Dizzy-n-Copter

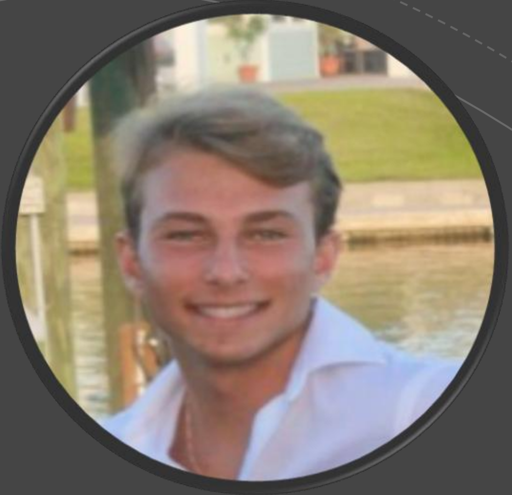
Group 29

- Sponsored by Dr. Mike Borowczak in DRACO Lab

Our TEAM

Corey Barbera

Computer Engineering



James Thompson

Electrical Engineering

Carlos Alfonso Vargas

Computer Engineering

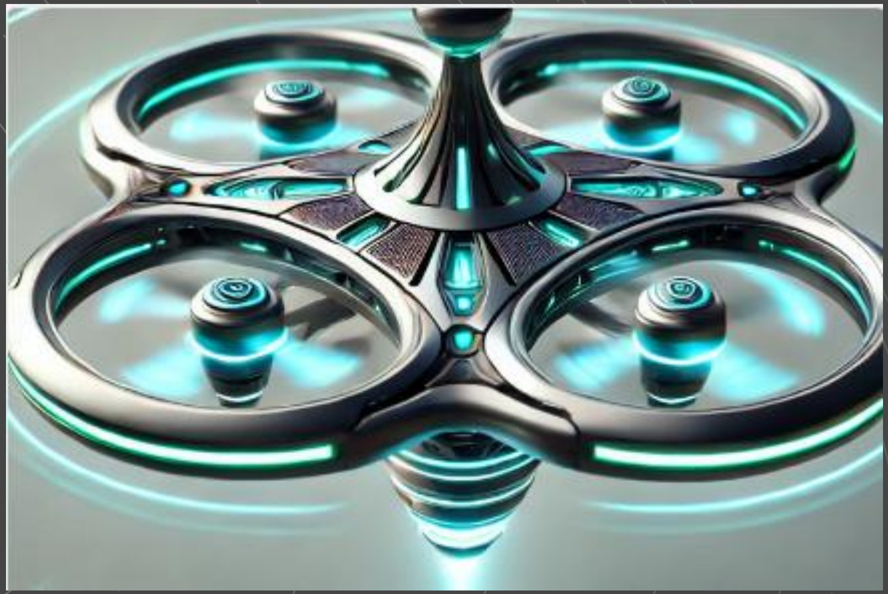
Alex Bayda

Electrical Engineering

Problem & Motivation

- High-end drones rely on expensive sensing systems
  - LiDAR systems can exceed $10,000
- Rotating sensors add cost, weight, and complexity
- Environmental mapping should be accessible & affordable.

"What if the drone itself became the rotating sensor?"



Project Goals

- Develop a fully functional drone that maintains a constant rotational frame speed of 60 RPM.
- Communicate key data via telemetry such as spin rate, battery life, and flight status to a base station in real time.
- Create an Indoor-safe drone that has enclosed propellers to protect the propellers themselves as well as others around.
- Achieve a minimum 5-minute flight time through optimized battery usage.
- Complete build weight of the drone under 250 g

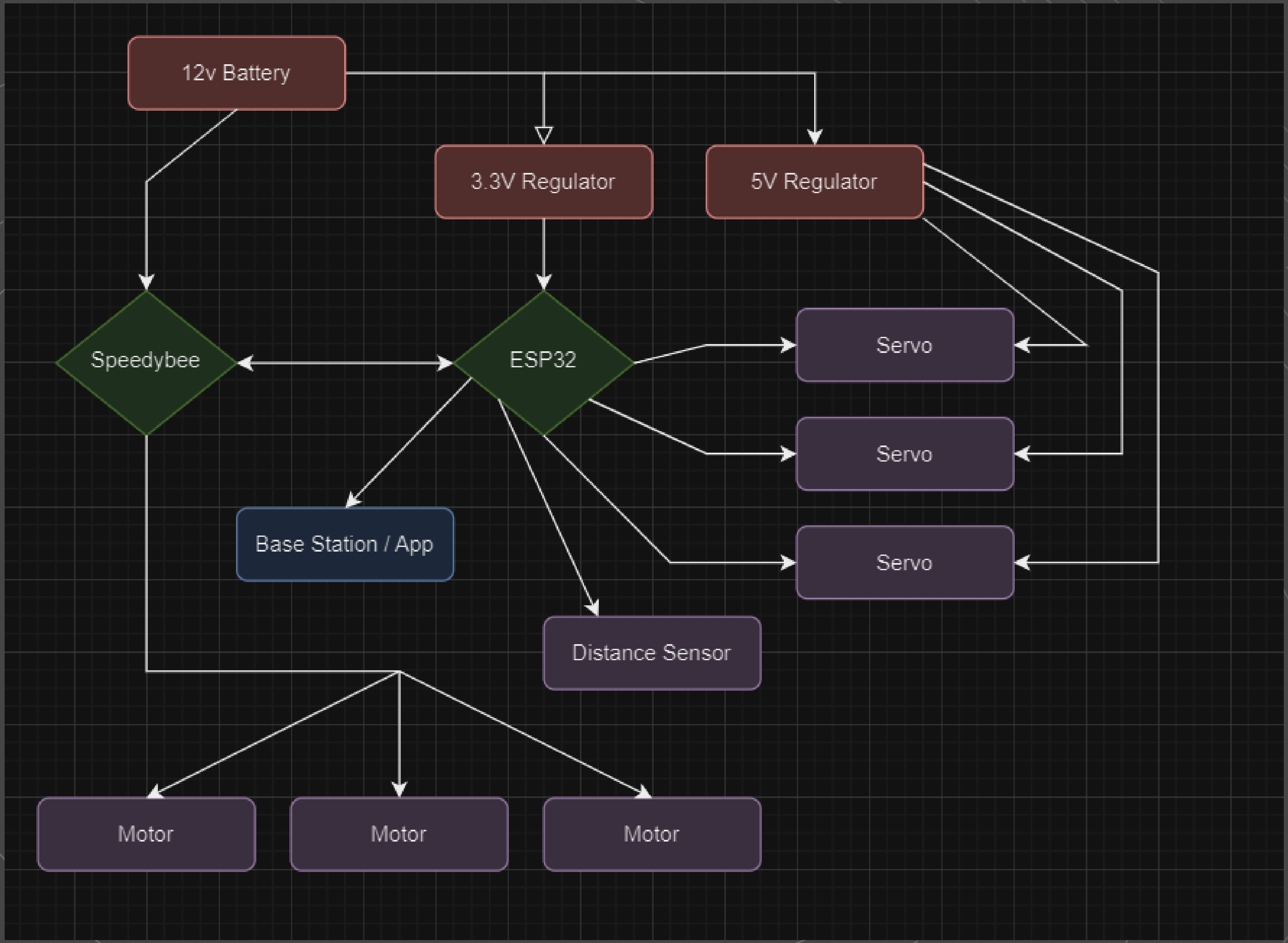
Measurable Objectives

- Spin Control
  - Maintain 60 RPM ±5% during sustained hover
- Telemetry
  - Stream spin rate, battery voltage, and flight mode
  - ≥ 10 Hz update rate to base station
- Flight & Safety
  - ≥ 5 min continuous flight
  - < 250g verified final mass
- Safety
  - Fully enclosed propellers

