

Advanced Multi-rotor Drone

Fall 2018 - Spring 2019

Client: Design Magnitude Idaho (DMI)

TEAM TBOD:

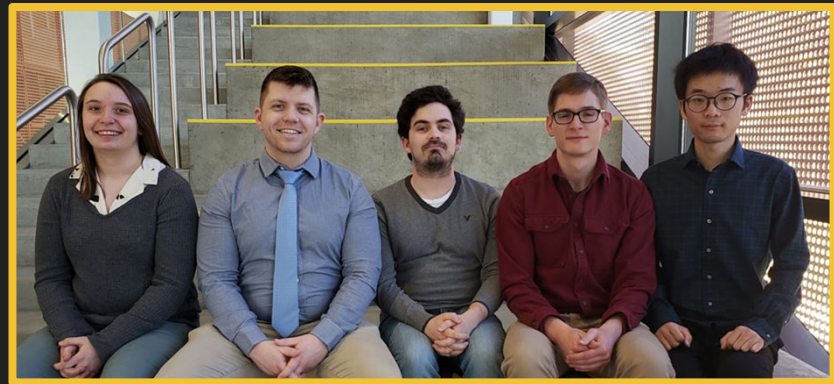
Member 1: Makynzie Zimmer (ME)

Member 2: Caleb Smith (ME)

Member 3: Matthew Shryock (EE)

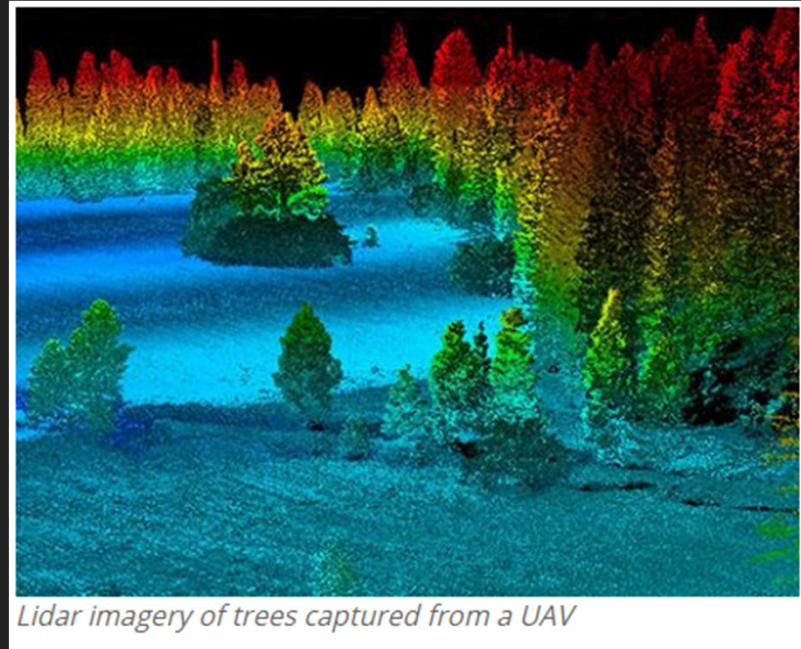
Member 4: Preston Stephens (CompE)

Member 5: Pengqiang Ge (EE)



Introduction

- ❖ Learning
 - What makes a drone fly?
- ❖ Drones used for land surveying & 3D mapping by Dr. Karl
 - Restricted range due to battery life
 - Lets see if we can make a drone that solves that problem
- ❖ Can't you just go buy one?
 - Yes, but...
 - You don't learn anything
 - No room for innovation
 - It's not as fun



Lidar imagery of trees captured from a UAV



Early Concept

- ❖ From the beginning we knew we wanted to incorporate:
 - Power Efficient FPGA's
 - Lifting Body
- ❖ Hence TBOD
 - Two Birds, One Drone
- ❖ First prototype by end of 2018
 - This turned out to be wildly unrealistic
- ❖ We learned that we take for the granted the staggering complexity of drones



