Department of Mechanical and Aerospace Engineering

Lunar Lobos: LOBOT Project

Aerospace Engineering Capstone Senior Design 2021-2022

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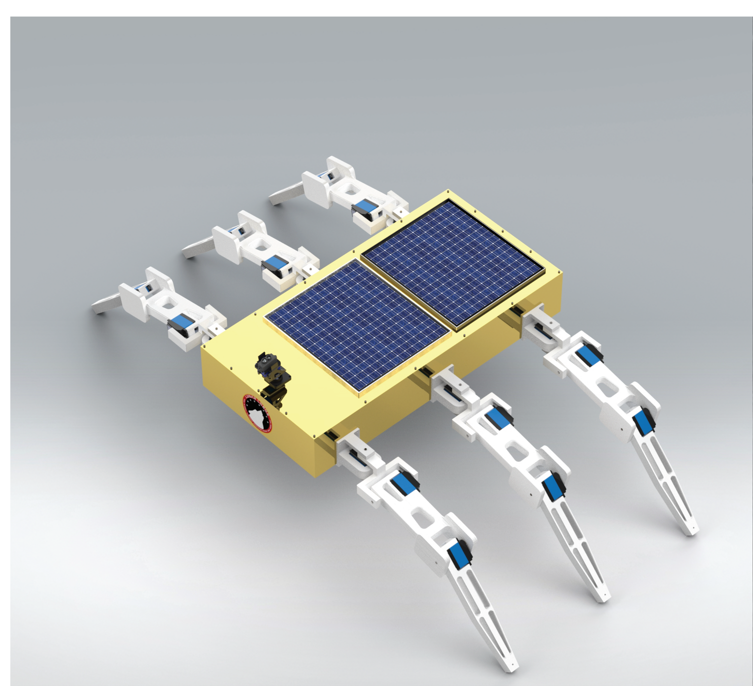
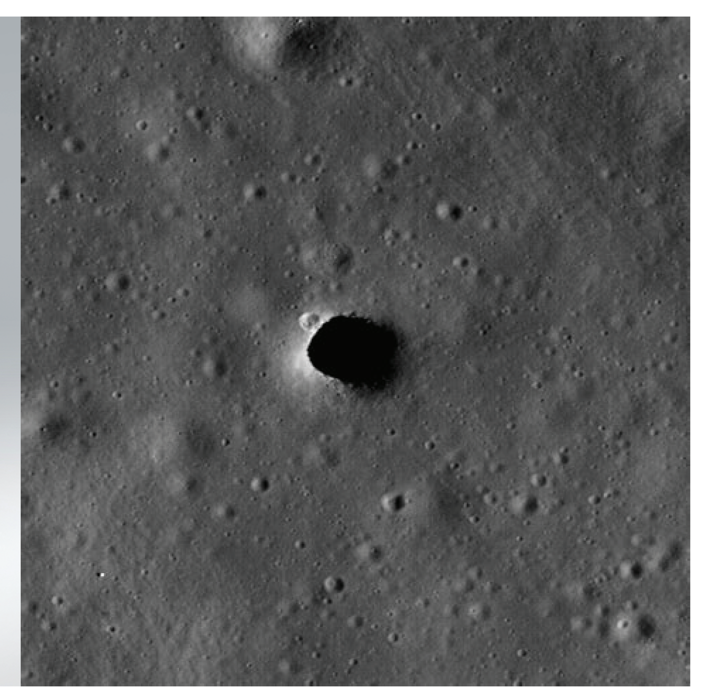
Mission Overview

