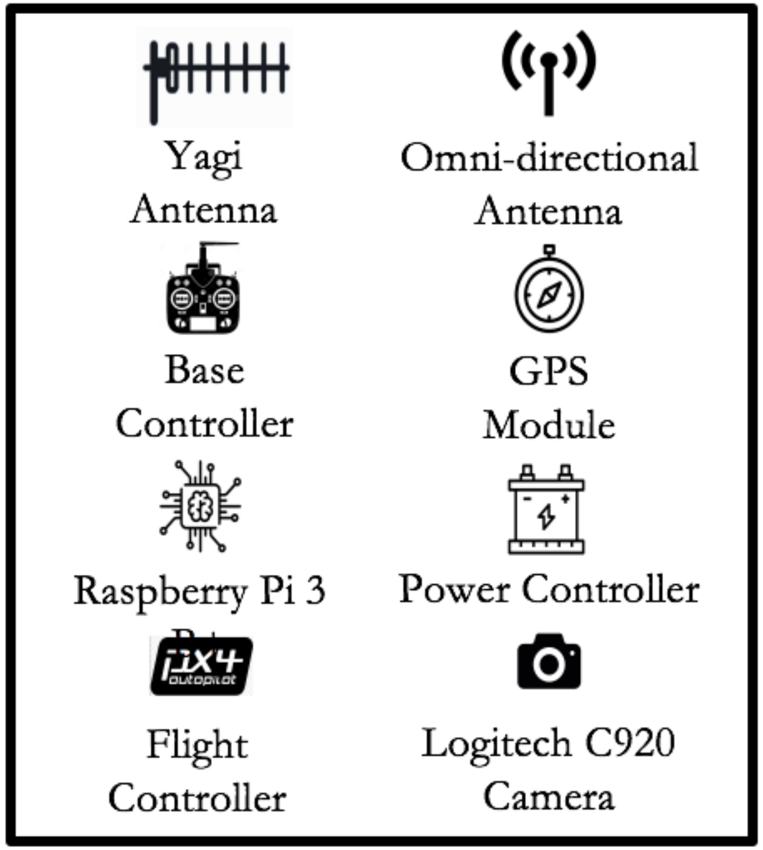
Changes to Design

- Motor power converter removed
  - Simpler design, easier installation, cheaper components
- One 8000mAh battery instead of two
  - Reduces weight by 355g
- Neural network to replace color filtering for object detection
  - Neural networks can identify obscured targets better than edge detection and color filtering