Engineering Specifications

Requirement	Target Values	Description
Performance	Rotate @ 60 RPM ± 5%	The drone must rotate at 60 RPM around the Z-axis and remain stable during sustained hover
Flight Time	≥ 5 minutes	The drone must sustain hover while rotation for a minimum of 5 minutes.
Weight	≤ 250 grams	The complete build weight of the drone must be under 250 grams.
Telemetry	Spin rate, battery voltage, and flight mode.	The drone base station must stream telemetry data.

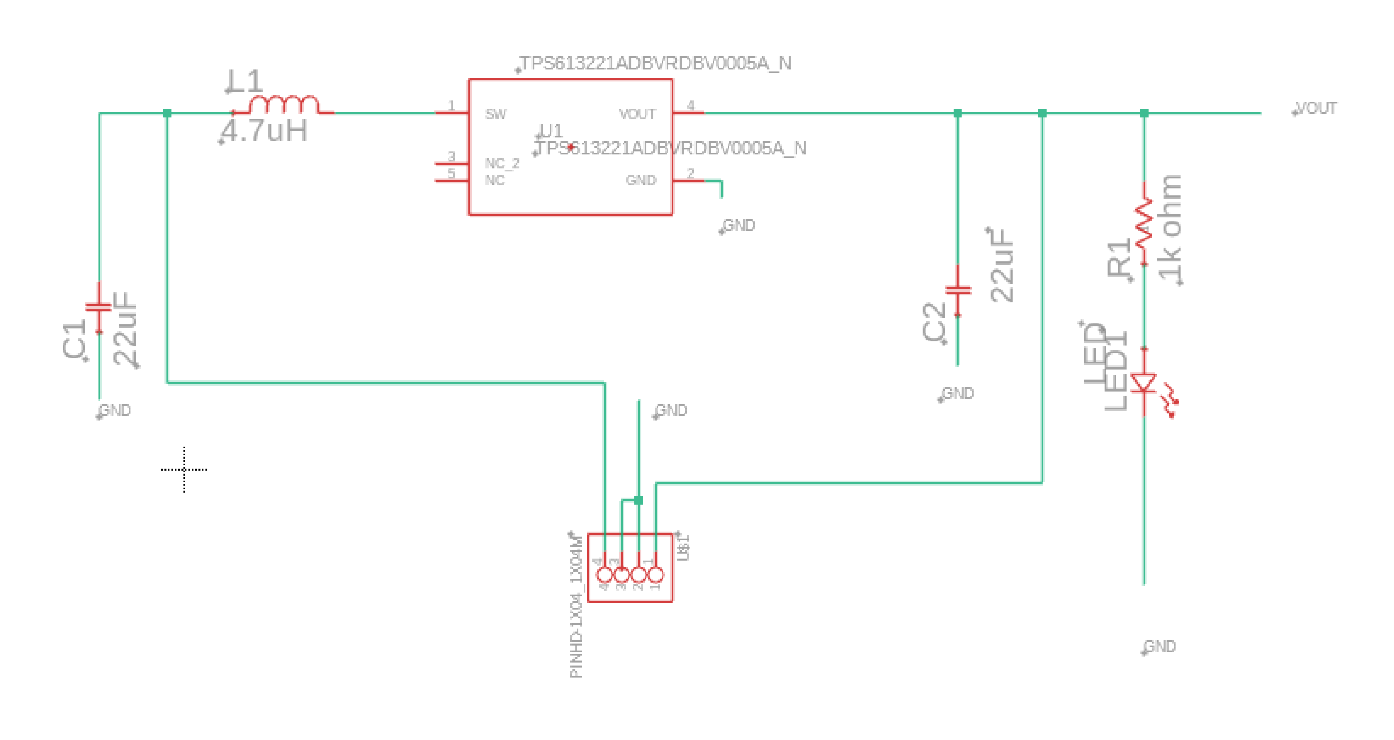
Hardware Block Diagram

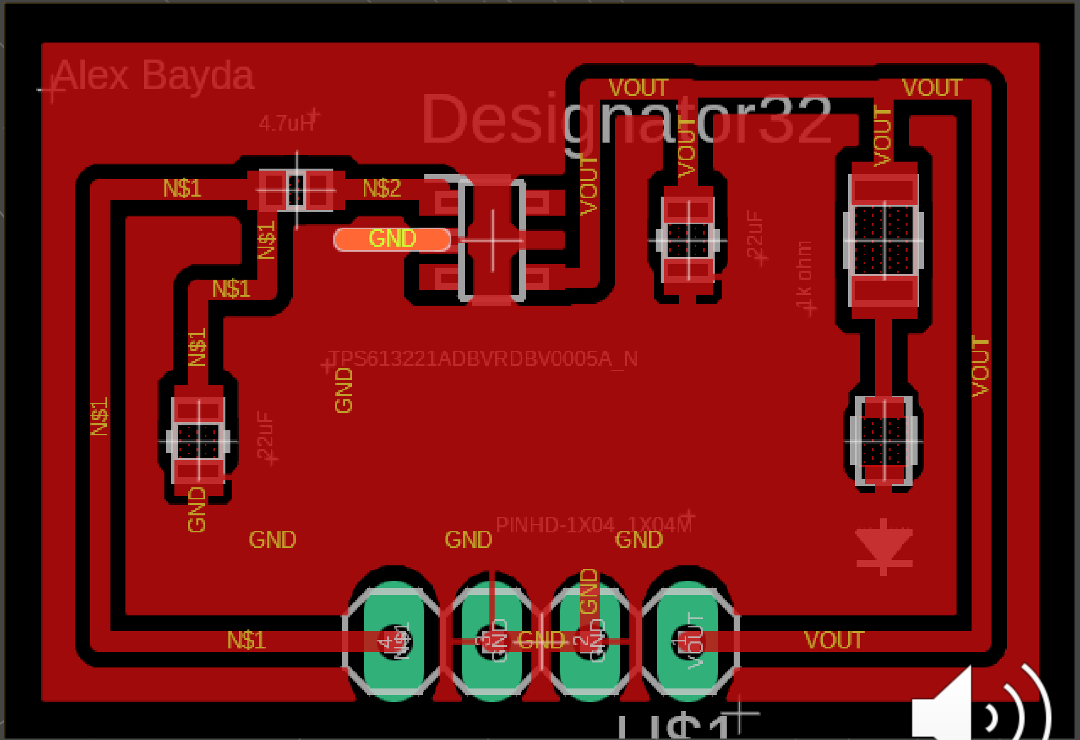


Power Distribution

TPS613221 & TPS613222 Voltage Regulators:

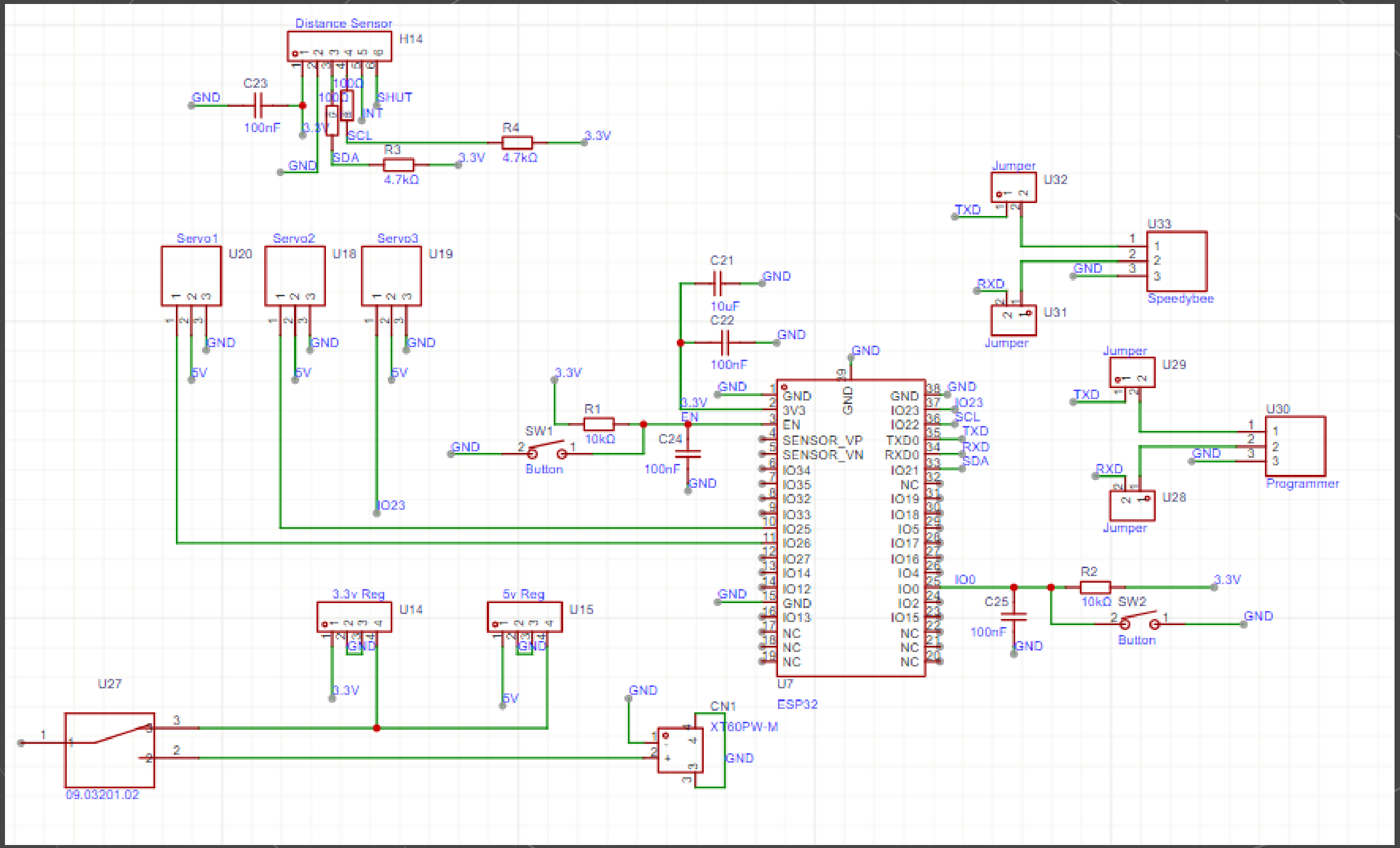
- 5v being provided to servos
- 3.3v being provided to MCU

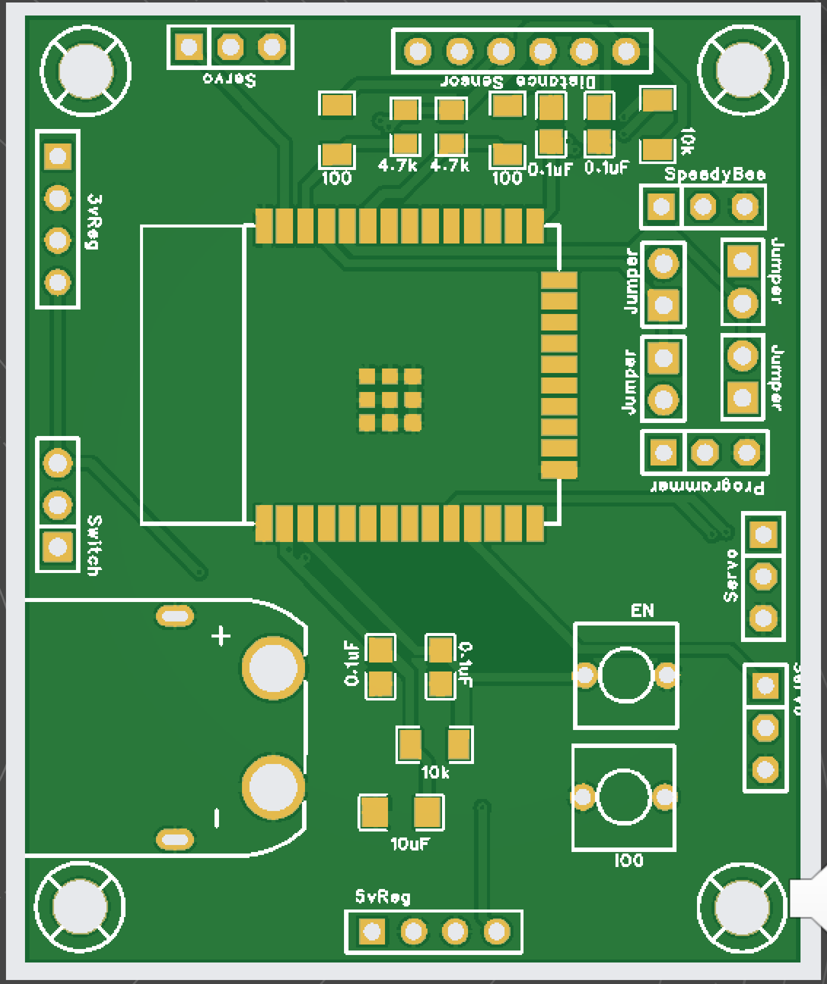




Primary PCB

- Designed for Robustness and minimal interference
- Compact layout optimized for drone frame mounting

