

Ascend 0-G: Micro-Gravity Vertical Cardio Climber

Texas A&M University: Team Aggienauts

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Initial Problem Statement

Deep space missions expose astronauts to altered physiologic conditions that can significantly impact cardiovascular health. In reduced gravity, fluids shift differently in the body, which can lead to cardiac deconditioning and muscular atrophy. This can result in reduced aerobic capacity, posing a risk to astronaut health before, during and after missions. There is a need for an integrated medical device that supports cardiovascular function in astronauts during prolonged spaceflight [1].

The aim of this device is to maintain astronaut musculoskeletal and cardiovascular health in microgravity through a compact, modular zero-gravity vertical climber system. It integrates elastic resistance and motor-assisted adjustability, to provide strength and cardiovascular training without relying on gravity. Designed for spaceflight constraints, it meets NASA requirements for vibration isolation, crew safety, and adaptability, supporting sustained astronaut performance and long-duration missions to the Moon, Mars, and beyond.

Subsystem Designs



Figure 2: Close-up of Pneumatic System Design



Figure 3: Close-up of Frame Redesign

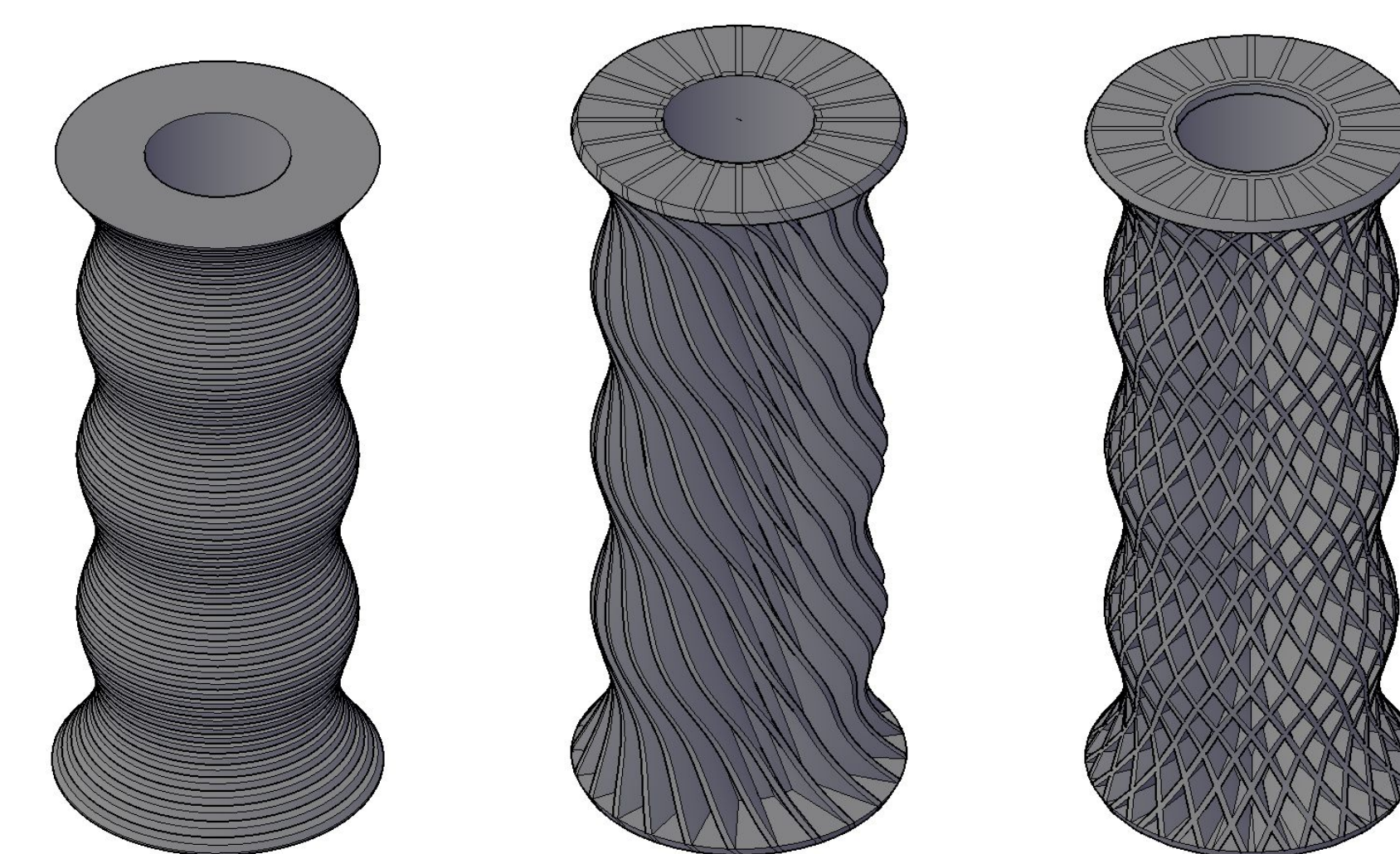


Figure 4: CAD ideation for Handles

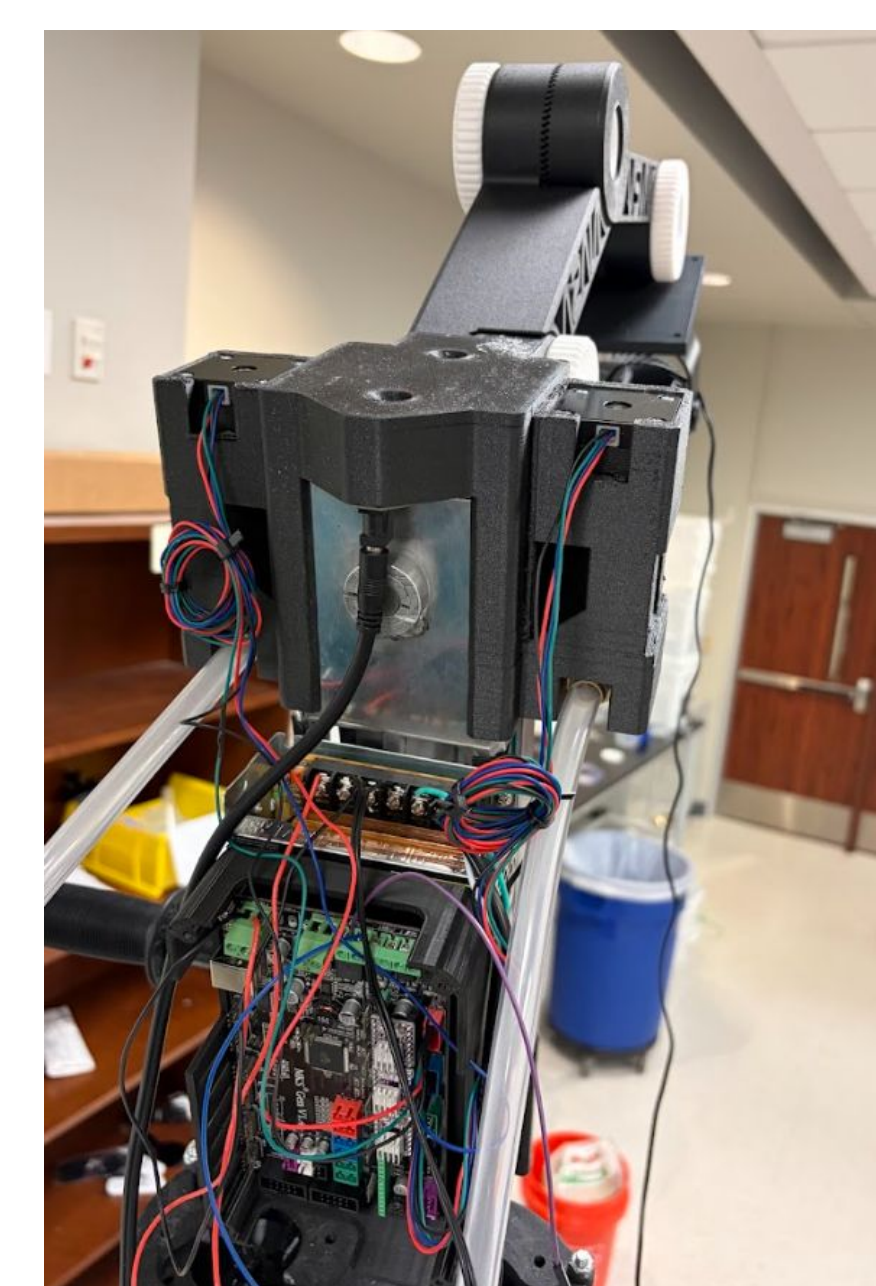


Figure 5: Electronics Module



Figure 6: Demonstration using Wooden Base and Harness System

Current Subsystem Tests

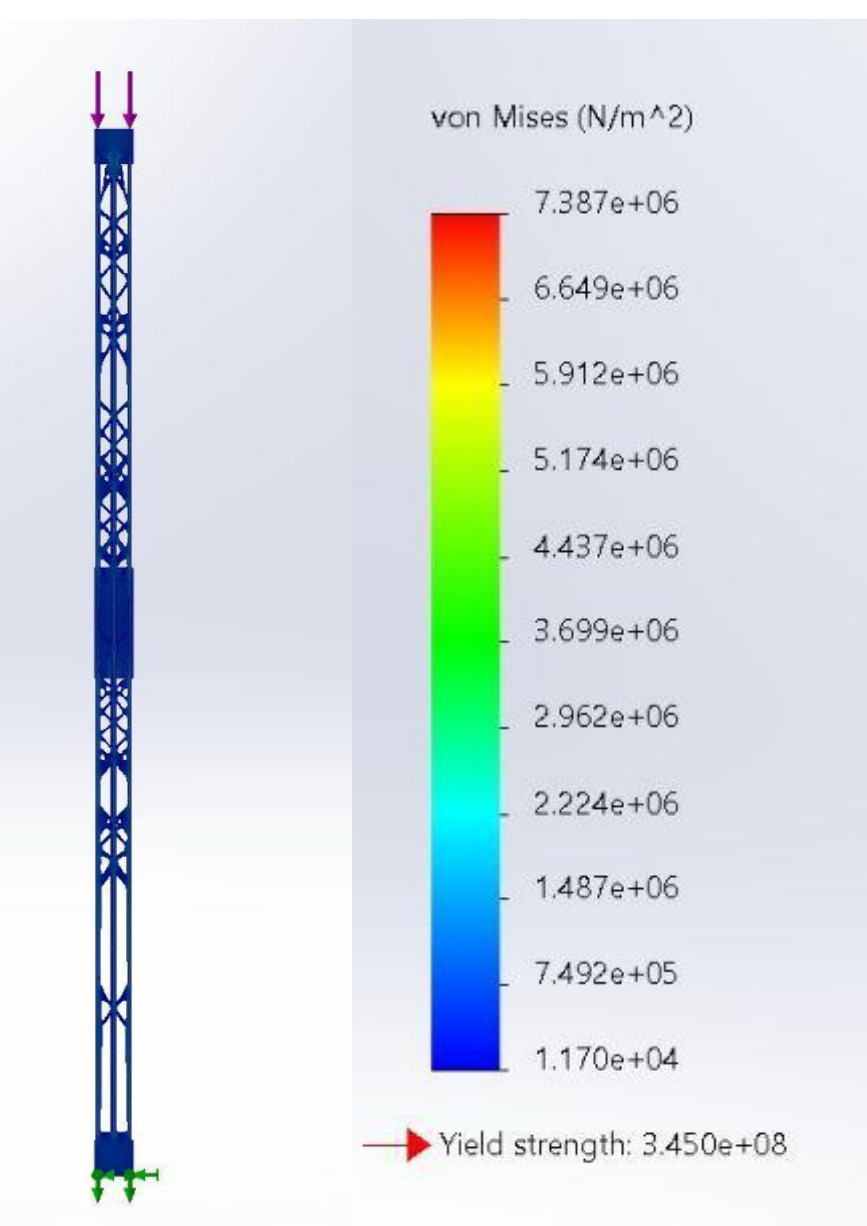


Figure 7: Frame Integrity Simulation



Figure 8: Instron testing of base connections

We evaluated the system through harness load testing, structural validation, and resistance calibration. Load testing of the harness subsystem confirmed the system's ability to withstand realistic user forces [2], while SolidWorks simulations verified frame integrity under expected conditions. Instron testing of base connections demonstrated bolt failure loads exceeding NASA safety requirements [3]. Piston resistance testing confirmed fine-tuning capability. Synthetic sweat testing was also successful in determining handle material.



Figure 9: Minimum Piston Resistance Adjustment Test



Figure 10: Harness Load Test

	White Flexible Resin (F39)		
Sample #	1.4	2.4	3.4
Initial Mass (mg)	1258.2	1177.3	1253.2
Final Mass (mg)	1309.1	1224.9	1302.8

Table 1: Results from Synthetic Sweat Corrosion Test

Future

The primary focus of any future work is on altering the design of the vertical climber to be collapsible. This will be done by adding in a sort of tension ratchet system in to be able to decrease tension to allow for the structure to collapse into a third of the height without breaking any cords, and again to increase the tension to allow for working conditions. Clasps and hinges would also be added to the points of collapse for stability, and rotatability. After that, we plan to conquer galaxies far, far away!

