FINAL PRESENTATION

GENERAL ATOMICS BEARING FIXTURE

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BACKGROUND

- The system should be able to accommodate a 12U CubeSat, and fix it to a Spherical Air Bearing
- The fixture must be able to adjust the center of mass (COM) of the system in order to align it with the center of rotation (COR)
- The device will be utilized as a test mount fixture, and aid in the client's experimentation

- Our stretch goal was to be able to accommodate a 12U, 6U and a 3U while fulfilling its other functions
- Our stretch goal for this was to automate the relocation process
- The client is General Atomics

REQUIREMENTS

Customer Requirements	Weight
Reliable	3
Durable	3
Secure to CubeSat rails	5
Adjustable CubeSat position	4
Fixture is lightweight	3
Ease of CubeSat install	2
CubeSat is secured	5
Allow rotation and tilt	3
Securely mates with bearing	5
Minimize effects on CubeSat	4
Adaptable to 3U, 6U	1

Engineering Requirements	Units
Reliability of components	%
Endures wear of multiple uses	Cycles
Fixture compatible with rails	mm
Adjustable in 3 axes	#
Minimize weight	N
Reduce time/tools for CubeSat install	mins,#
Max. force required to dislodge CubeSat	N
Range of motion (35°)	Degrees
Bearing dims. compatible with fixture	mm
Min. moment of inertia	Kg*mm^2
Fixture compatible with 3U, 6U	mm

SOLUTION

- Adjust X- and Z-axis COM location by repositioning satellite
- Adjust Y-axis COM location by repositioning counterweights
- Four NEMA-17 stepper motors deliver torque to 1/4-16 ACME lead screws through 1:3 pulley reductions
- Arduino/Raspberry Pi control system automatically adjusts COM location with PID control using feedback from inertial measurement unit