Haley Barrett

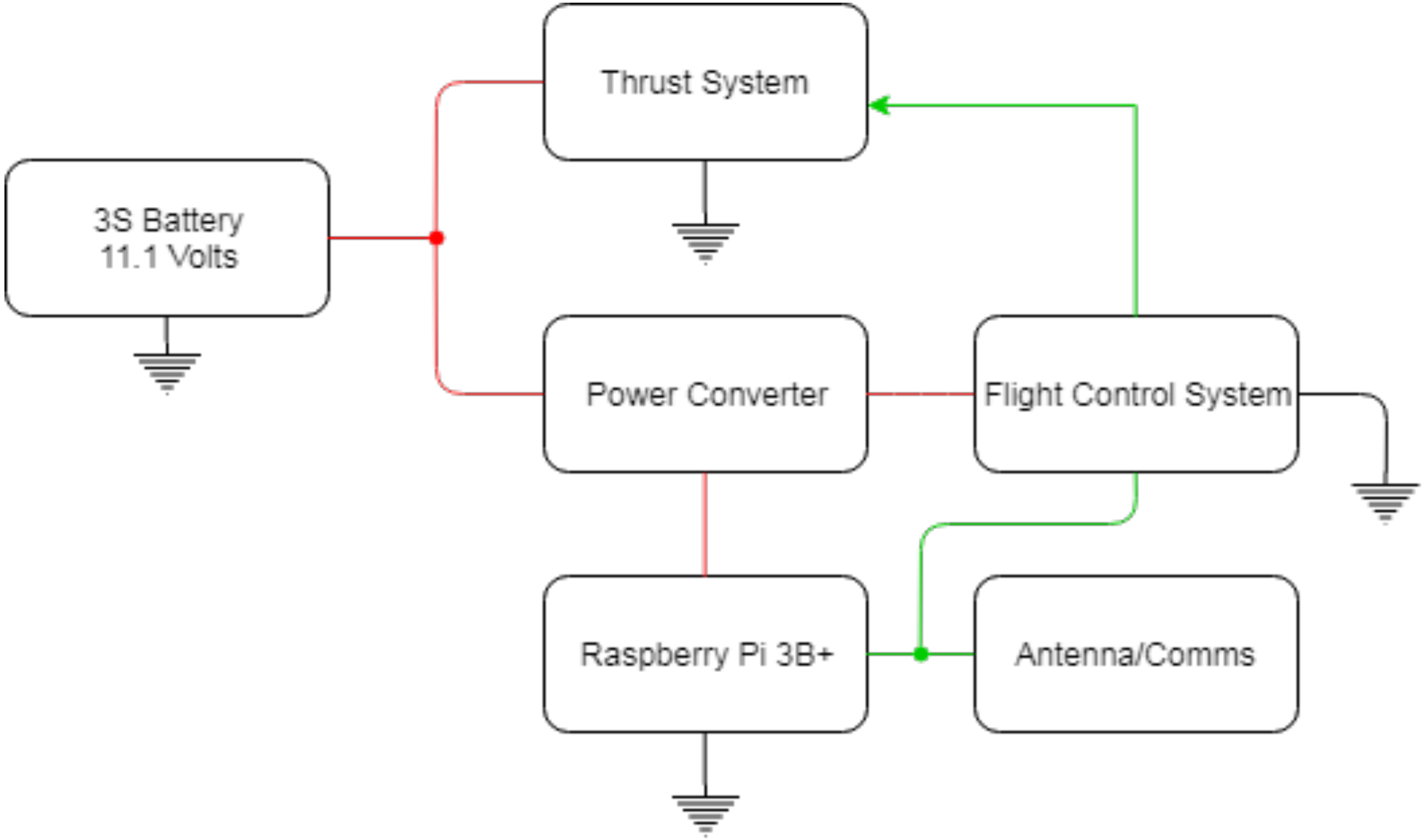
Electrical Design





Kody Koch

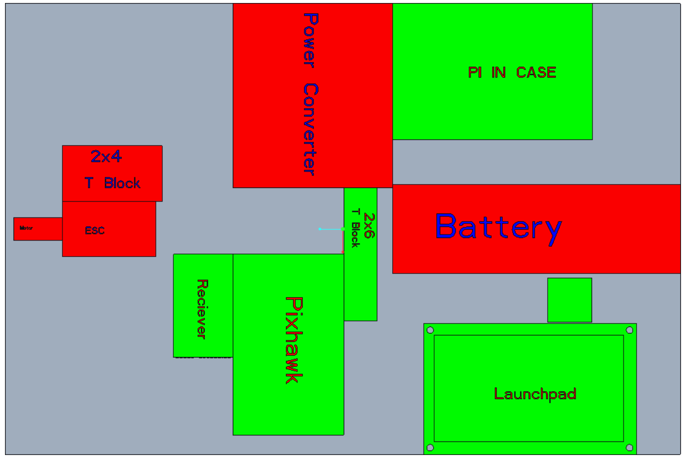
Electrical Block Diagram

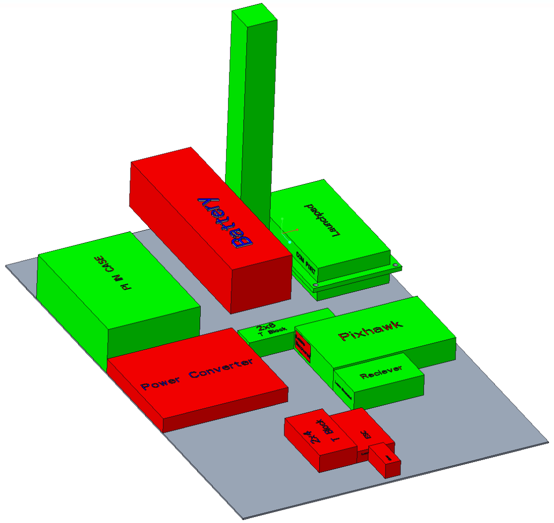


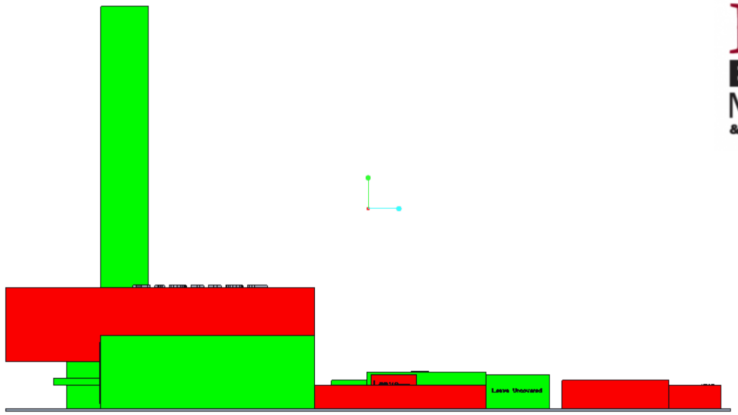
Legend:
Power
Data/Signal

Kody Koch

Sizing Electronics





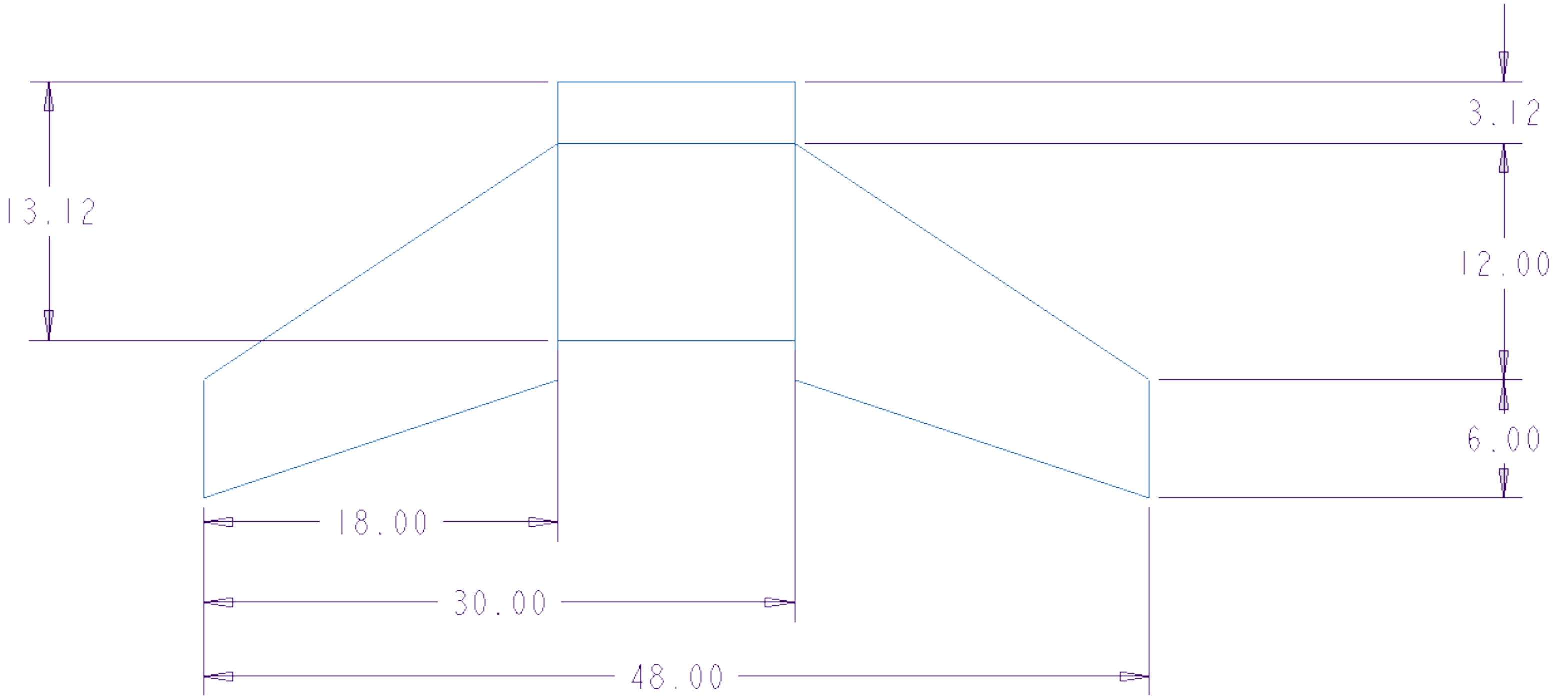


Dimension	Measurement (in)
Length	12
Width	8
Height	2
Total Volume (in^3)	192

- Multiple arrangements considered
  - focused on center of gravity (CG) location and access to specific components
- Final fuselage design has extra room for wiring

Kody Koch

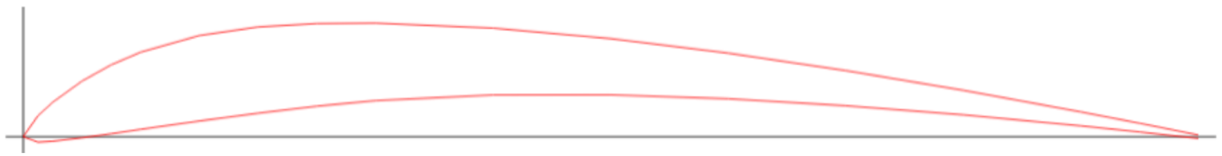
Mechanical Design



- Fuselage width chosen to accommodate 10” prop
- Minimized electronic volume
  - Electronic sizing affects overall wingspan
- 48” (4ft) total lateral size

Joshua Reid

Mechanical Design Cont.