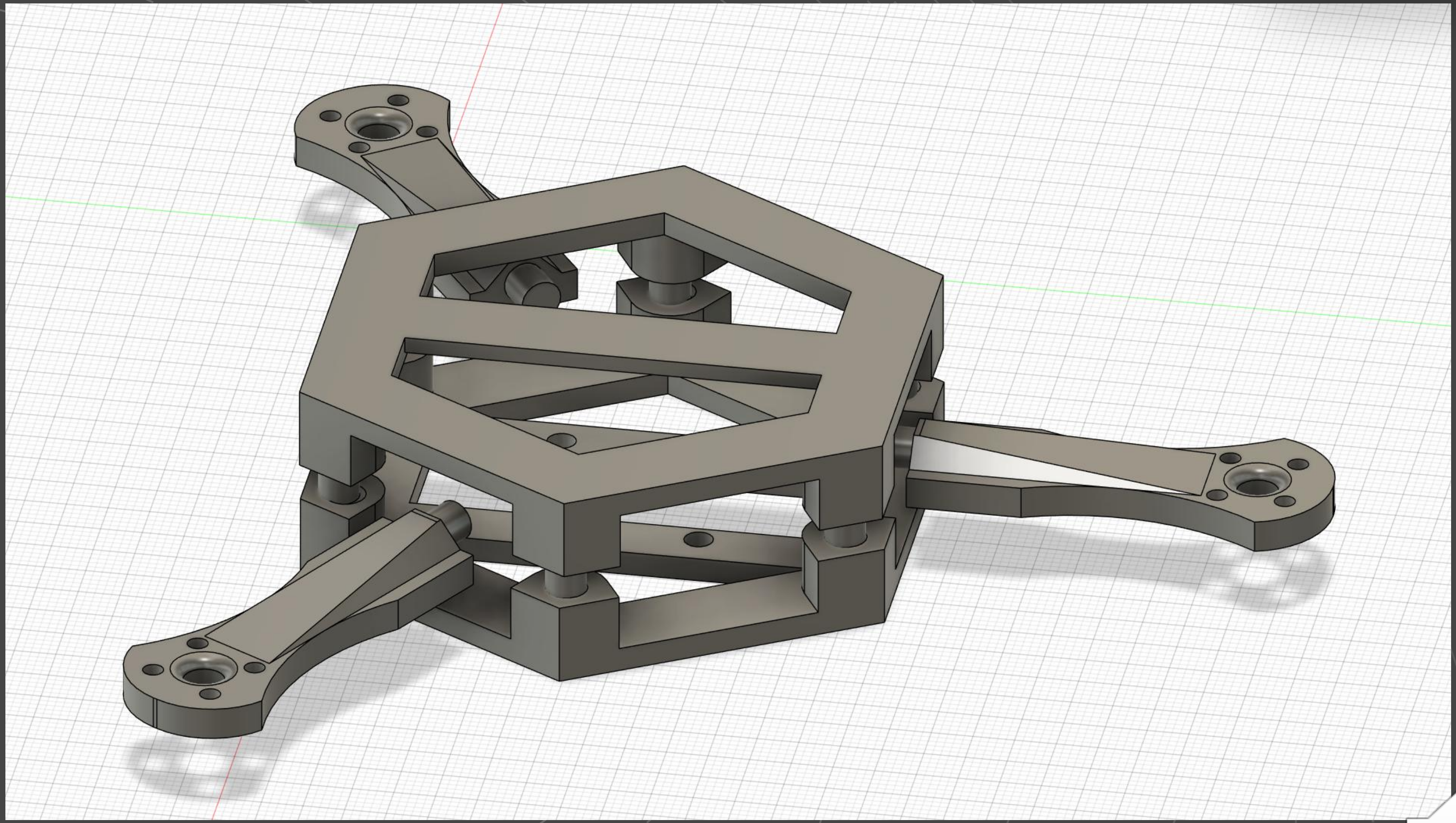




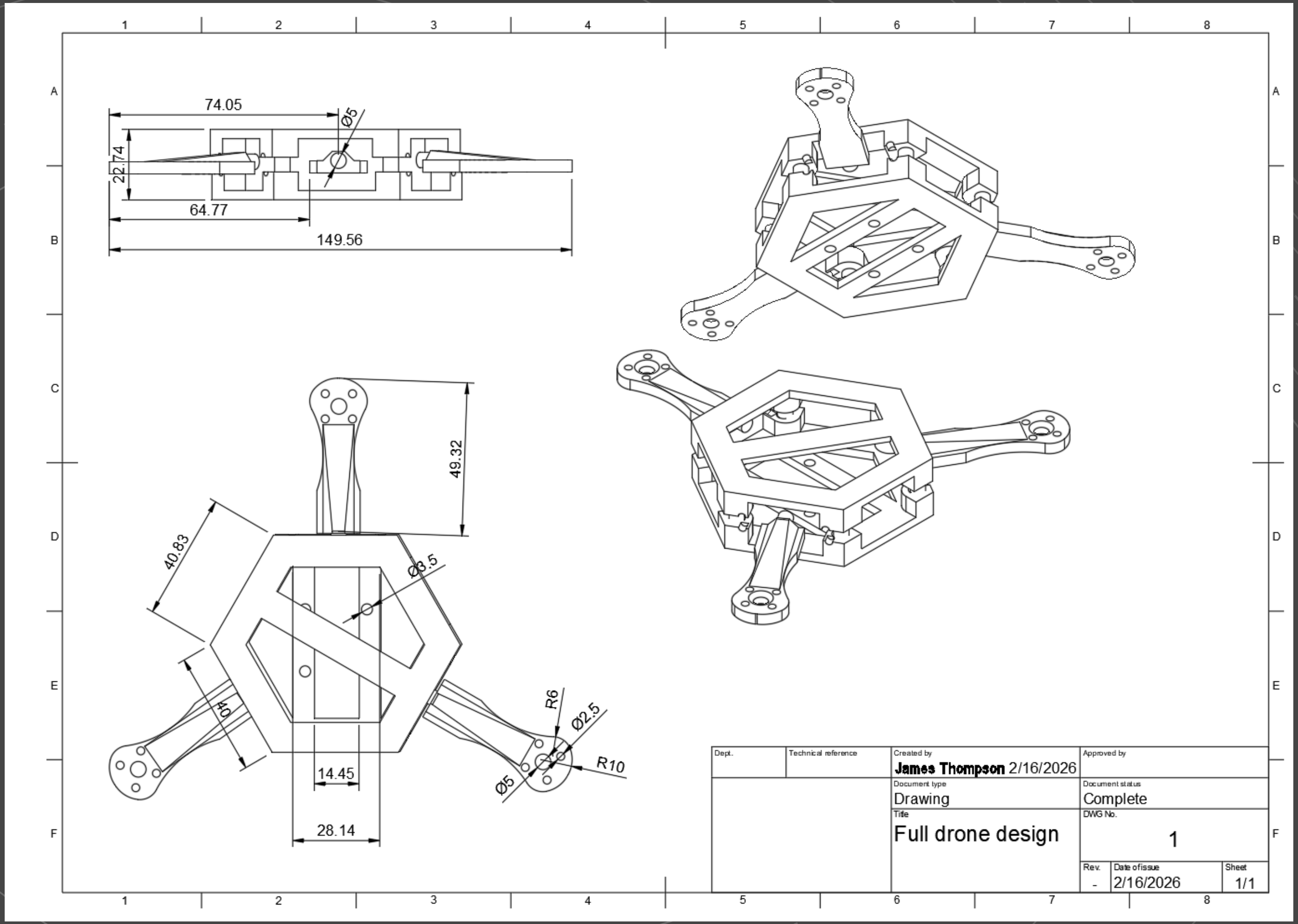
CAD Design

Design Program:

- This design was meant to be modular
- The need to attach the Speedybee, PCB and Battery
- Servos will be included into the side with their own fittings
- Prop protection will be made out of Nitinol. A metal that remembers it's shape



Final Design Drawing

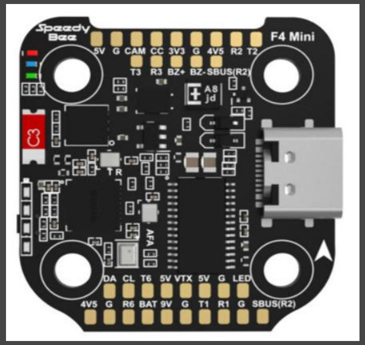


Flight Controller Selection

Selected Component: SpeedyBee F405 Mini Flight Controller

Why this component?

- Compact 20x20 mm which is ideal for our drone
- Lightweight design (~13.5g)
- Real-time performance for stabilization and spin control
- Supports Betaflight
- Integrated 4-in-1 ESC compatibility



Criteria	SpeedyBee F405 Mini	RDQ Bardwell F7 V2
Integrated Features	4-in-1 ESC	
Mounting Size	20x20 mm	30x30 mm
Weight	~13.5g	~14g
Firmware	Betaflight	Betaflight
Cost	~$109.99	~$129.99

Microcontroller Selection

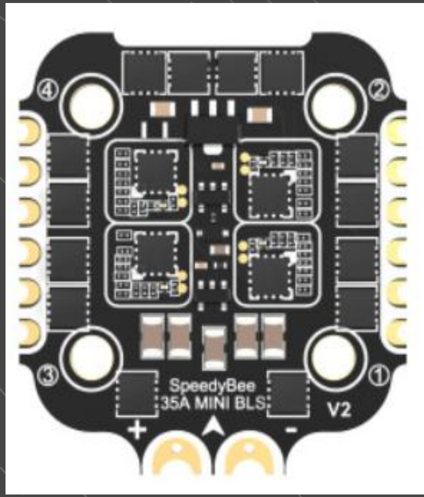
Selected Component: ESP32
Why this component?

- Integrated BLE Component
- Familiarity with communication
- Real time performance

Criteria	**ESP32**	**STM32**
Bluetooth	Integrated	External Component
Processing	Dual Processor	Dual Processor
Communication	BLE, Wifi	None
Cost	Generally Cheaper	Generally Pricier

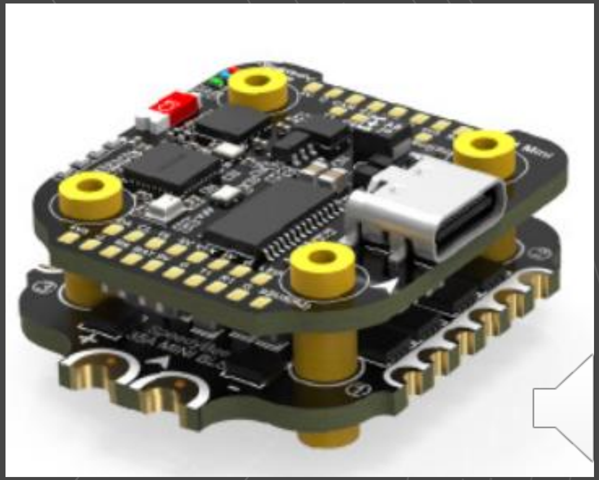
Electronic Speed Controller (ESC) Integration

Selected Component: SpeedyBee F405 Mini V2 20x20 4-in-1 ESC



Why this component?

- Direct 4-in-1 ESC interface
- Guaranteed electrical and firmware compatibility
- DShot protocol supports reliable motor response for spin stabilization
- Compact and lightweight design
- Simplifies debugging and tuning

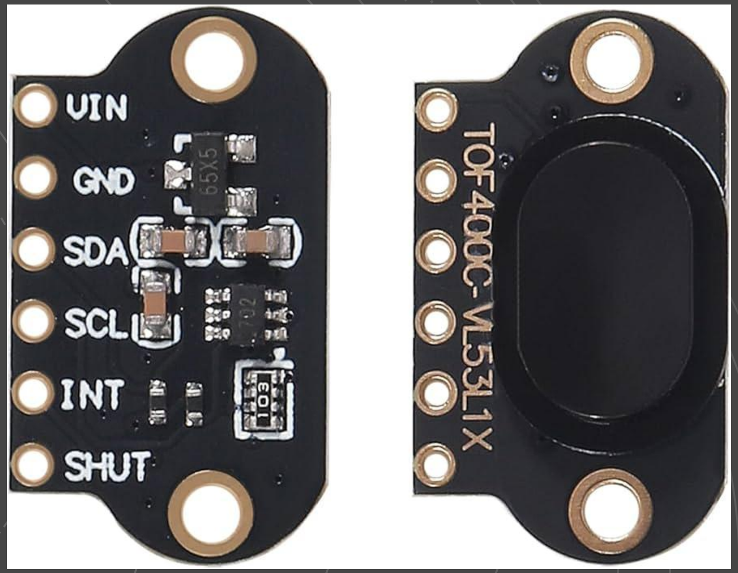


Distance Sensor Selection

Selected Component: VL53L1X Time-of-Flight (ToF) Distance Sensor

Why this component?

- Because the drone continuously rotates, a single ToF sensor mounted underneath can generate a full 360-degree distance profile without the mass or complexity of multi-sensor or LiDAR systems.
    - Reliable indoor, unaffected by propeller noise
    - Response time suitable for continuous rotation
    - I2C digital interface integrates with Flight Controller.



Drone Battery Selection

Selected Component: Tattu 3S 45C LiPo

Why this component?

- Offers a nice power-to-weight ratio for sub 250g drone
- Very high discharge capability supports motor spikes
- Fast voltage response for hover and spin stability
- Compatible with selected motors, ESC, and FC
- Moderate cost and wide selection for UAV applications

Battery	Capacity	Weight	Est. Hover Time	Role
Ovonic 3S 120C	2200 mAh	~ 140g	~ 10 min	Fallback 2
Zeee 3S 60C	1500 mAh	~ 134g	~8.6 min	Fallback 1
Tattu 3S 45C	1300 mAh	~120g	~7.8 min	Primary

Drone Motor Selection

Selected Component: 1505 Motor 2650KV

Why this component?