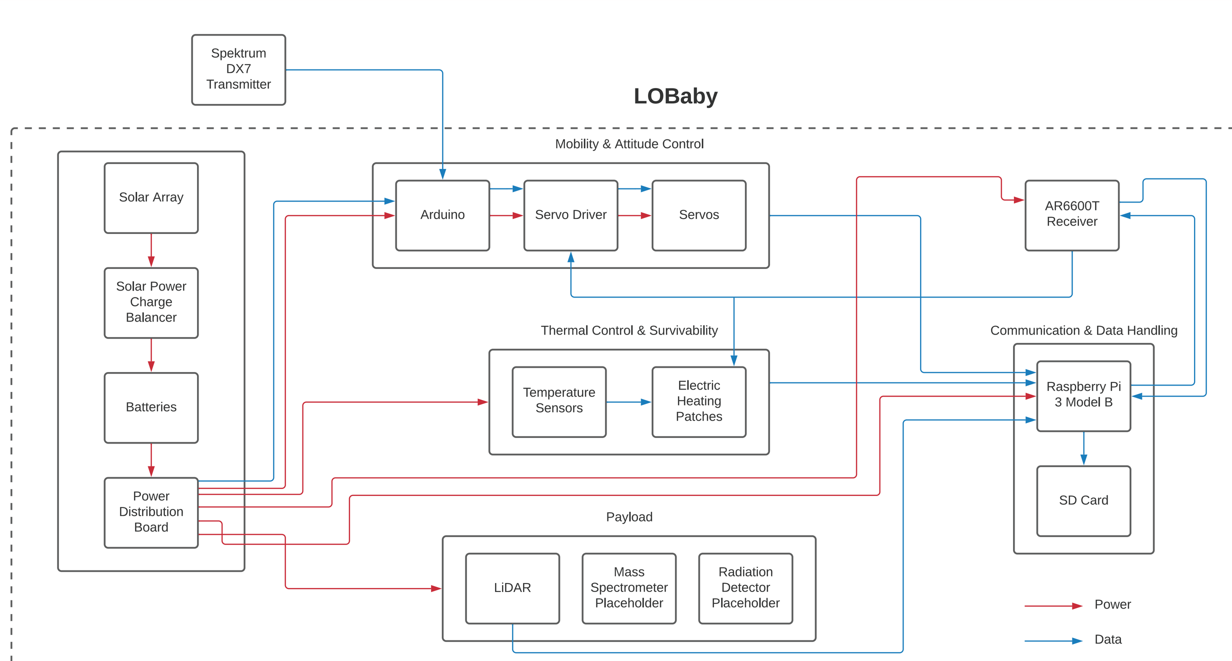
Purpose: Design, develop, and demonstrate robotic systems with alternative rover locomotion modalities for use in off-world lunar terrain applications.

Customer Requirements: Minimize mass, size, and power consumption, capable of operating in harsh lunar environments, capable of carrying a scientific payload, capable of traversing extreme terrain not passable by wheels or treads.

Objective: Study exosphere conditions, such as radiation levels, above and below the lunar surface to determine the feasibility of human habitation in lunar lava tubes like the Marius Hills Skylight shown below.