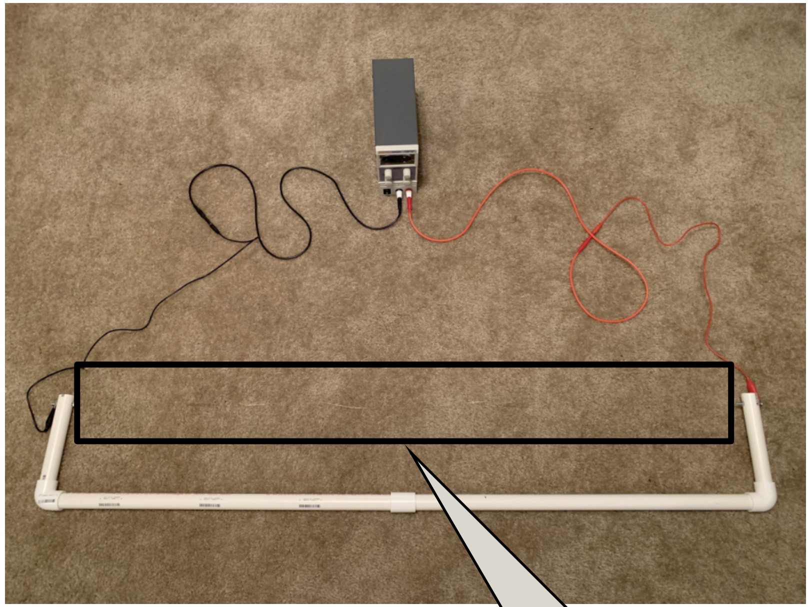


Dillner 20-32C Airfoil

- Flying wing design
- Wings will be shaped to match that of the Dillner airfoil
  - Mimics avian wings
- EPS foam used for both the fuselage and wings
  - Fuselage will be reinforced with a thin layer of wood
- Powered by a single rear pusher motor

Joshua Reid

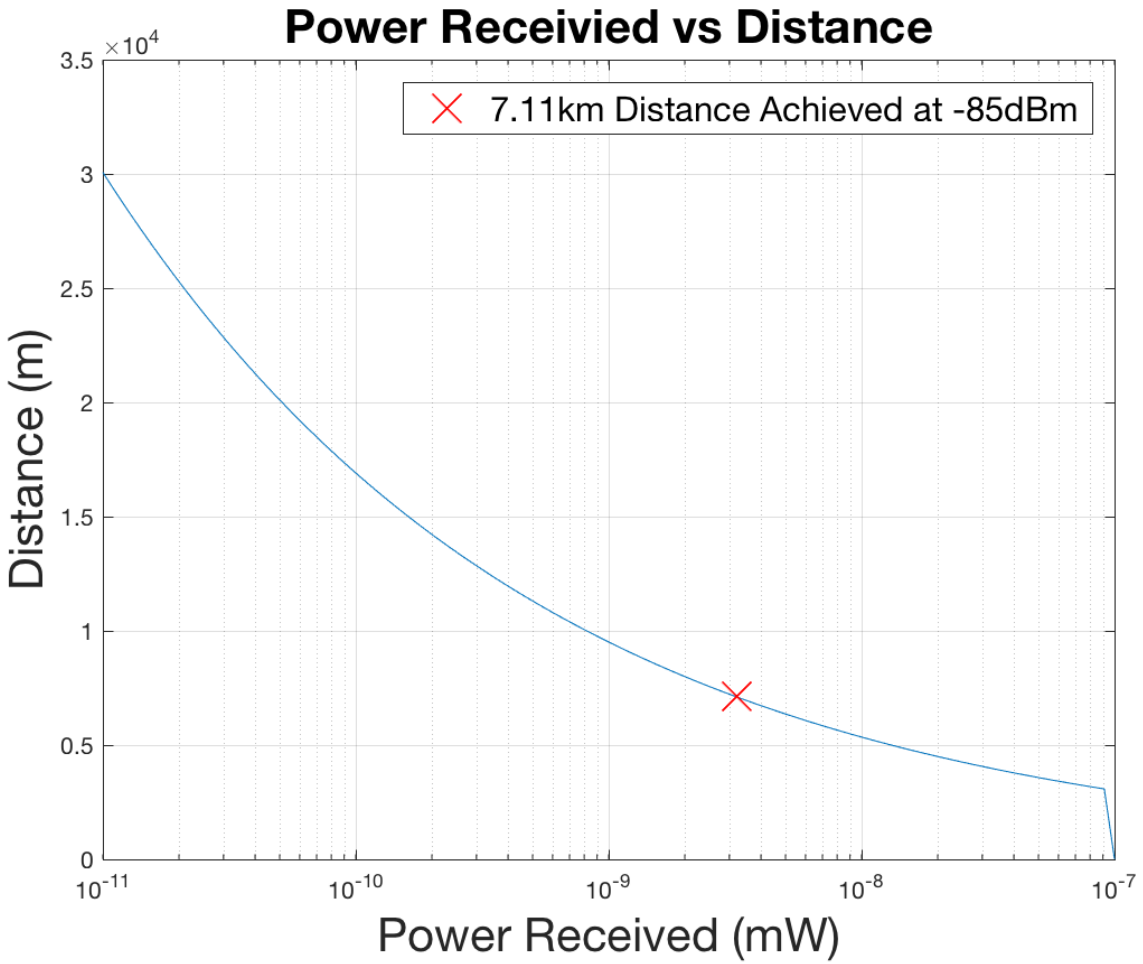
Hot Wire Foam Cutter Prototype



- Foam Cutter
  - ➢ Produces clean edges
  - ➢ Used to shape the structure of the drone out of EPS foam