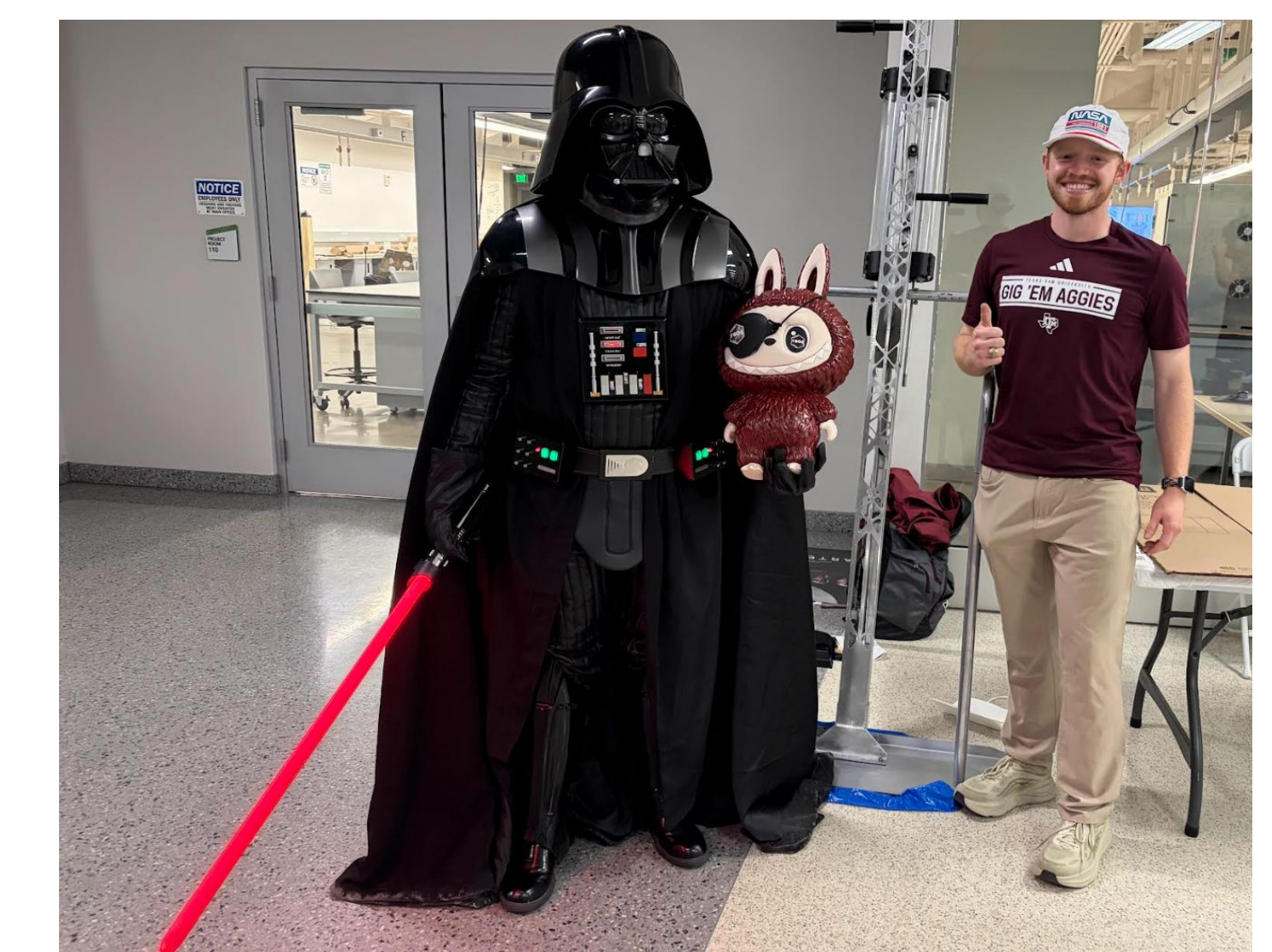


Figure 11: K-12 Outreach at Night at the Zach

References

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Figure 1: Vertical Climber Design Progression

