Inertial Compensation Unit

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Sponsor: Aaron Freeman, General Atomics

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GENERAL ATOMICS

Acknowledgments

- General Atomics for providing camera and bearings
- Sponsors Aaron Freeman and David Reeves
- Professor David Copp

Momentum Compensation

- Dynamic model in Matlab Simulink
- Tune PID control loop
- Compare component selections
- Verify system performance against system requirements

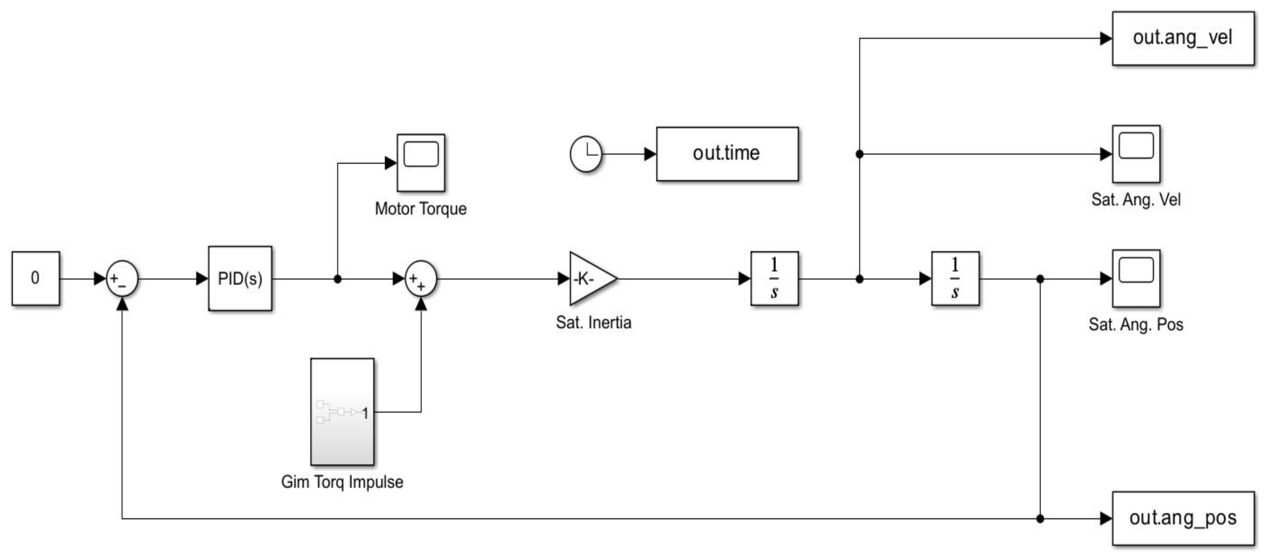

Fig. 3 Azimuthal Axis Control Loop

Current Performance

- Simulated torque impulse results in displacement below .5 degrees stipulated by **PR-002**
- Will recalibrate when design is complete

