CubeSat Reaction Wheel Attitude Control Platform

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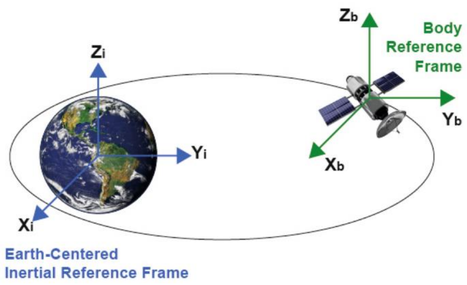
ABSTRACT

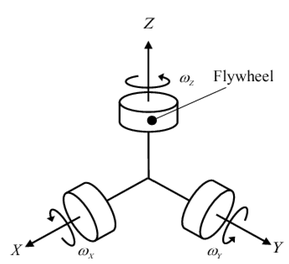
- In the classroom, learning the math behind spacecraft attitude control is math-intensive. It is common that students struggle to develop the connection between the math they are learning and visualizing how it could be applied to a real-world application.
- The goal of this project is to design and 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.

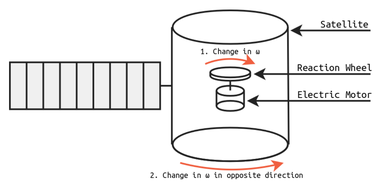
CubeSat attitude control is to enable the CubeSat to point in the desired direction that is set in relation to a reference frame.

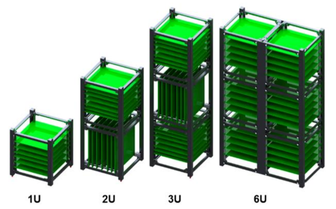




METHODOLOGY

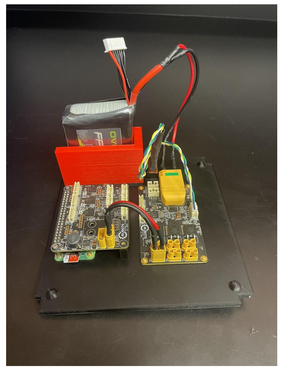
- Design and 3D print a 1U, 3U, and 6U CubeSat test bed.
  - Due to volume constraints, 1U will only rotate about 1DOF and an expanded 1U will rotate about 3DOF.
- Design and 3D print the 1U, 3U, and 6U gimbal ring assembly to allow for free rotation in 3 degrees of freedom.
- Research electronics and 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.



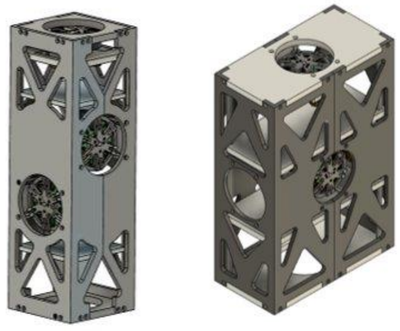


CURRENT STATE

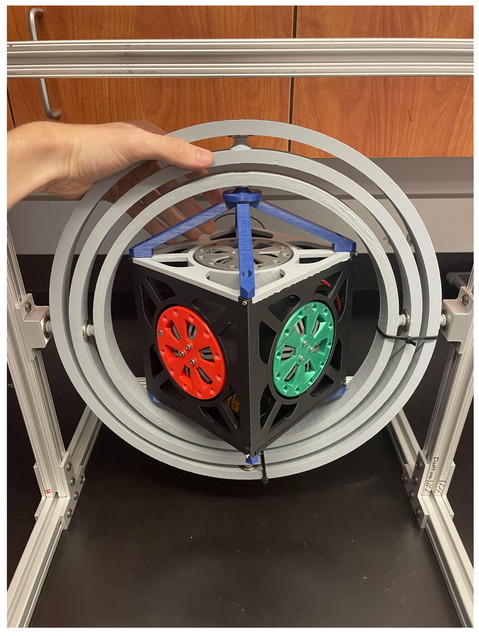
- Prototype Expanded 1U CubeSat printed and assembled into gimbal ring system. Configured for 3DOF.
- 1DOF stability of Expanded 1U achieved using PID controller.
- Electronics bed designed for multi-motor control and is applicable to any size CubeSat: Zero 2W, MJBots motors and controllers, Adafruit LSM9DS1, 22.2 V LiPo Battery.
- CAD designs complete for 3U and 6U CubeSats.



Electronics Plate



3U and 6U CubeSat Designs



Expanded 1U CubeSat Prototype in 3DOF Configuration

MOVING FORWARD

- Achieving 2DOF and 3DOF stability of Expanded 1U Sat.
- Manufacture 3U and 6U CubeSats and accompanying gimbal ring systems.
- Develop Attitude Control in Vacuum Testbed (ACTIV) to test CubeSat in an accurate microgravity environment.
- Continue development of EasyControls website.

ACTIV Initial Design

6U CubeSat 3DOF Stability in ACTIV