Wildlife Telemetry Drone Project

Undergraduate Symposium Presentation

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Overview

1. Project Description
2. Benchmarking
3. Customer Requirements
4. Design Process
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Project Description

Assist migratory studies of bats in remote Northern Arizona terrain.

- Project objective- redesign Iteration 3 to produce a lightweight, collapsible, and strong drone frame that is easy to assembly.

Sponsor/Client Interest: Dr. Michael Shafer has been conducting research in radio tracking systems.

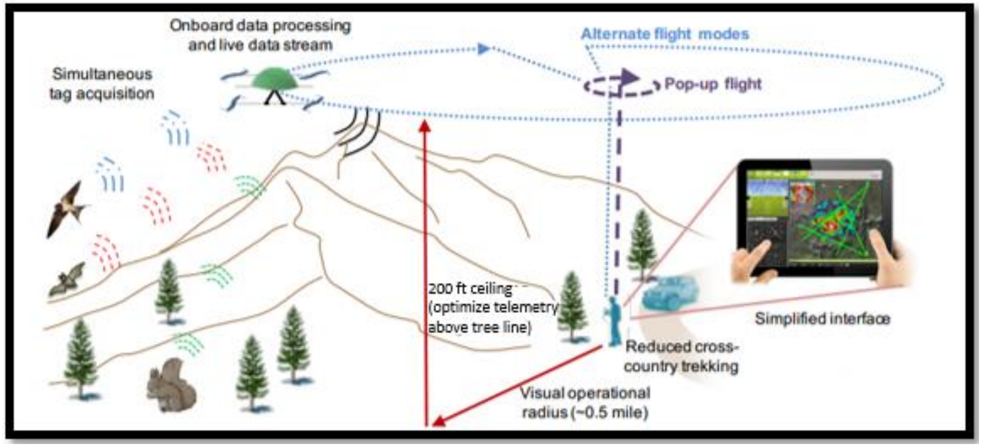

Figure 1: General Drone Operational Concept.

Figure 2: SolidWorks Assembly of Iteration 3.

Project Description

Additional requirement of enclosing all electronics (except ESCs) was added after the initial project description.

- Electronics must be able to connect to their corresponding components.