Development

Tortuga (Turtle)

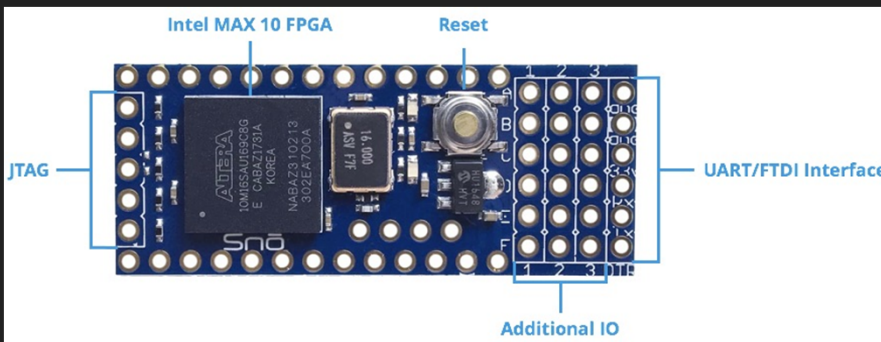
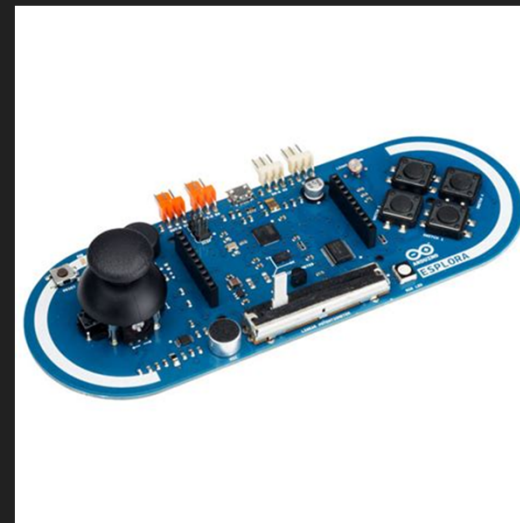


- ❖ Three main areas of development:
 - Electrical - Power System
 - Control System - Flight Control
 - Mechanical - Airframe/Teststand
- ❖ Interdisciplinary Team
 - Electrical:
 - Preston, Mat, PQ
 - Mechanical:
 - Caleb, Makynzie



Overview of Electronics

- ❖ Brushless DC Motors
- ❖ Electronic Speed Controllers (ESC's)
- ❖ FPGA preloaded with arduino architecture
- ❖ Remote control



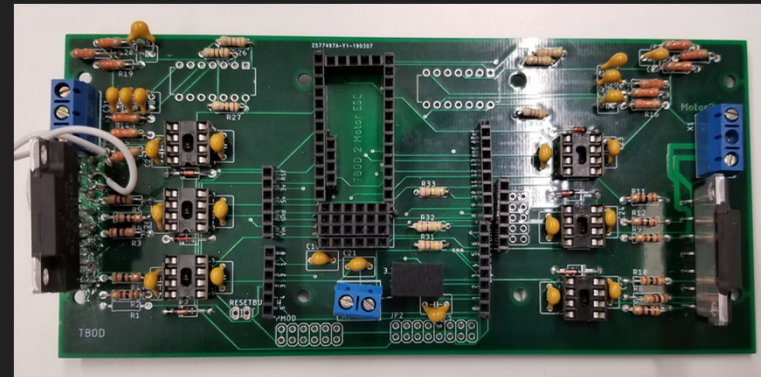
Brushless DC Motors

- ❖ KV400 AntiGravity Motors
 - Hyper Efficient
- ❖ Carbon Fiber Blades
- ❖ These motors put off Back EMF, this allows precision control of the motor