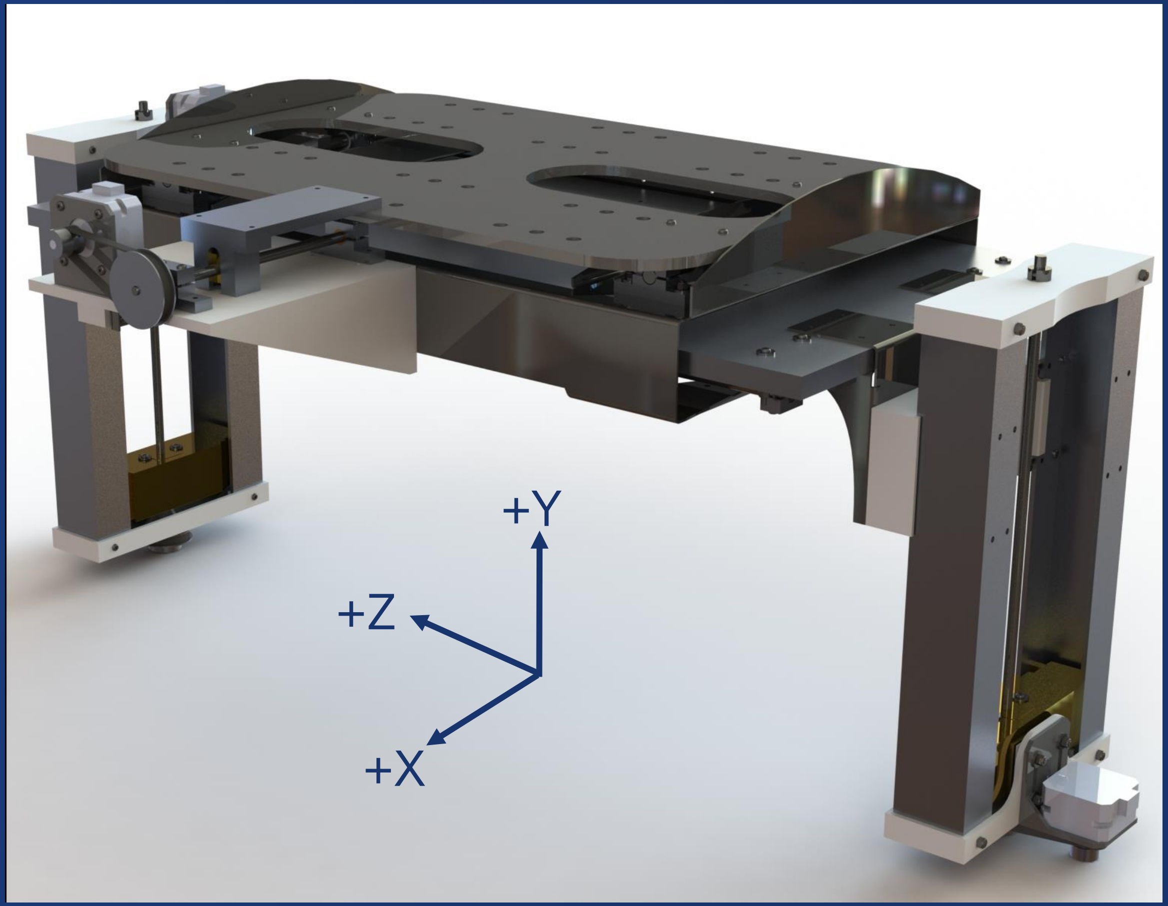

Figure 1: SOLIDWORKS assembly rendering

DECISION MAKING

- The reason we decided to use the CubeSat's own mass instead of adding weights was so the system would not have to facilitate the movement of additional weight. The satellite has more than enough mass to change the COM. Now our system weights less than others of its kind.
- The team added channels on the sides for horizontal brass weights to slide down. The width of the channel and the material, brass, were decided upon to lower the distance needed to shift the COM down to the COR. With a less dense material, or smaller width of the weight, the railing would collide with the bearing stand when it tries to reach its maximum 35 degrees of tilt.
- The NEMA 17 Stepper Motors were chosen because a motor analysis found them suitable in terms of torque and power to our purposes.
- The team has done extensive research into how to automate the system, and with our previous knowledge of Arduinos, a Raspberry pie was determined to be efficient.

MANUFACTURING

- All parts have been manufactured, most of the installation is complete
- There are some slight adjustments that need to be made on the satellite plate and brackets, scheduled to be completed Friday at the shop
- If time permits, some custom tools will be made to allow for easier modifications and assembly
- Some cosmetic changes will be completed as well