- Compact 1505 stator size provides strong power-weight ratio for UAVs
- Lightweight design (~9g per motor)
- Sufficient thrust for stable hover and maneuvering
- Efficient current draw
- Compatible with 3.5-inch propellers

Criteria	**XING2 1404 – 3800 KV**	**1505 – 2650 KV Plus**
Torque per Amp	Medium	Higher
Max RMP	Higher	Lower
Hover Efficiency	Good	Better
Throttle Response	Snappy	Smooth
ESC Stress	Medium	Lower
Battery Demand	Medium	Lower
Hover Current	Medium	Lower

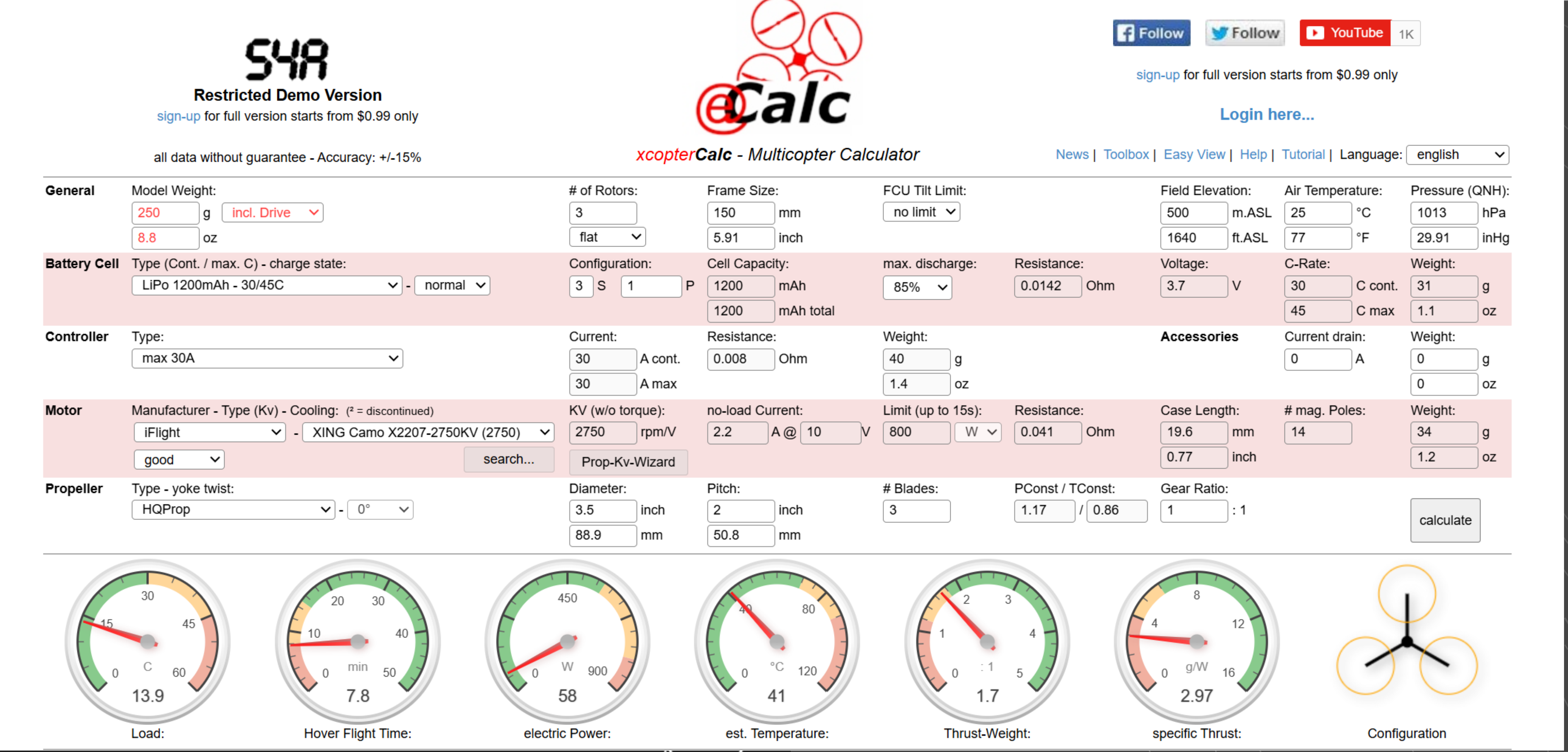
Propeller Selection

Selected Component: HQProp 3.5x2x3

Why this component?

- Improved hover stability and control for indoor flight
- Higher static thrust
- Compatible with 1505 motors
- Acceptable efficiency tradeoff for increased stability and control

	HQProp 3.5x3x3	**HQProp T3.5x2x3**	**Emax Avan Blur 2x2.9x3**	**Gemfan Hurricane 2009-3**
Weight	~1.5g	~.9g	~1.1g	~0.4g
Efficieny	Medium	Medium	High	Very High
Lift	High	Medium	Low	Low
Drag	High	Medium	Medium	Low
Material	Polycarbonate	Polycarbonate	PC Blend	Polycarbonate
Stability	Excellent	Good	Good	Moderate



$$T_m \approx C_T \times \rho \times n^2 \times D^4$$

Where:

- $C_T \approx 0.1$ (thrust coefficient for small tri-blades)
- ρ = air density (1.225 kg/m^3)
- n = revolutions per second (RPS) = RPM/60
- D = prop diameter in meters

Drone Frame Material Selection

Role:

- Serves as the structure for the drone
- Lightweight structure and durable for sub 250g full build

Why:

- Frame is responsible for supporting all of the electrical components

Material	Carbon-Fiber-Reinforced Nyllon (PA-CF)	Polyethylene Terephthalate Glycol (PETG)	Polylactic Acid (PLA)	Thermoplastic Polyurethane (TPU)
Strength	High	Medium	Medium	Low
Stiffness	High	Medium	High	Low
Weight	Low	Medium	Low	Medium
Impact Resistance	High	High	Low	Very High
Print Difficulty	High	Low	Very Low	Medium
Suitability	Good	Good	Prototype	Bad