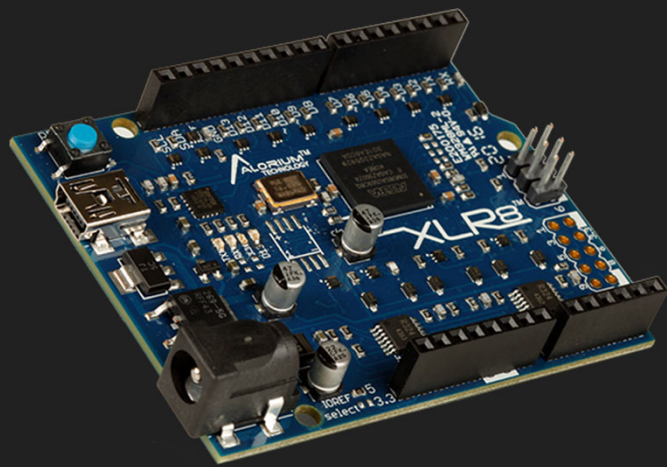
What is an Electronic Speed Controller (ESC)?

- ❖ Designed and Fabricated our ESC's from scratch
- ❖ Why do this?
 - Learn Everything about ESC
 - Cut out the bulk, including the microcontroller
 - Filter the Back EMF
 - We can scale ours to control even more motors
- ❖ Drones require an ESC for each motor, while our design

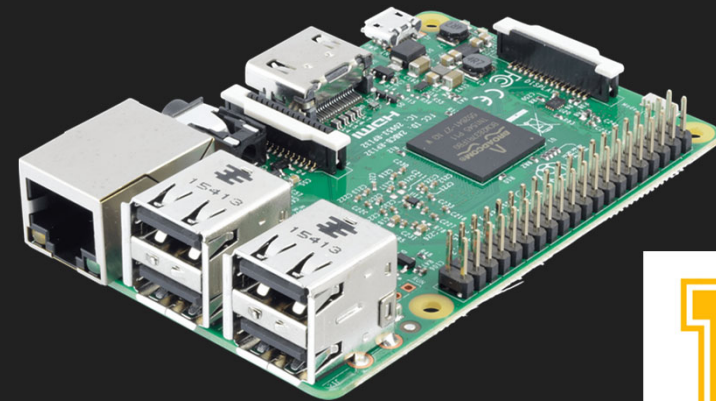


Field Programmable Gate Array (FPGA)

- ❖ Why an FPGA?
- ❖ Math doesn't work out
- ❖ Could use Raspberry Pi but it requires significantly more power
- ❖ Virtual hardware uses less power and is more lightweight

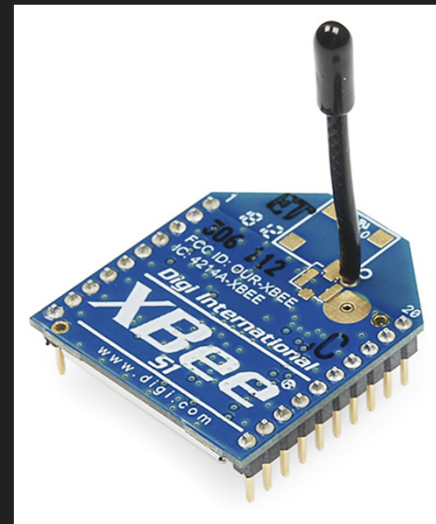
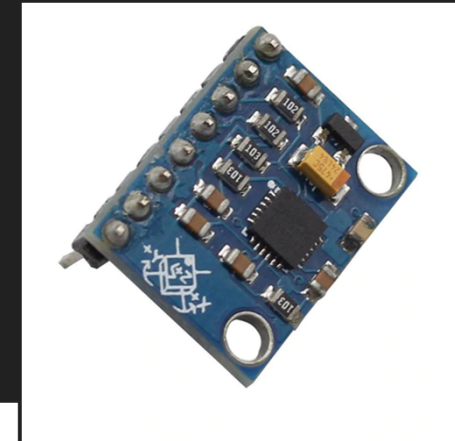