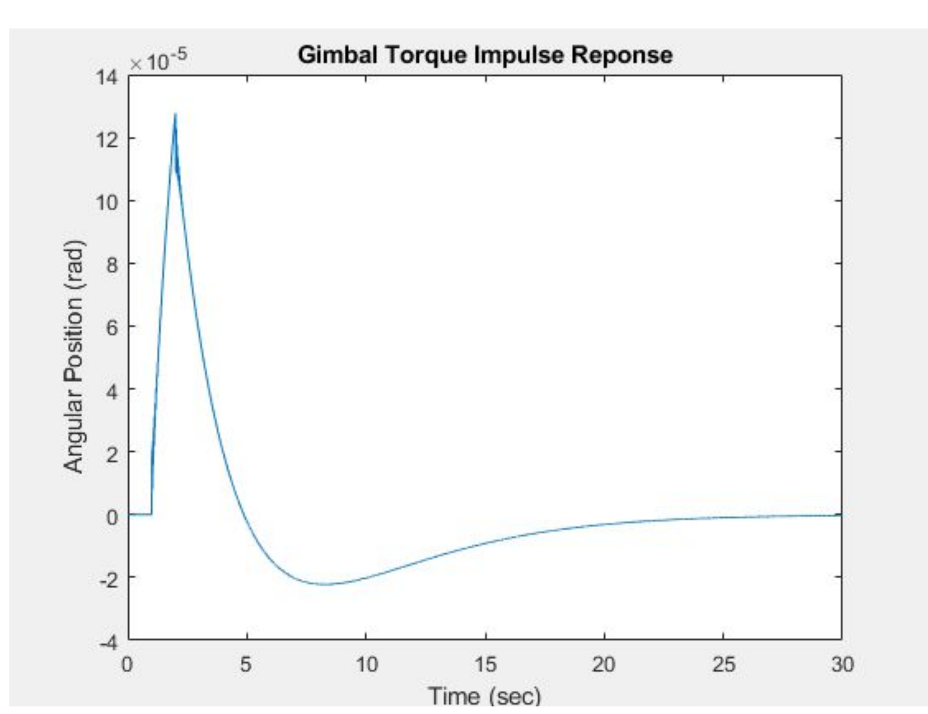

Fig. 4 Impulse Torque Response

Project Summary

We are developing a gimbal and counter gimbal mechanism to enable gimbal motion on small spacecraft without affecting attitude. The gimbal will be placed in low earth orbit on a 1U cubesat with a high resolution camera to capture visual data of Earth.

Requirement Type	Requirement
Performance	• (PR-001) Gimbal must have a field of regard of **±45 degrees** in azimuth and elevation • (PR-002) Gimbal must have a pointing accuracy of **±0.5 degrees** • (PR-003) Gimbal must be capable of **20 deg/sec** in any direction in its field of regard • (PR-004) System must consume **<10W average** and **<30W peak**
Functional	• (FR-001) System must impart **0 net angular momentum** onto the host platform • (FR-002) Payload must transmit or store useful visual information **(30m/pixel resolution at 600km)** • (FR-003) Must be able to demonstrate functionality on earth
System	• (SR-001) System must fit in volume of **1U (10cm cube)** • (SR-002) System must have mass under **1kg** • (SR-003) System must be powered by **28V** supply

Table 1: Design Requirements

Key Features

1. Momentum Compensator
2. Gimbal Mechanism
3. Payload Mount
4. Camera
5. Gimbal Motors
6. Base Platform
7. Raspberry Pi

Final Design

- 3D printed gimbal base, yoke, camera mount, reaction wheel mount
- Machined aluminum reaction wheels
- Laser cut acrylic frame
- Raspberry Pi for flight computer and visual output

