CubeSat Reaction Wheel Attitude Control Platform

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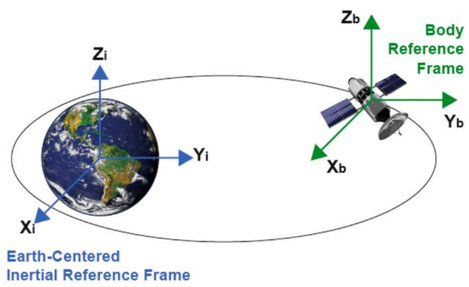
ABSTRACT

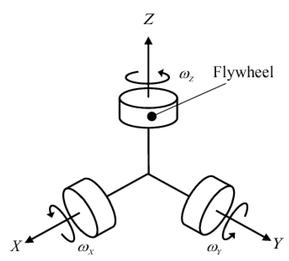
- In the classroom, learning the math behind spacecraft attitude control is math-intensive. It is common that students struggle to develop the connection between the math they are learning and visualizing how it could be applied to a real-world application.
- The goal of this project is to design and manufacture a 1U, 3U, 6U CubeSat testbed for autonomous control systems utilizing reaction wheels. The testbed will include three separate reaction wheels each mounted on its own respected axis of the rotation plane to control the attitude in 3 degrees of freedom.
- The end goal of the CubeSat testbed is to be integrated into a website where anyone online can upload their own controls algorithm and watch a live stream of how their algorithm performs on hardware in real-time. Additionally, there will be a guided tutorial included in the website to help students learn spacecraft controls.

PROJECT GOALS

- Develop a 1U, 3U, and 6U CubeSat Reaction Wheel Attitude Control Platform.
- Integrate CubeSat control into a website to allow anyone to upload their own control algorithm and watch a live stream to evaluate how it performs.
- Include spacecraft controls tutorial in website to guide students.

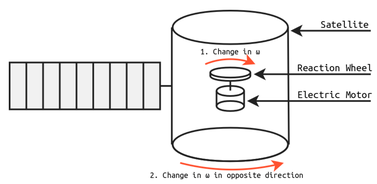
CubeSat attitude control is to enable the CubeSat to point in the desired direction that is set in relation to a reference frame.

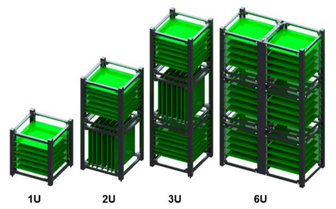




METHODOLOGY

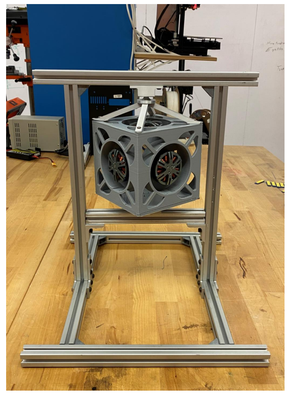
- Design and 3D print a 1U, 3U, and 6U CubeSat test bed.
  - Due to volume constraints, 1U will only rotate about 1DOF and an expanded 1U will rotate about 3DOF.
- Design and 3D print the 1U, 3U, and 6U gimbal ring assembly to allow for free rotation in 3 degrees of freedom.
- Research electronics and develop software to control reaction wheel motors while reading IMU and motor encoder sensors.
- Develop software infrastructure for wireless communication between website and CubeSat.
- Develop example PID controller to control CubeSat attitude.



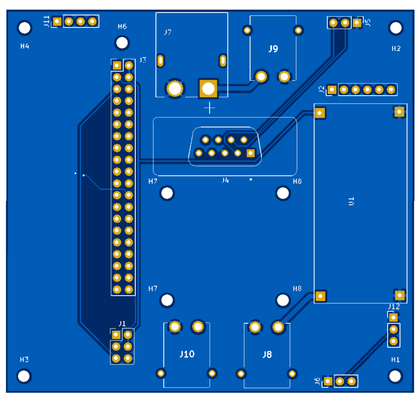


CURRENT STATE

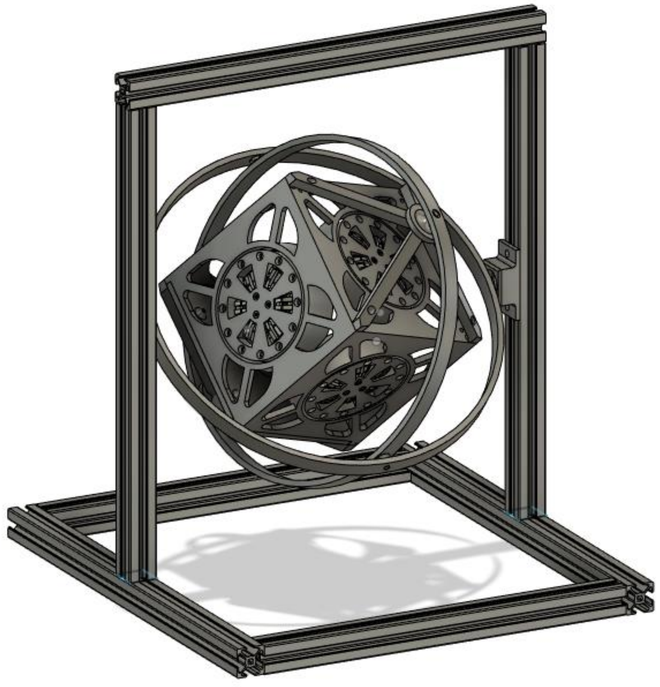
- Prototype Expanded 1U CubeSat printed and assembled into testbed frame.
- Electronics for all sizes of CubeSat platforms determined: Moteus Motor and Controller, Raspberry Pi Zero 2W, Adafruit MPU 6050, and 11.1 V LiPo battery.
- Designed PCB for 3 degrees of freedom.



Expanded 1U CubeSat



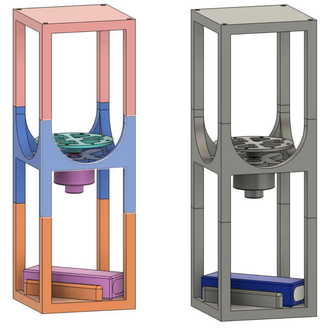
PCB For CubeSat Platform



Expanded 1U CAD Prototype in 3DOF Configuration

MOVING FORWARD

- Integrating electronics into expanded 1U CubeSat
- Implementing PID controller into expanded 1U CubeSat about 1 degree of freedom (2DOF and 3DOF followed promptly after)
- Designing gimbal rings to allow CubeSat to rotate about 2 and eventually 3 degrees of freedom.
- Developing design for 3U and 6U CubeSat gimbal rings and test stand.



3U CubeSat CAD Prototype

6U CubeSat CAD Prototype