VS



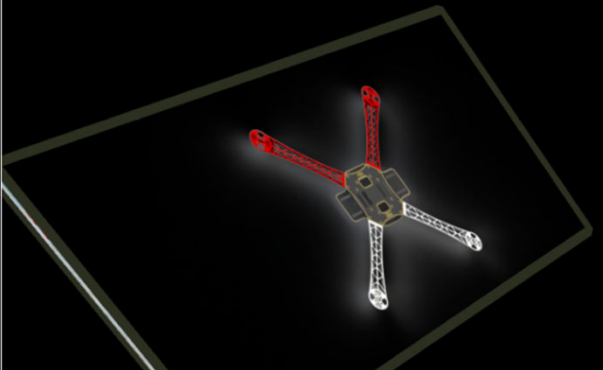
Modules

- ❖ 9 Axis IMU
- ❖ Soft processor (AVR Core)
- ❖ MAX10 FPGA
- ❖ XBee RF Module

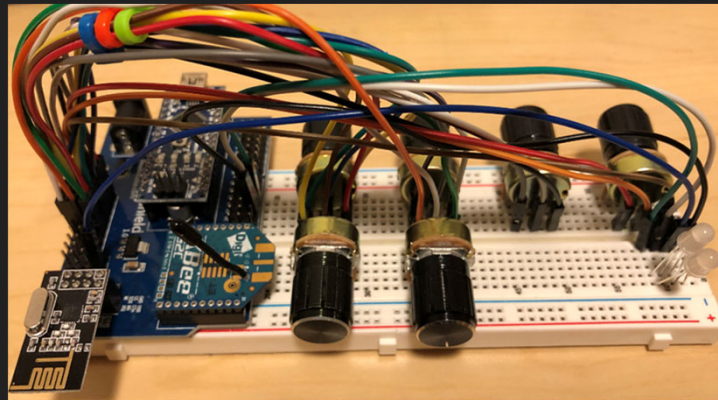


Uko wrcvkqp #cp f #r go qvg#E qp vtqn

```
Q: Euler Angles:  
0.6166382 Yaw (psi) : -103.211205  
0.15148926 Pitch (theta): 32.092716  
-0.56121826 Roll (phi) : -67.503075  
0.5308838
```



- ❖ Zmwyep-exsr\$wsjx{ evi\$nwtp}w\$iepxq i\$hexe\$vsq \$li\$ srfsev\$wirwsw
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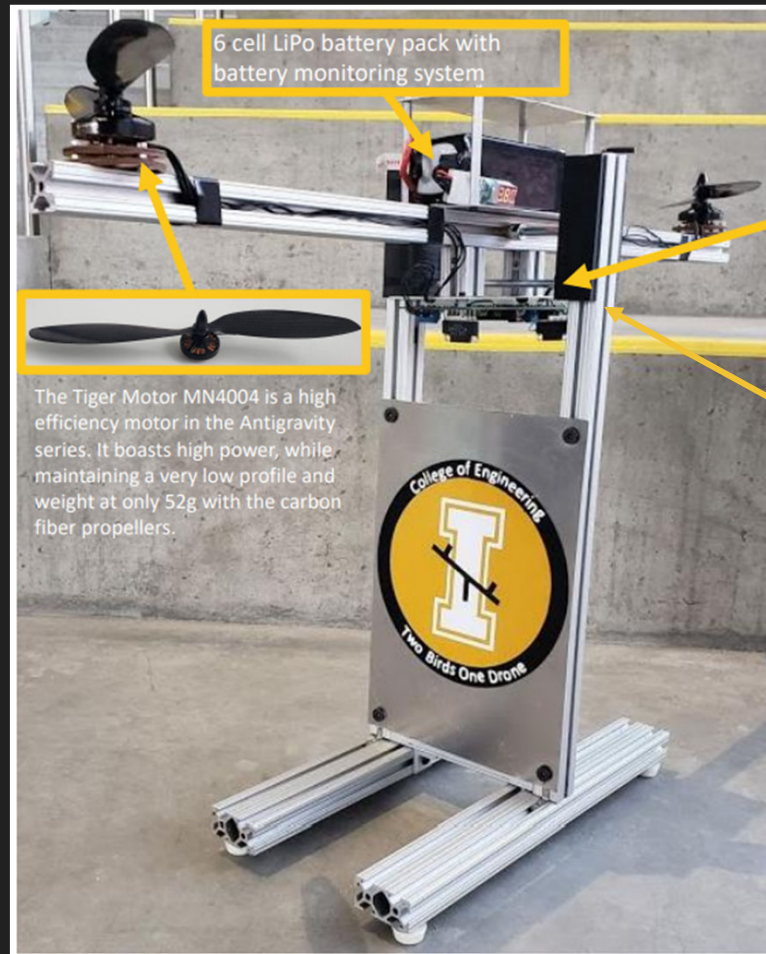
360 Test Stand