Figure 2: Front View

Figure 3: Side View

Figure 4: Top View

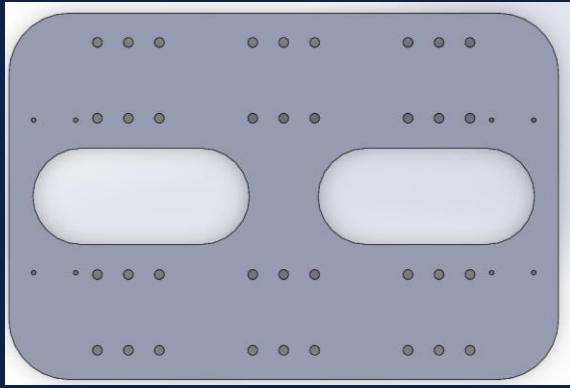

Figure 5: Current Satellite Plate

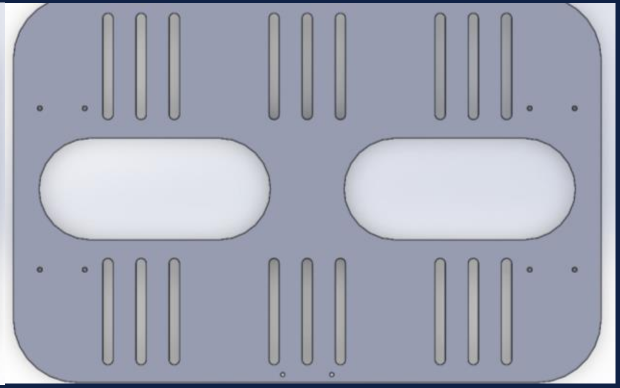

Figure 6: Planned Fix for Satellite Plate

TESTING

- Testing still underway:
  - Satellite retention
  - Locational precision
  - Control system response time
- Results to date:
  - Drivetrain functions as expected
  - Mass, moment of inertia within tolerance
  - Satellite mounts compatible with 3U, 6U, and 12U CubeSats