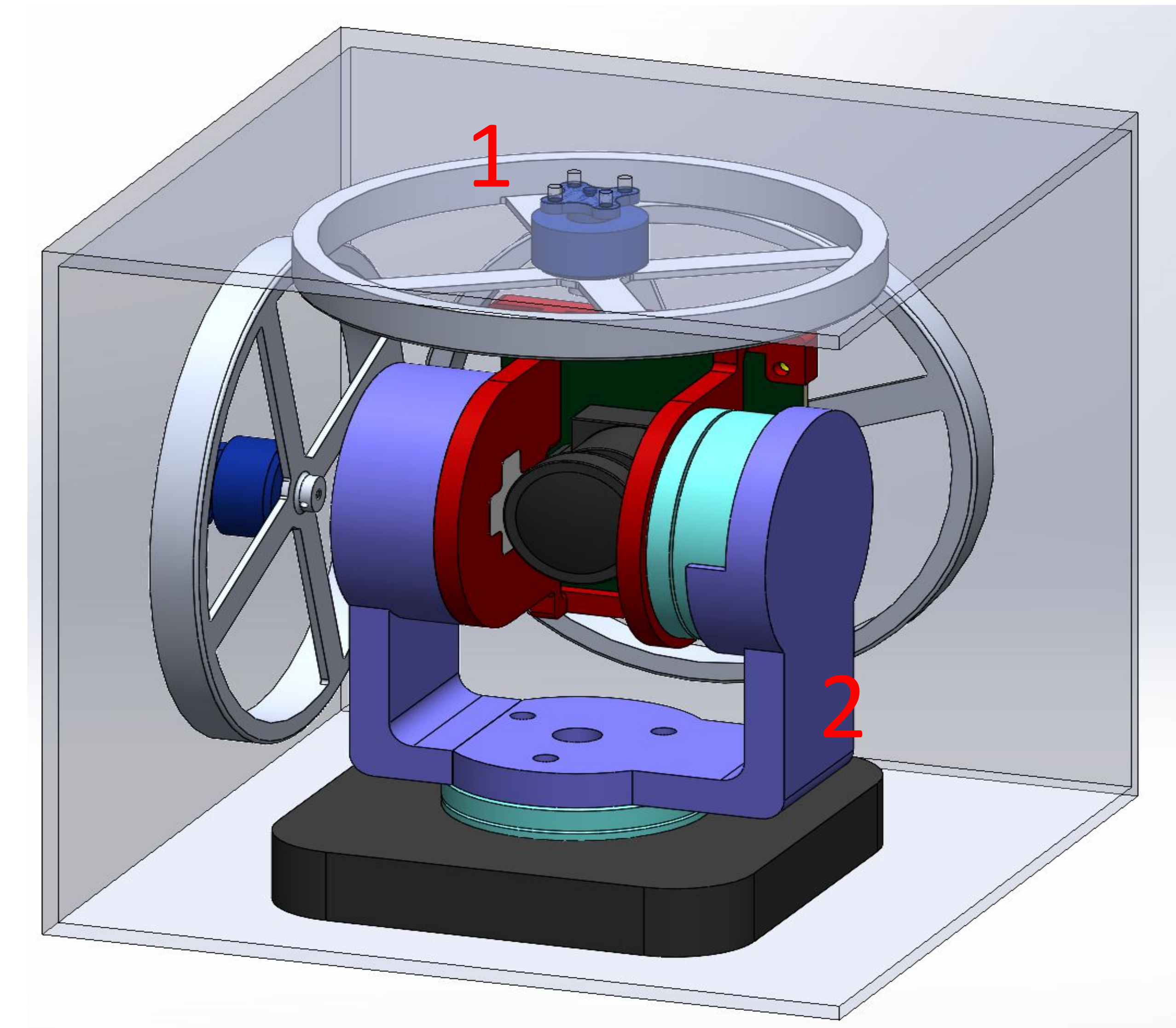

Fig. 1 Full Assembly

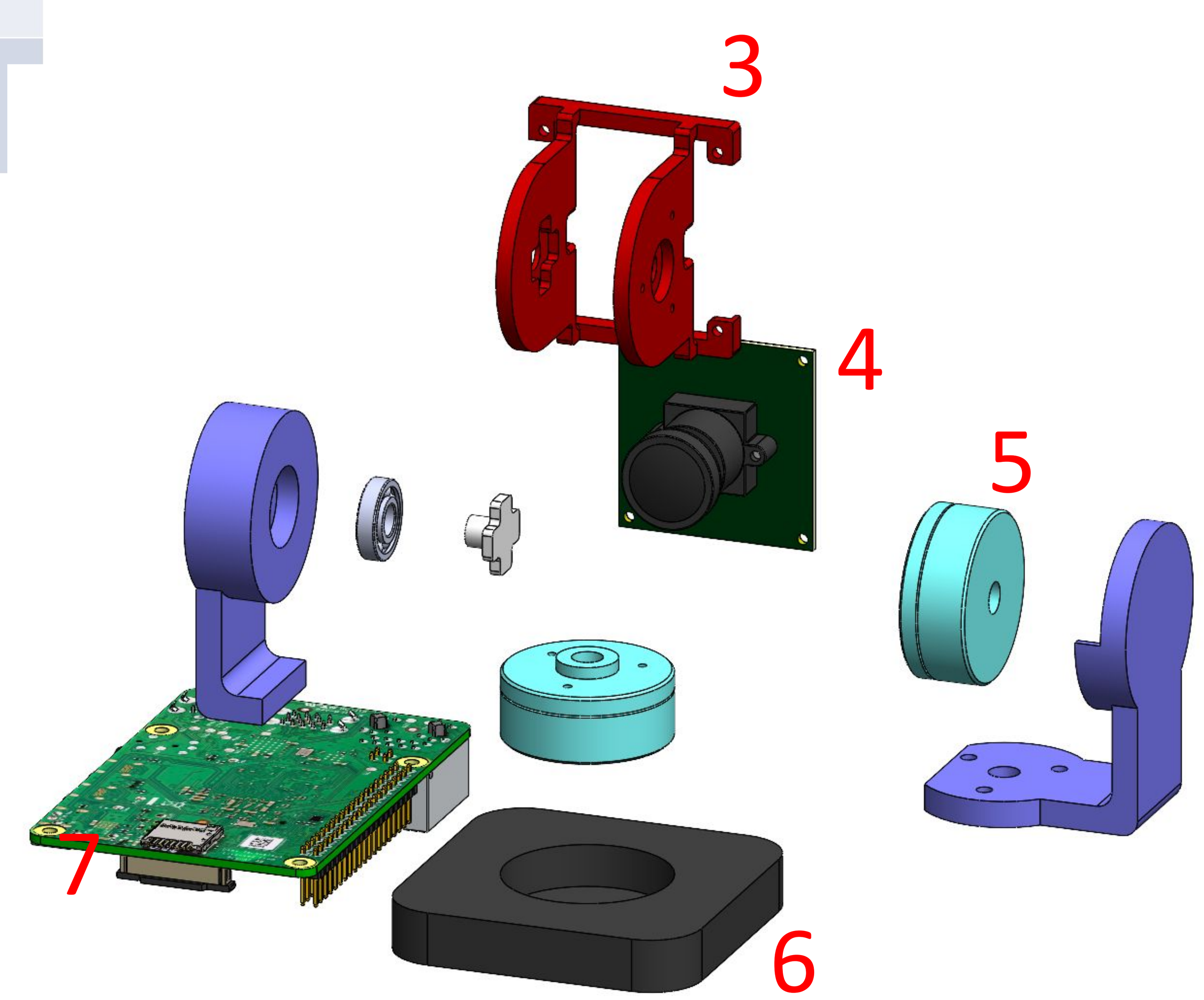

Fig. 2 Gimbal Mechanism Exploded View

Proof of Concept

- Demonstrate IMU, encoder, motor, motor controller, and Raspberry Pi compatibility
- 3D printed gimbal
- LLaser cut frame

Electronics

- Electronics model via Simulink in MATLAB
- Raspberry Pi serves as computer for transmitting data and visual output for payload
- Must not surpass 30W for power consumption

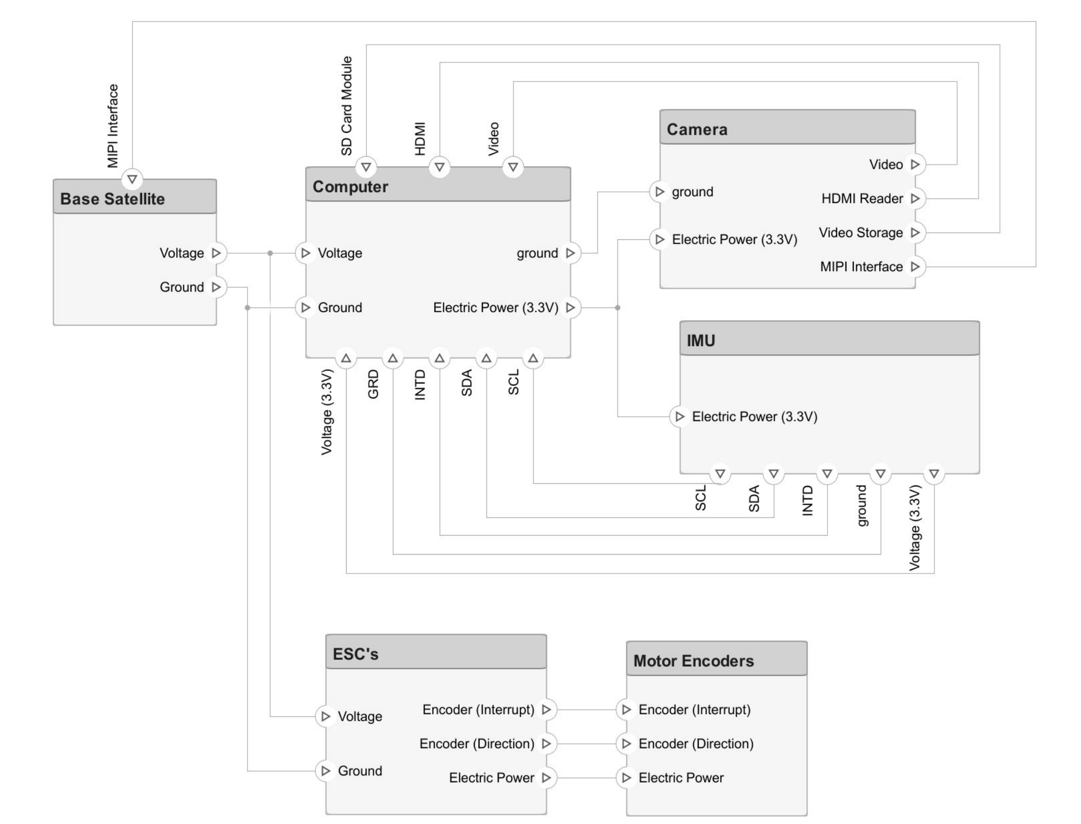

Fig. 5 Electrical Concept Diagram

Social/Enviro Impact

- Visual Data to monitor climate change
- Global communication and navigation
- Privacy risk
- Space debris

Future Improvements

- Reduce gimbal mass and volume for performance and packaging
- Implement electronics mounting solution
- Secure and organized cable management

Team Contributions

- Travis Lee - Mechanical
- Qisen Lin - Mechanical/Payload
- Brian Fok - Controls/Electrical
- Jacob Ochoa - Electrical/Payload
- Brandon Tang - Team Lead