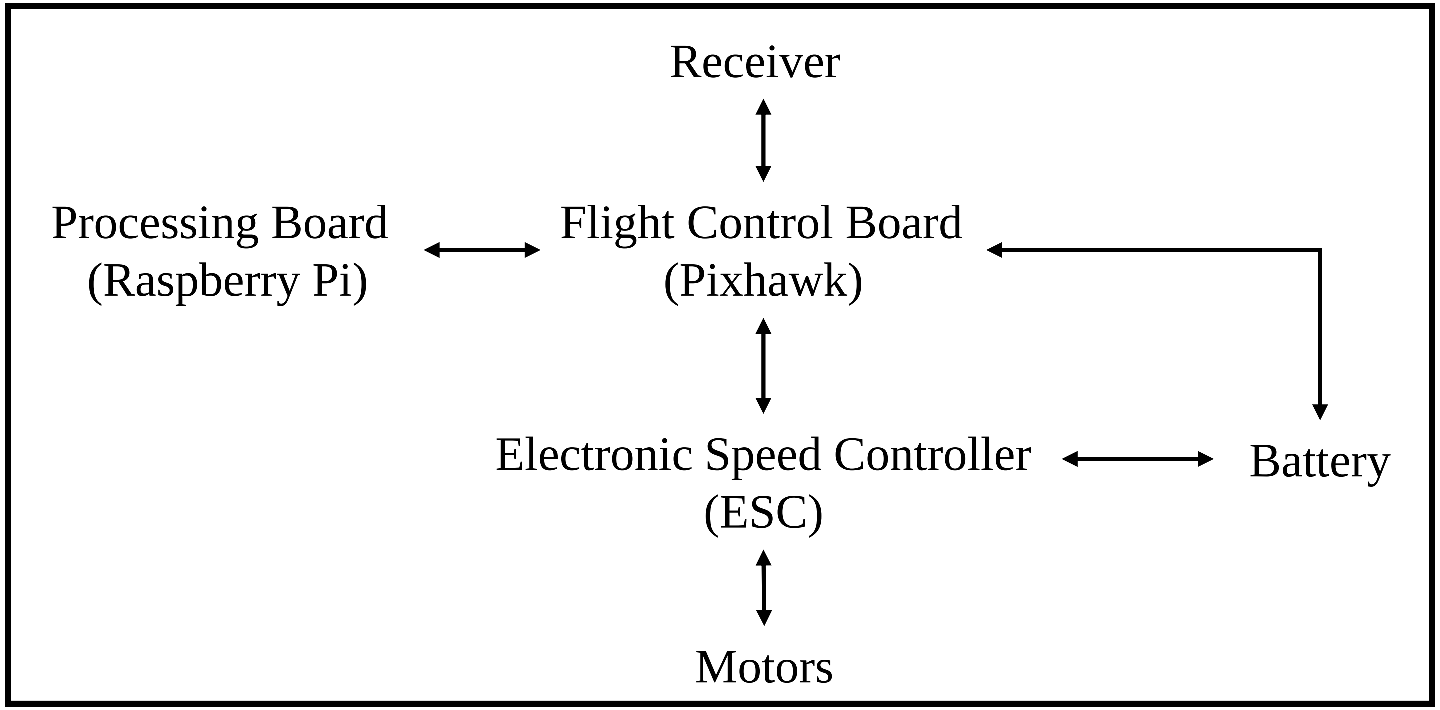

Figure 3: General Layout of Quadcopter Electronics.

Benchmarking

Figure 4: SolidWorks Assembly of Iteration 1.

Figure 5: SolidWorks Assembly of Iteration 2.

Iteration 1:

- Electronics and propellers were not compatible.
- Extensive use of aluminum made frame too heavy.

Iteration 2:

- Redesigned frame; 3D printed components, lightweight base material, and carbon fiber arrow arms.
- Properly sized propellers.
- Truss arm design maximized strength but had low torsional rigidity.

Benchmarking

Figure 6: SolidWorks Assembly of Iteration 3.

Iteration 3:

- 3D printed motor mounts and brackets.
- Cross members between motor mounts provide torsional rigidity.
- Refined landing gear using truss system.
- Power system provides ~4 kg of thrust.
- Too large and difficult to transport, over engineered.

Benchmarking

Research was conducted on existing frame components to aid in the design of Iteration 4.

- Arms must be able to resist torsion from motors.
  - Double boom
  - Square wooden arm
  - Truss design
- Motor mount designs were to be 3D printed.
  - Truss arm design
  - Double boom arm design
- Central hub must minimize volume for ease of transportation.
  - Stackable hub
  - Long central hub

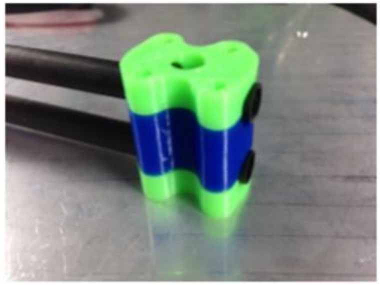

Figure 7: Jimustanguitar Motor Mount.

Customer Requirements

From the project description and benchmarking data, the following customer requirements were developed:

- Lightweight (80)
- Strong/Rigid (80)
- Collapsible (50)
- Low Center of Gravity (30)
- Aesthetics (10)

The importance of each requirement is indicated by their associated weightings, which are out of 250 total points.

Design Process

Design A features stackable central hub and double boom arm design. It was completed before the enclosed electronics requirement was enacted.