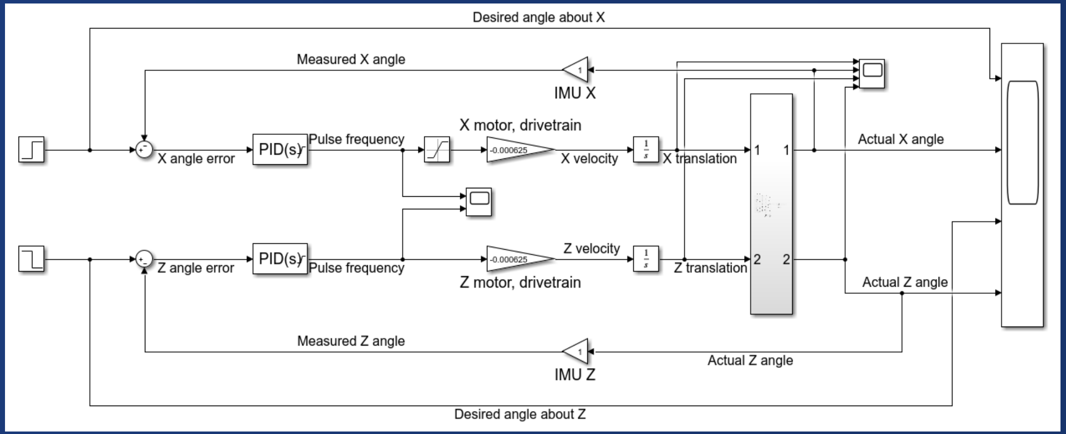

Figure 7: Simulink model of control system

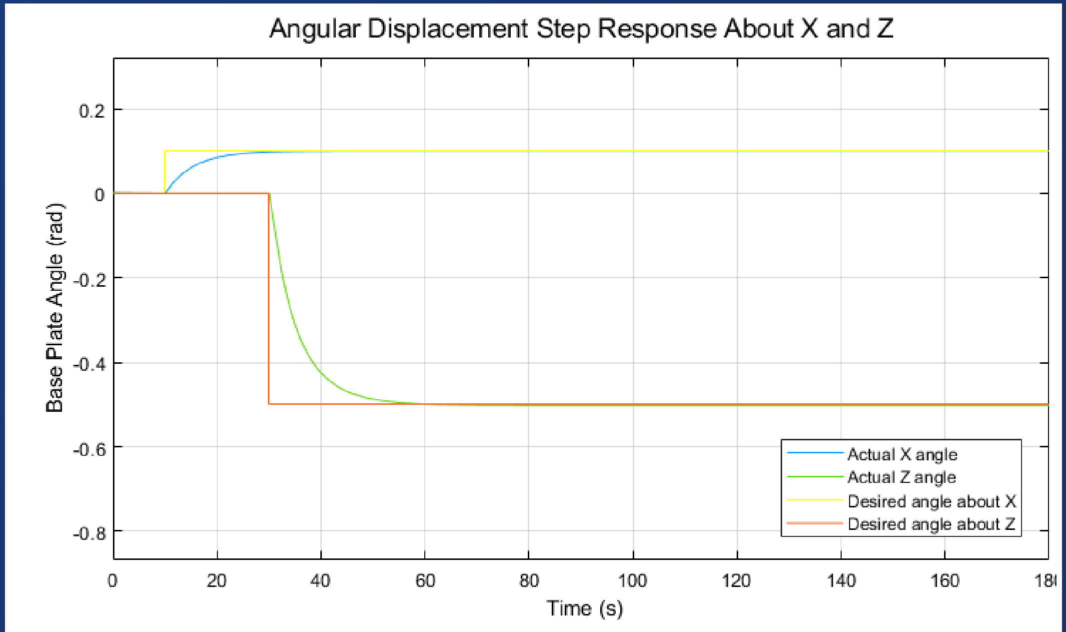

Figure 8: Model response to desired angle reference signal

BUDGET

- Budget : $8,000.00
- Total Items Purchased : 142
- Total Cost of Items : $2,167.91
- Percent of Budget Used : 27.1%

Manufacturing

- Total Spent : $1,112.58
- # of Items : 23
- % of Used Budget : 51.3%

Assembly

- Total Spent : $549.47
- # of Items : 75
- % of Used Budget : 25.4%

Electronics

- Total Spent : $252.97
- # of Items : 33
- % of Used Budget : 11.7%

3D Printing

- Total Spent : $252.89
- # of Items : 11
- % of Used Budget : 11.7%

FUTURE WORK

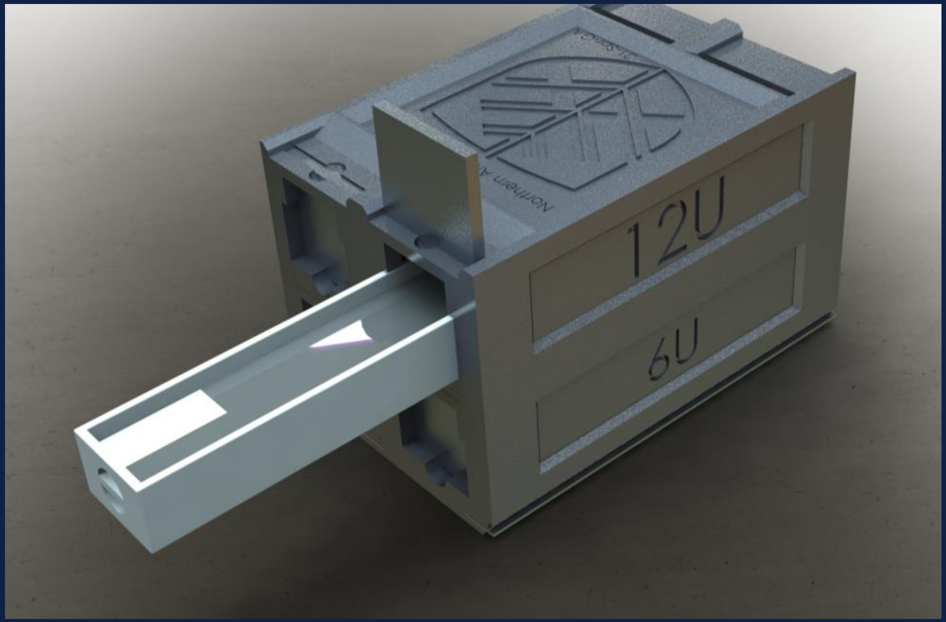

Figure 9: Replica CubeSat

- Excluding the slight alterations to a few of the parts, all remaining work is software and testing related.
- The current iteration of our code to run the system appears to work but will be refined as is necessary.
- Some stretch goals to be completed if possible are:
  - Allow for quicker adjustment of satellite bracket locations (should be addressed with the current planned alteration to the satellite plate)
  - Custom tooling for easier modification
  - Refinement to the code to allow all operations to be autonomous
  - Cosmetic work, likely some deburring of sharp edges that may have been missed
  - Potential conversion to batteries on the system to remove the need for a power line to be connected