Joshua Reid

Theoretical Range



- dBm represents signal strength
- Sensitivity is based on Bit Error Rate (BER) and Data Rate
- Calculation Results
  - For a sensitivity of -85 dbm, or $10^{-8.5}$ mW, distance calculated is 7.11km
  - 3.56 times more distance than optimal target goal

Matthew Roberts

Experimental Range - Testing

Yagi Antenna

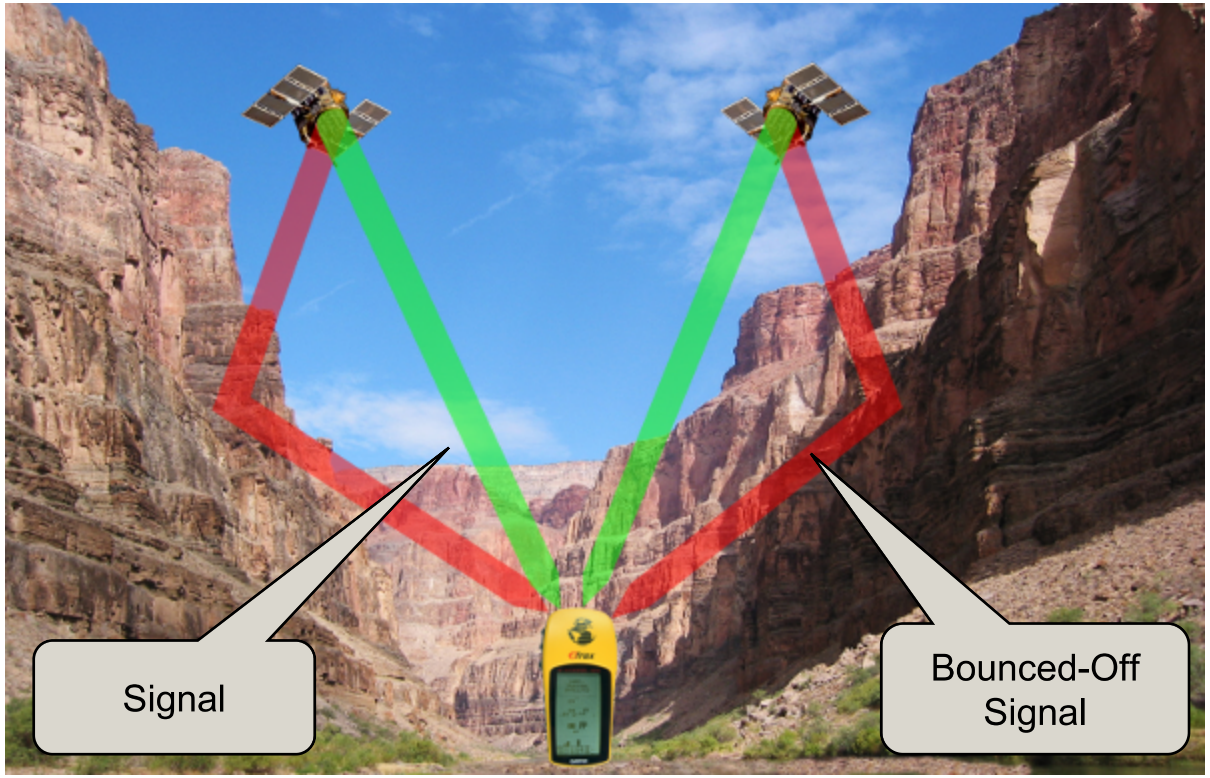
Omni-directional Antenna

TI CC1310 Transceiver

- Results:
  - Range of 2.13km (1.33mi)
  - BER of 0.01% - less than 0.01% is ideal
  - Average of -74.4dBm during flight
  - At -85dBm, errors began to occur
- Target of 1km has been met and exceeds our optimal value of 2km

Matthew Roberts

Range Testing Cont.