- ❖ **Allows 4 degrees of freedom**
 - Roll, Pitch, Yaw, Altitude
- ❖ **Testing of Simulation**
 - Remote Control
 - Motion Sensing
- ❖ **Visualization Software displays and interprets data from the sensors**



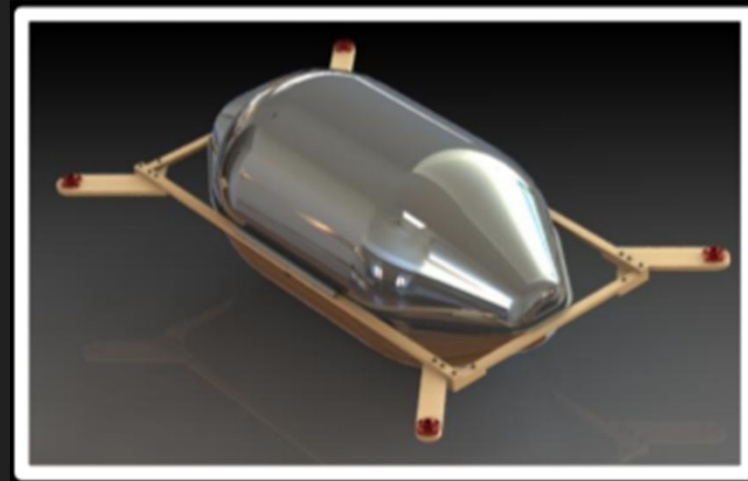
Teeter-Totter

- ❖ Test our system in a safe controlled environment
- ❖ Limits movement to rotation on one axis.
- ❖ Modular design allows for testing of various different components
 - Batteries
 - Motors
 - ESCs
 - Control system



Lifting Bodies (Balloons)

- ❖ Helium filled balloon
 - $\frac{1}{3}$ to $\frac{1}{2}$ airframe weight offset
- ❖ Excel Program for determining:
 - Dimensions of Mylar for cutout
 - Volume of balloon
 - 1g of lift = 1L of Helium
- ❖ Manufactured using:
 - Thermal Tape
 - Sheet Mylar
 - Heat Clamps and Heat Rollers
 - NOT EASY



1. Squirt



2. Tortuga



BIG BERTHA



Lessons Learned...

- ❖ The sooner you need something the longer it takes to ship
- ❖ Double check calculations,
- ❖ Schematics can be WRONG
- ❖ Heat is Hot, be careful
- ❖ Build Early, Build Often
- ❖ Teeter is not spelt Teater
- ❖ It's worth smoothing sharp edges
 - Both literally and metaphorically
- ❖ We learned a lot about drones, but a lot more about the engineering process



Future of the Project

- ❖ PID control
- ❖ Automation of flight patterns
- ❖ Integrate all the individual components into a functional drone
- ❖ Bigger/Better Balloons
- ❖ Remote Control/Sensor System
- ❖ Test Stand data collection
- ❖ Preliminary field testing
- ❖ Land Surveying/3D Mapping
- ❖ Personal Taxis
- ❖ Online Shopping Delivery
- ❖ Etc



Questions?