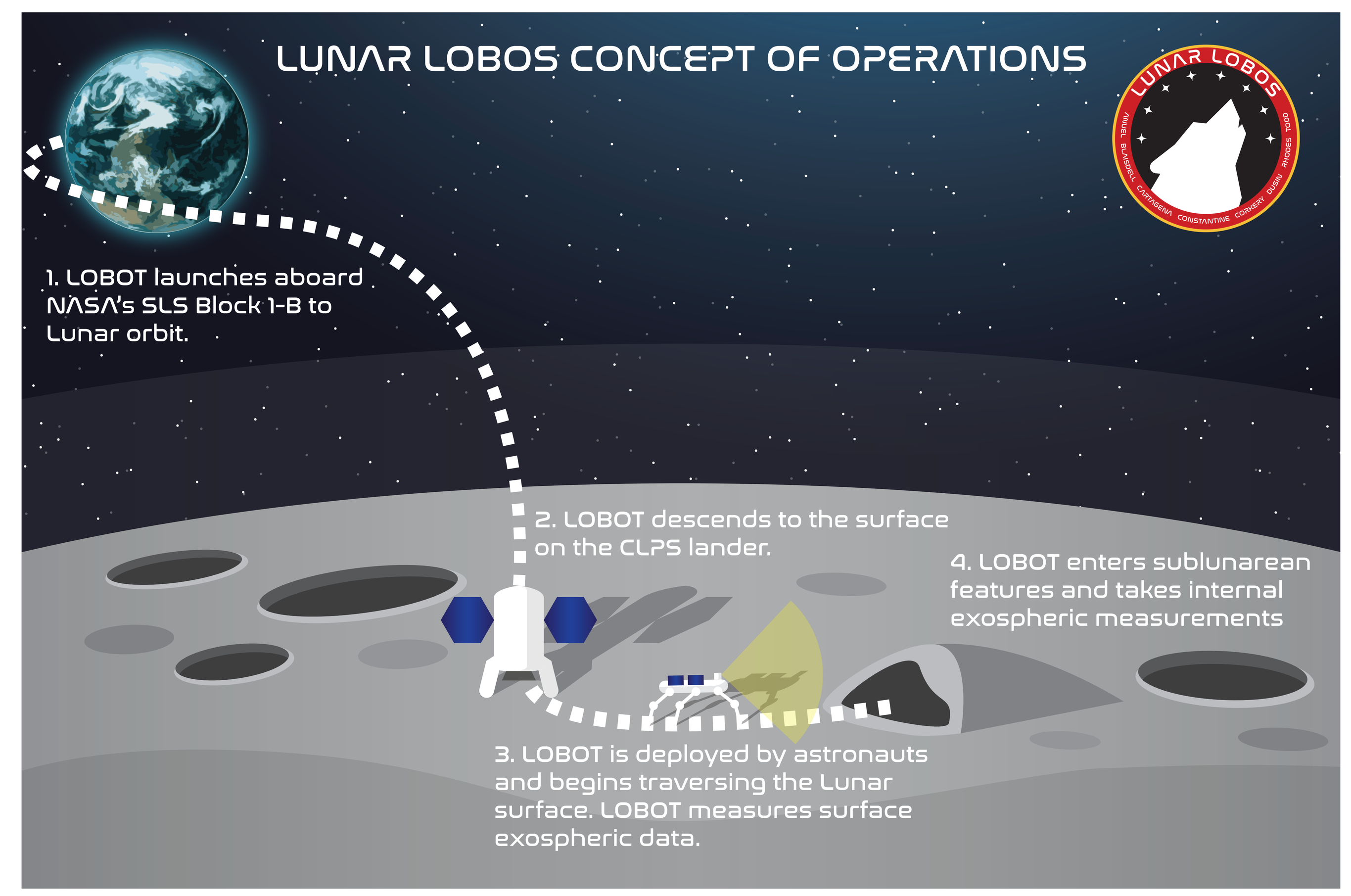



Functional Block Diagram



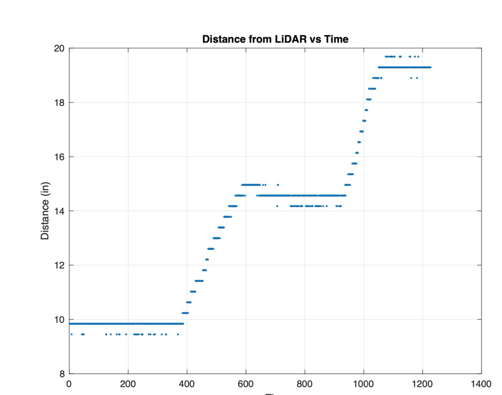
The above diagram show the flow of information and power through the rover prototype. The Arduino is the "brains" of the rover, taking in signals from the receiver and controlling the movement of the servos. 5V power is supplied from the batteries to the electronic systems and is replenished during downtime by two, 9 W solar panels.