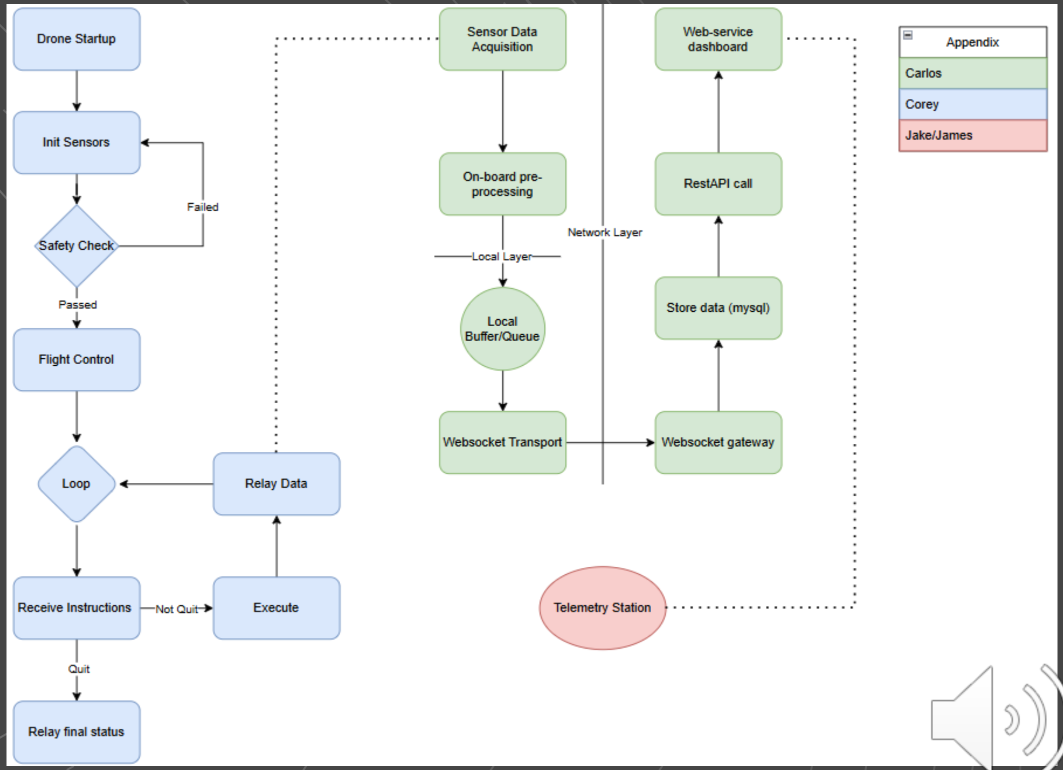
Sensor Software Flowchart

Overall System Flow:
- Drone startup and system initialization
- Sensor initialize

Control Execution:
- Flight controller handles stabilization and spin control
- Control loop maintains hover and rotation

Communication:
- Telemetry streamed to base station via ESP32 BLE Services
- Flight status and sensor data transmitted in real time to android device

End Conditions:
- Landing procedure
- System shutdown
- Low battery or connection error safe landing.



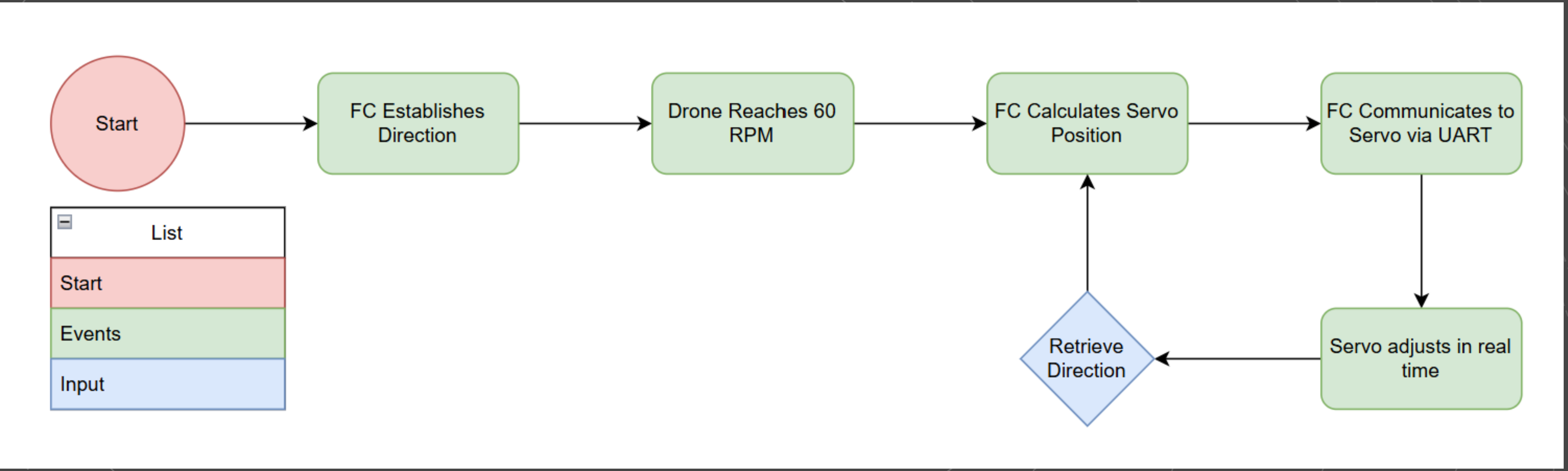
Movement Software Flowchart (Stretch goal)

Overall System Flow:

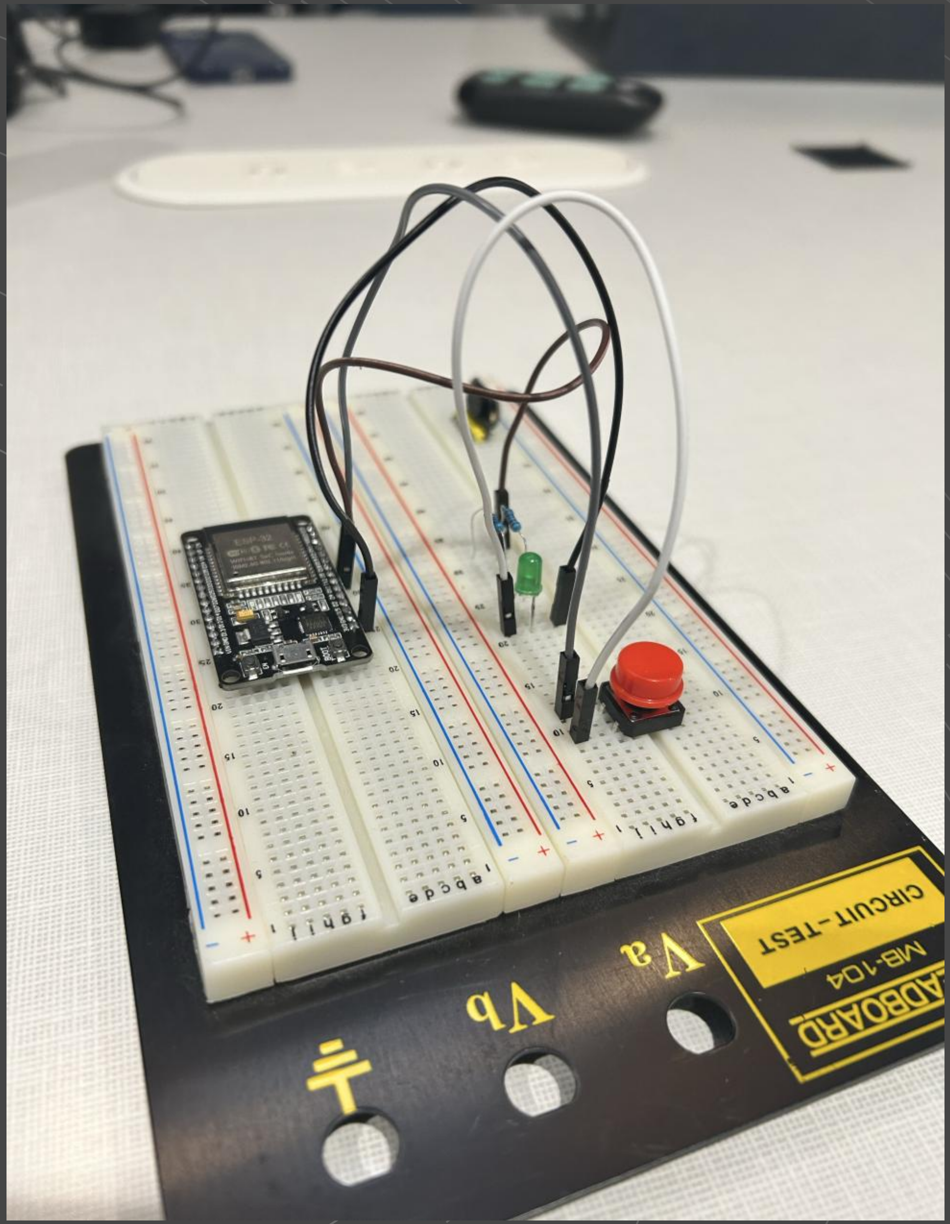
- Utilize Betaflight to handle forward translation