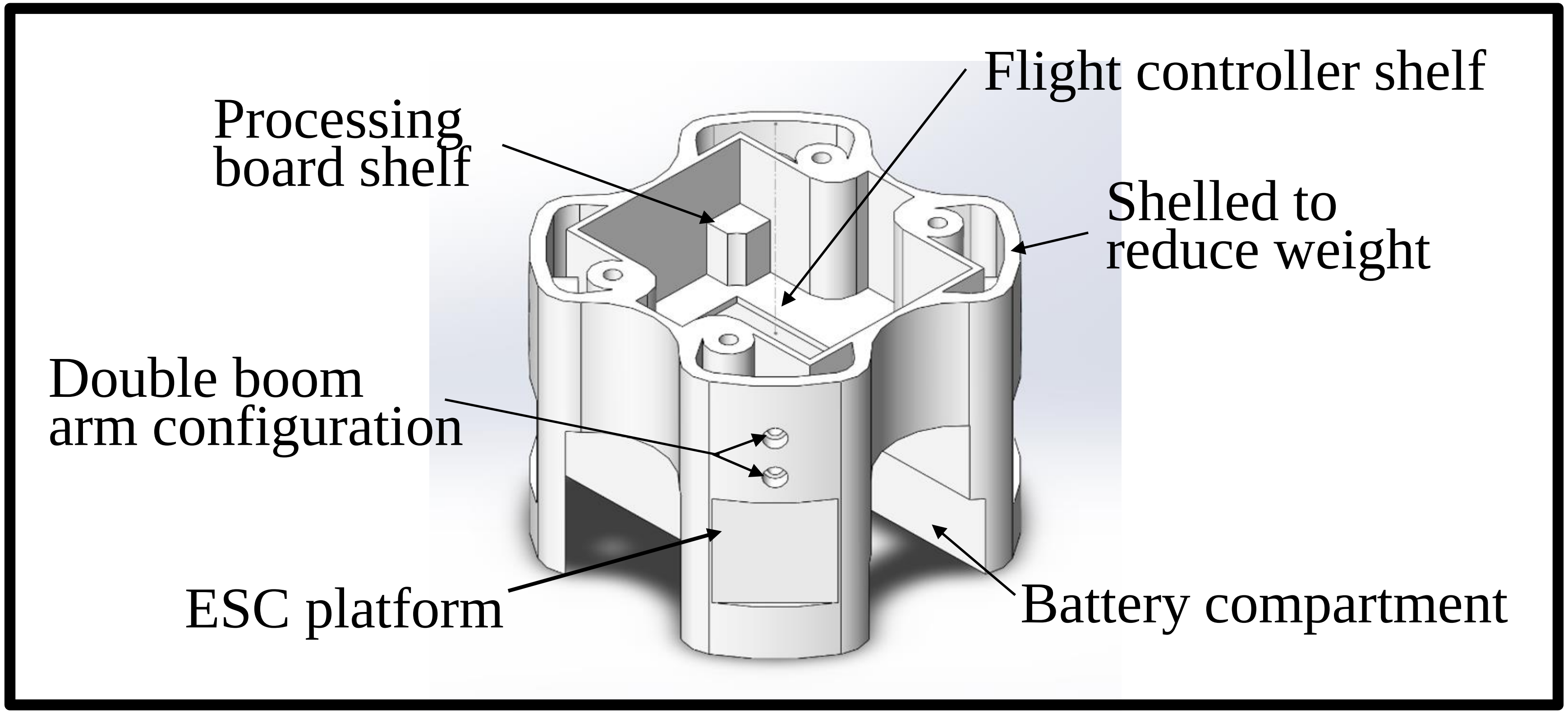

Figure 8: SolidWorks Model of Design A.

Design Process

Design B features stackable hub and truss arm design to increase rigidity. It was completed after enclosed electronics requirement was enacted.