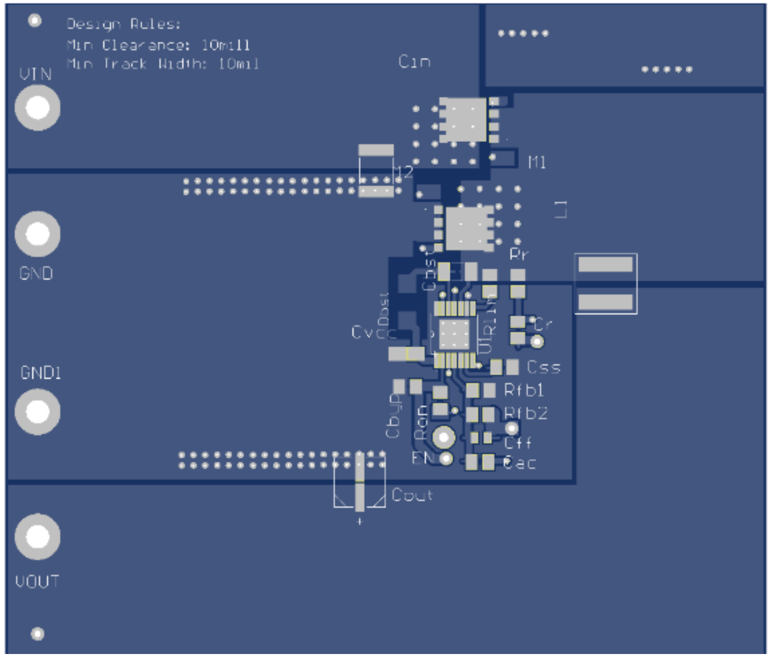
Multipath propagation illustration [1]

- Losses
  - Tests were done in an area with no foliage
  - A slight shift in the antenna will result in considerable loss
- Multipath propagation is the most prominent loss
  - Unavoidable
- Use of signal amplifier may be used for more reliable range

Matthew Roberts

Power Management Changes

- New power converter
  - ➢ 93.7% efficiency
  - ➢ Rated for 5V/8A
- Updated battery
  - ➢ 8000mAh/11.1V
- New flight time calculations
  - ➢ Total power consumption: 76.54W (40% throttle)
  - ➢ Battery optimal capacity: 6400mAh
  - ➢ Total flight time: ~56 minutes
  - ➢ Total flight time at max power: ~27 minutes

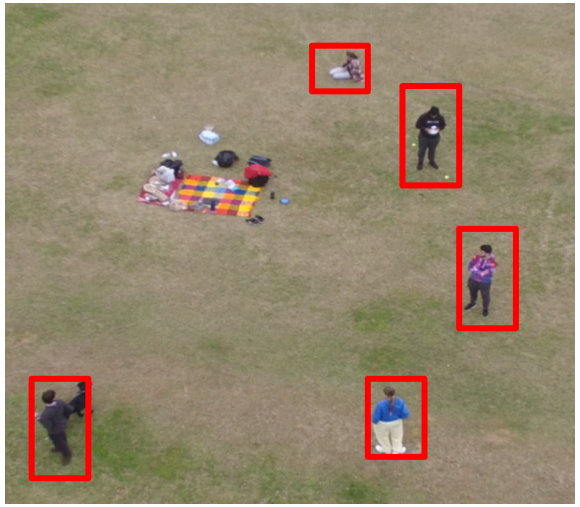


Top side of power converter

Matthew Roberts

Image Processing

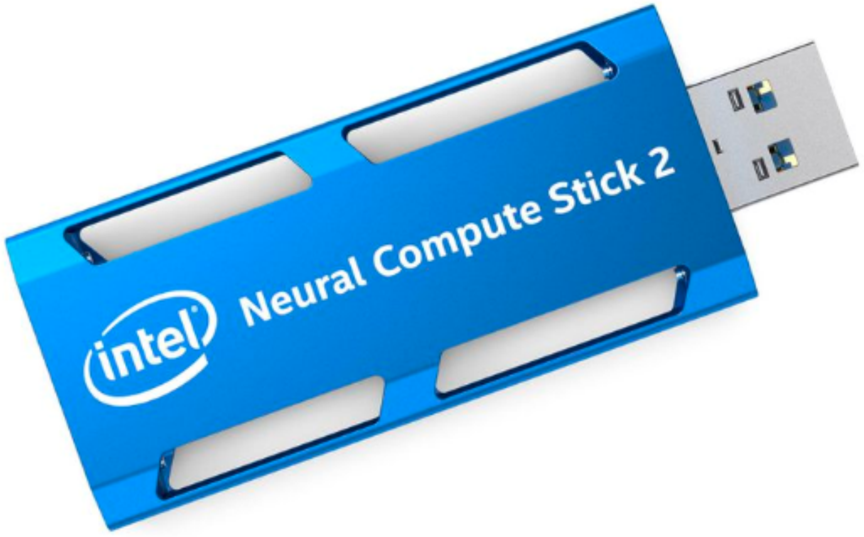
- Explanation of a neural network
  - ➢ A subcategory of artificial intelligence (AI) [2]
  - ➢ Deep learning + databases of information = trained model
- Retraining our neural network to optimize object detection
  - ➢ Filter hundreds of pictures, with and without targets
  - ➢ Can be trained manually or through algorithms



Francisco Silva

Image Processing Cont.