Control Execution:

- Flight controller still handles stabilization and spin control
- Control loop in ESP32 maintains forward direction and servo positioning



Prototype and Testing



Flight Controller Firmware

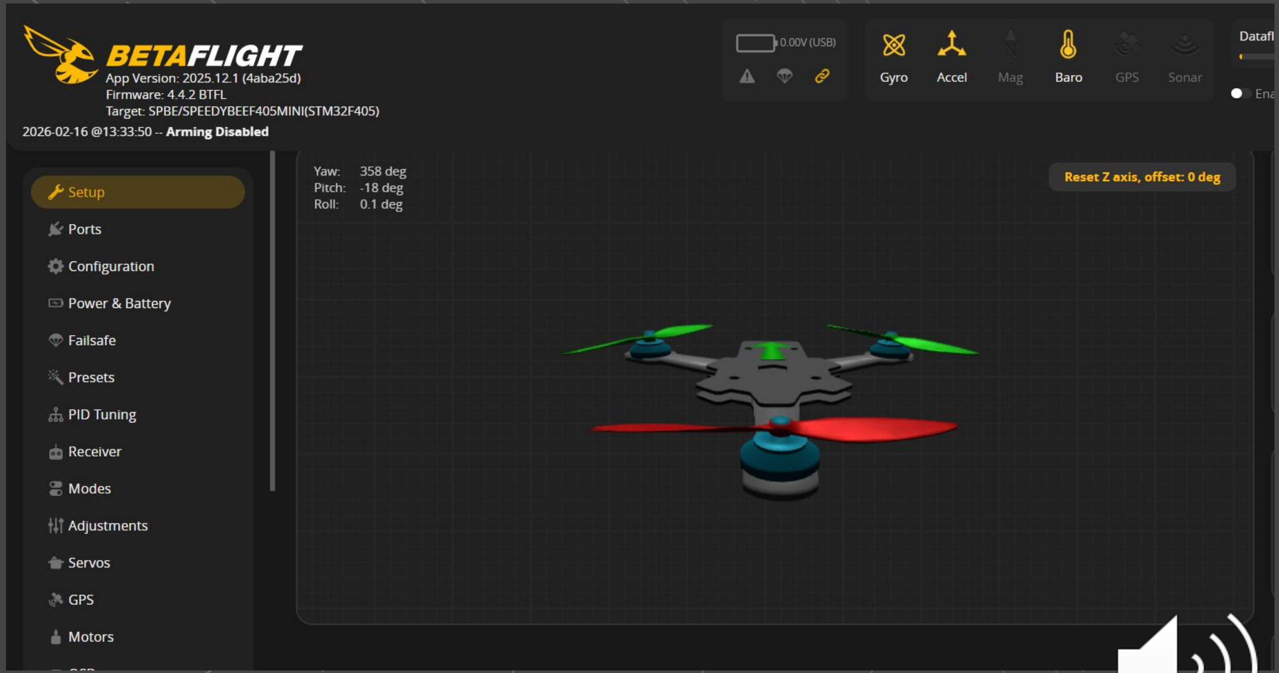
Selected Firmware: Betaflight

Role in System:

- Provide real-time stabilization and motor control
- Execture PID control loops for hover and spin stability
- Interfaces with sensors, ESCs, and telemetry links

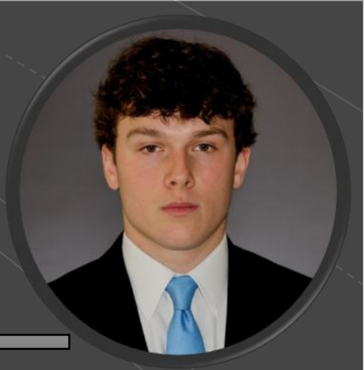
Why Betaflight?

- Suited for manual and semi-autonomous flight modes
- Optimized for high-rate control loops
- Compatible with SpeedyBee F405 Mini FC



Project Budget

Item	Price (USD)	Quantity	Status	Total	Sponsor Budget
Drone Frame	~$20	1	Printing	~$20.00	
SpeedyBee F407 Mini	$109.99	1	Received	$109.99	
1505 – 2650 KV	$19.57	3	Received	$58.73	
HQProp 3x3x3 Propellor	$1.62	3	Received	$4.86	
VL53L1X ToF Sensor	$7.49	1	Received	$7.49	
Miuzei Micro Servo 9g	$2.66	3	Received	$7.99	
Tattu 3S 1300mAh 45C	$17.49	1	Received	$17.49	
PCB	~$100	1	Shipped	~$100.00	
Miscellaneous	$10.00	N/A	Received	$10.00	
				$336.55	~$250



Work Distribution

Corey Barbera

- ESP32 Communications
- Movement Software
- Android App Developer
- Flight Controls
- Project Manager

James Thompson

- PCB Design and Implementation
- CAD Design
- Power Distribution Design and Implementation

Carlos Alfonso Vargas

- ESP32 Communications
- Movement Software
- Flight Controls
- Android App Developer

Alex Bayda

- PCB Design and Implementation
- Circuit Design
- Power Distribution Design and Implementation

Progress and Future Milestones

PCB Shipped (Present)

Drone Complete Build (~1-2 weeks)

Drone Hover/Rotation (~3-5 weeks)

Drone Forward Translation/Object Avoidance (~6-7) "Stretch Goal"

Final Demo/Showcase (~9 weeks)

- Anticipating the full system of the drone to be built one month before the showcase.
- Team goal for the project is to reach and complete one of our stretch goals of movement while rotation.

THANK YOU!