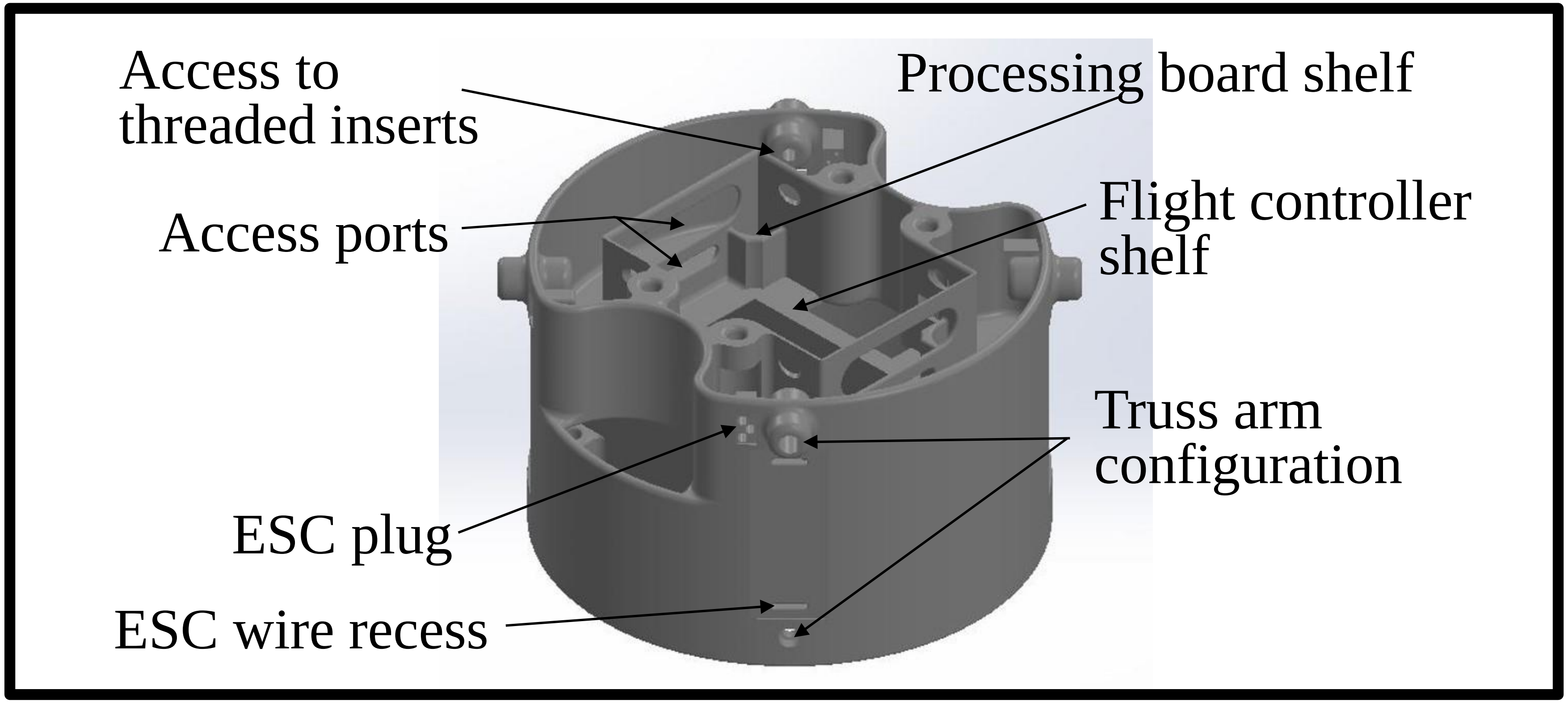

Figure 9: SolidWorks Model of Design B.

Testing

Physical Parameter	Testing Procedure
Weight	Measure weight of frame and ensure it is under 0.45 kg
Power to Weight Ratio	Measure net motor thrust and ensure it is twice the weight of the frame with electronics
Durability	Vertically drop drone from 0.5 m and check for damage
Rigidity	Conduct flight tests and ensure arms can handle torque of motors
Storage Volume	Collapse drone and place into 30 L backpack
Construction	Construct drone without use of diverse tool set
Cost	Calculate cost of used materials, must total under $250

Testing Results

Physical Parameter	Testing Result
Weight	Drone frame weighs 0.592 kg
Power to Weight Ratio	Net thrust of motors is 4 kg and with electronics drone weighs 1.45 kg resulting in a Power to Weight ratio of 2.76
Durability	No damage sustained from a 0.5 m drop
Rigidity	Arms are sufficiently rigid during flight
Storage Volume	Drone fits into 30 L backpack
Construction	Drone only requires one hex key to construct
Cost	Drone cost $93.86 to construct (not including 3D printing, or electrical component costs)

Final Design

Prototyping of Design B showed areas for tolerance and design intelligence improvements:

- External port/mount for flight controller power button
- Internal ports to allow battery harness to connect to ESCs