- Environment needed for object detection
  - ➢ Raspberry Pi + Raspbian
  - ➢ Neural Compute Stick 2 (NCS 2)
  - ➢ OpenVino (Intel convolutional neural network toolkit)
  - ➢ USB Camera
  - ➢ Python
- Neural network model
  - ➢ YOLOv3
    - ▪ Retrained to find only “persons”
  - ➢ Low object detection frames per second (FPS)
    - ▪ More NCS2 sticks = higher FPS
    - ▪ Goal of ~10 FPS



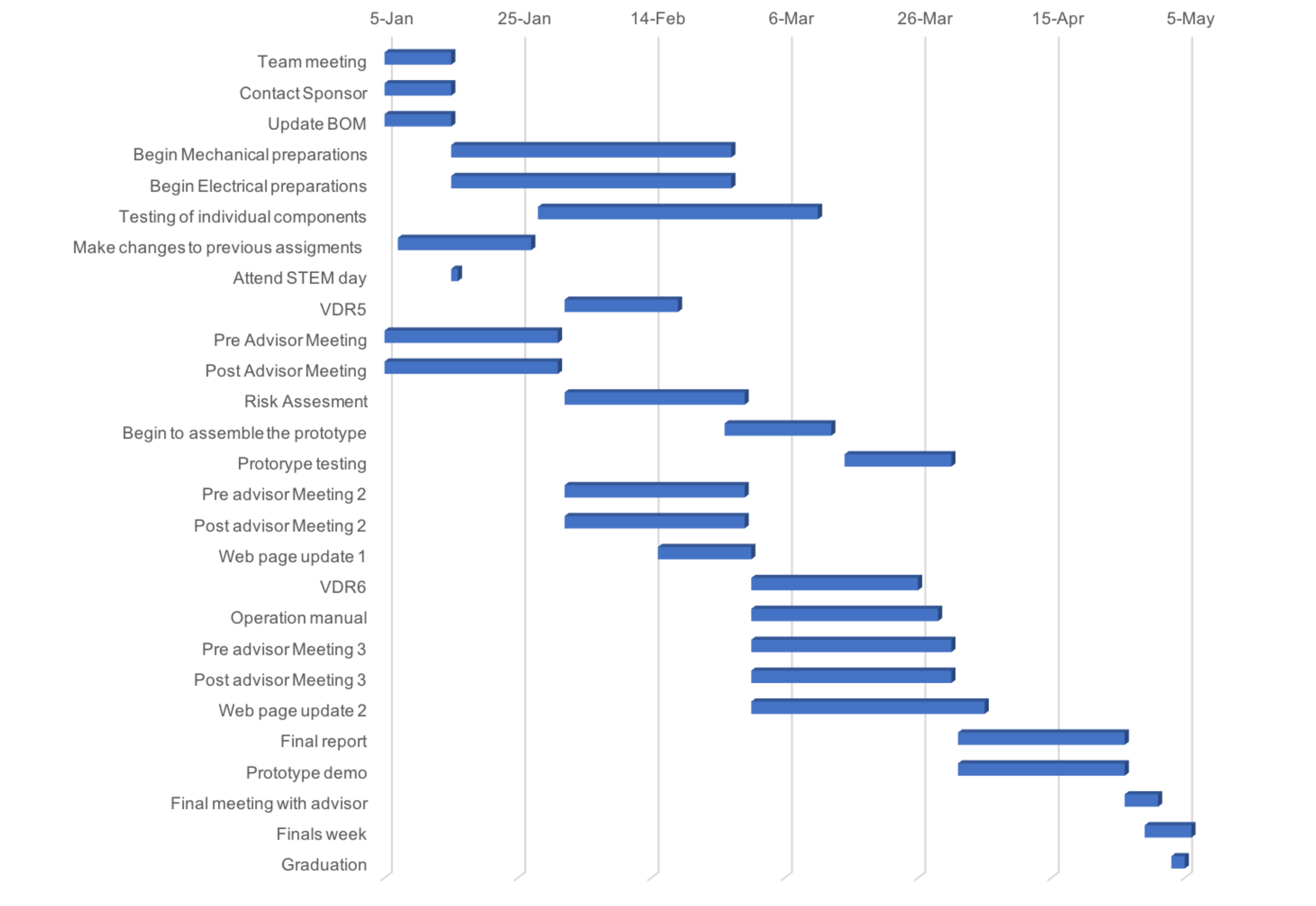
Francisco Silva

Budget Update

Budget Sector	Price Total ($)
Total Budget	1500
Sum of Parts Ordered	1,001.32
Sum of Remaining Parts	0.00
Total Sum of Parts	1,001.32
Budget Remaining	498.68