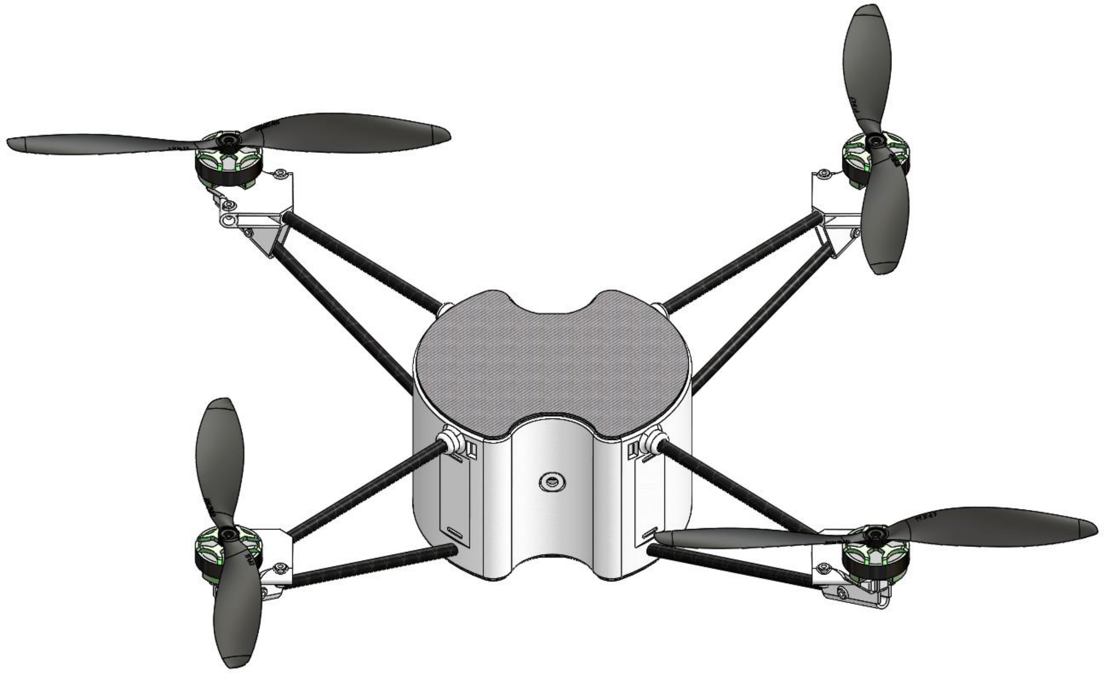

Figure 10: SolidWorks Assembly of Final Design.

Final Design

Iteration 3	Final Design (Iteration 4)
Six different lengths of carbon fiber arrow sections	One length of carbon fiber arrow section
17 separate 3D printed parts	Five 3D printed parts; including central hub
All carbon fiber arrows are epoxied into 3D printed junctions; completely rigid	Only permanent connections are arrow inserts; collapsible
Large propeller clearance	Propellers closer to frame; more maneuverable

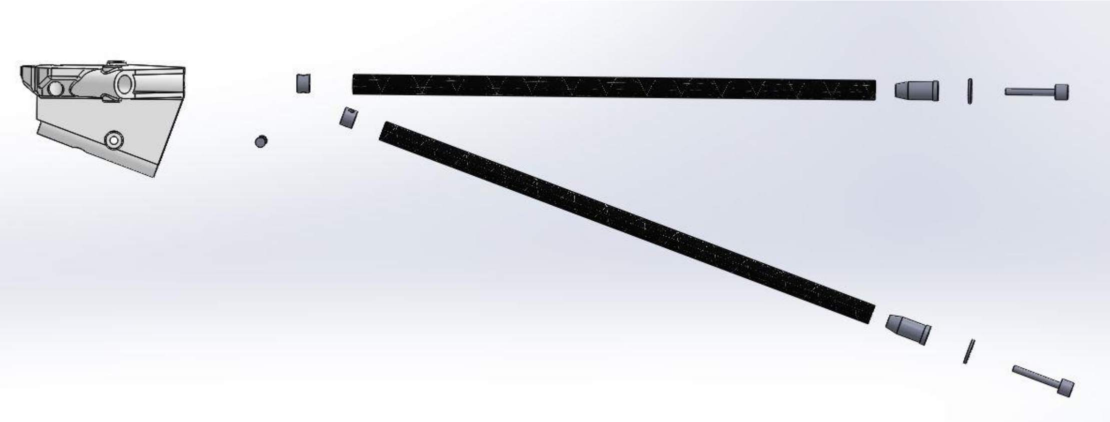

Figure 11: SolidWorks Arm Assembly of Final Design; Exploded View.

Questions?

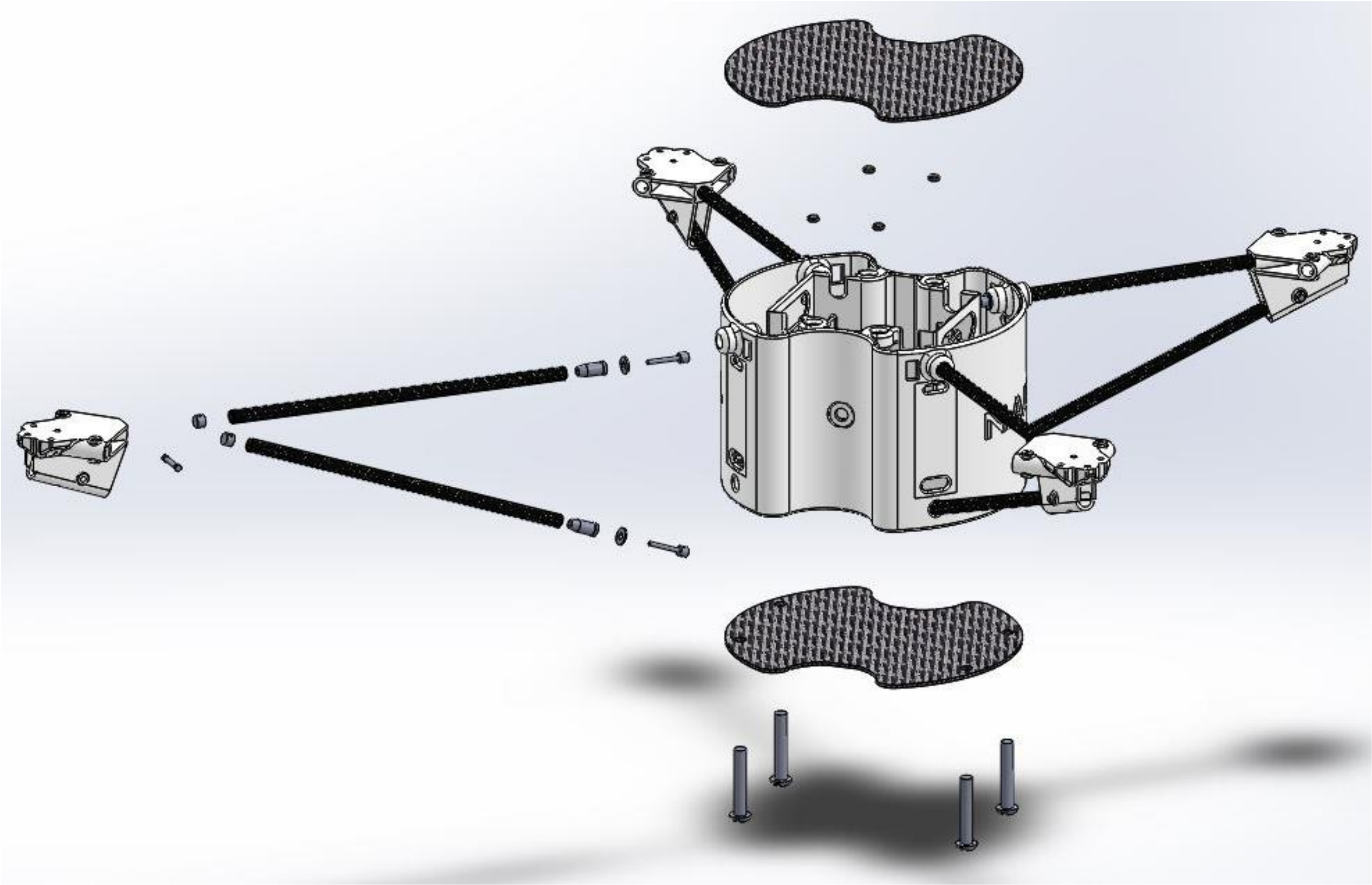

Figure 12: SolidWorks Assembly of Final Design; Exploded View.

References

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