Juan Patino

Timeline



- Accomplished
  - Phase 1 range testing
  - Construction of foam cutter
  - Laser cut airfoils
  - Modeled electronics for sizing
  - Finalized dimensions of structure
- Current Progress
  - Accumulation of aerial images to feed to the neural network
  - Researching software capable of feeding a neural network
- Future work
  - Phase 2 range testing
  - Construct the vehicle
  - Solder the power converter
  - Assemble prototype

FSU EMERGENCY MANAGEMENT & HOMELAND SECURITY PROGRAM

Juan Patino

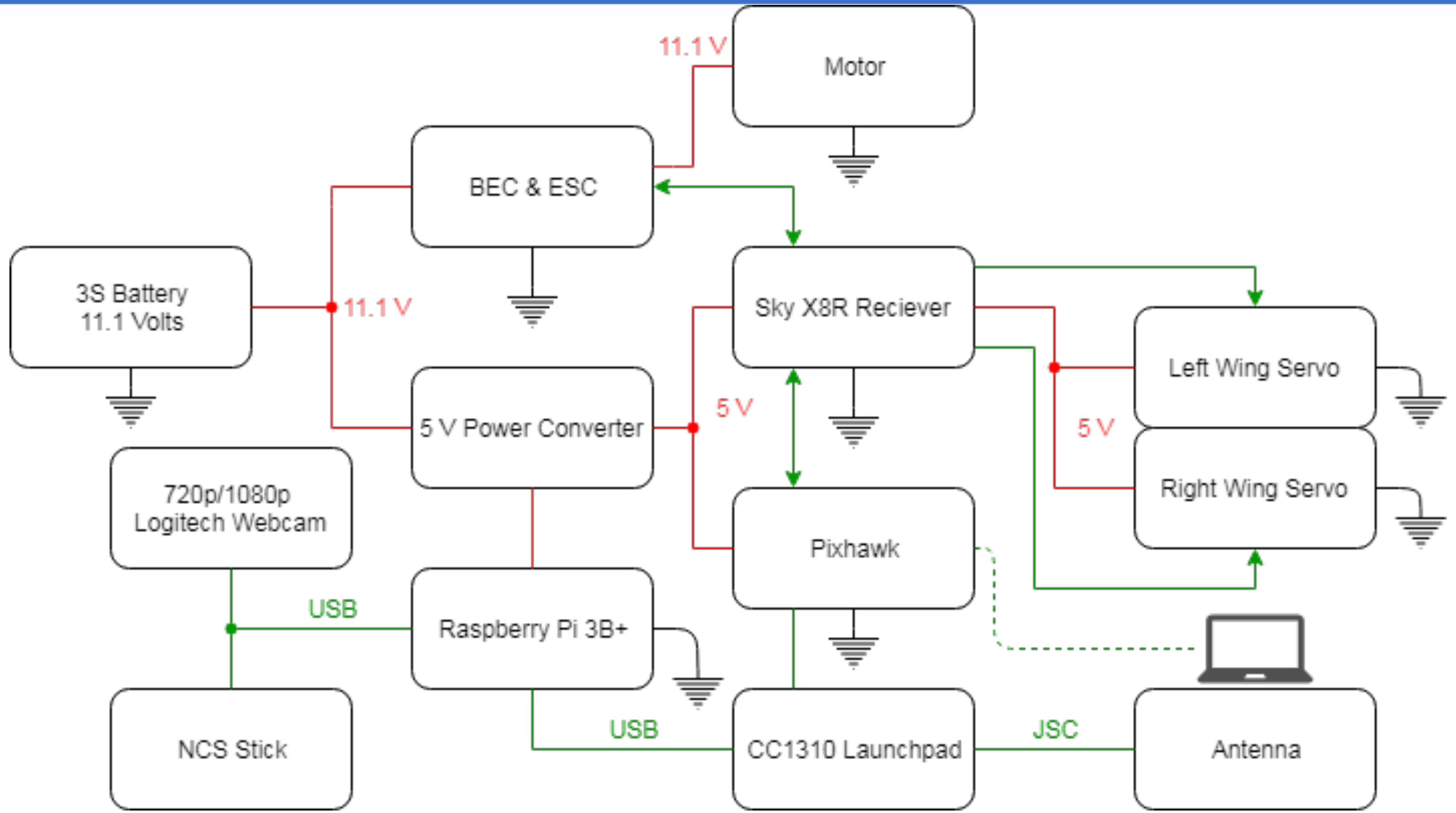
References

1. Javiersanp - GPS tracking satellites.jpg, CC BY-SA 3.0, Retrieved February 18, 2019 from https://commons.wikimedia.org/w/index.php?curid=9966587
2. What is artificial neural network (ANN)? - Definition from WhatIs.com. (n.d.). Retrieved February 11, 2019 from https://searchenterpriseai.techtarget.com/definition/neural-network

Juan Patino

Questions?

Detailed Block Diagram



Kody Koch