CONOPS

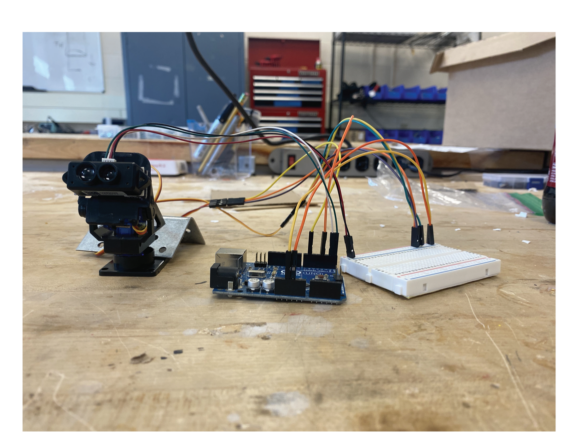


Validation and Testing

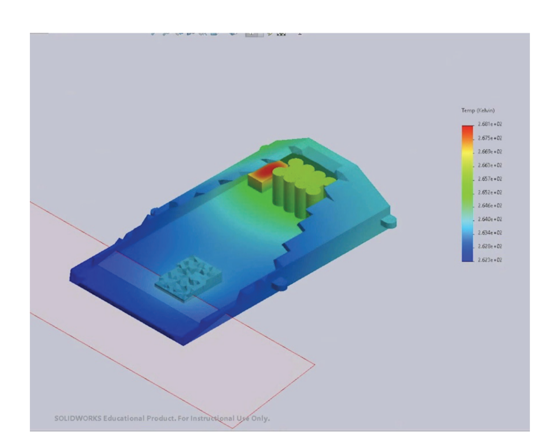
To verify the design choices that were made in the first half of the class, the team performed nineteen validation tests ranging from finite element analysis and ANSYS Thermal simulations to maximum shear strength testing and solar charging verification. These tests showed the team which aspects of the design could be moved into manufacturing and which required further development. A few of these tests are shown here.



Data Collection Test: The LiDAR data was stored on an SD Card and used to create this graph of changing distances.



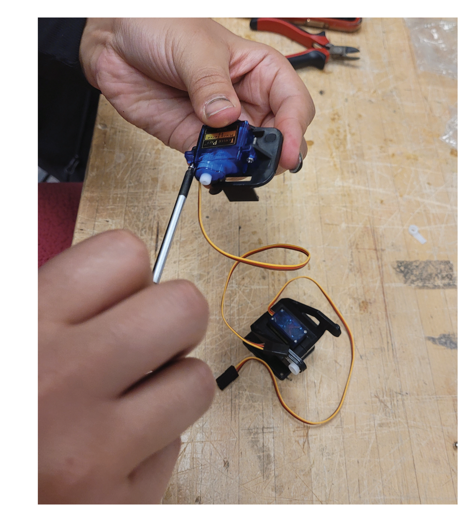
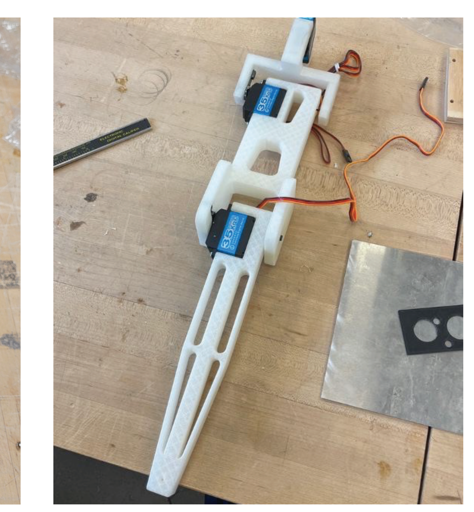
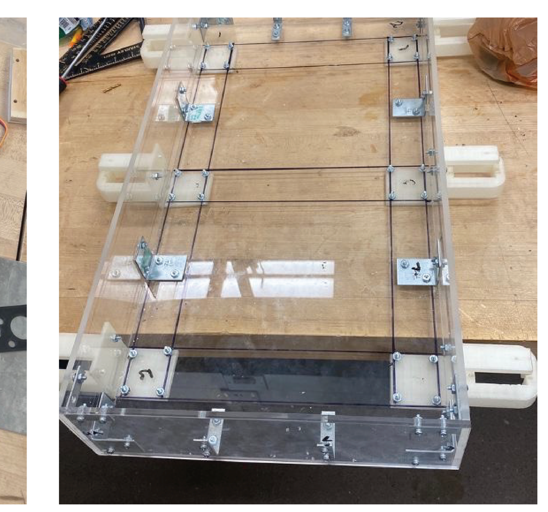
LiDAR Test: The LiDAR module was attached to an Arduino and recorded distance data at various angles.



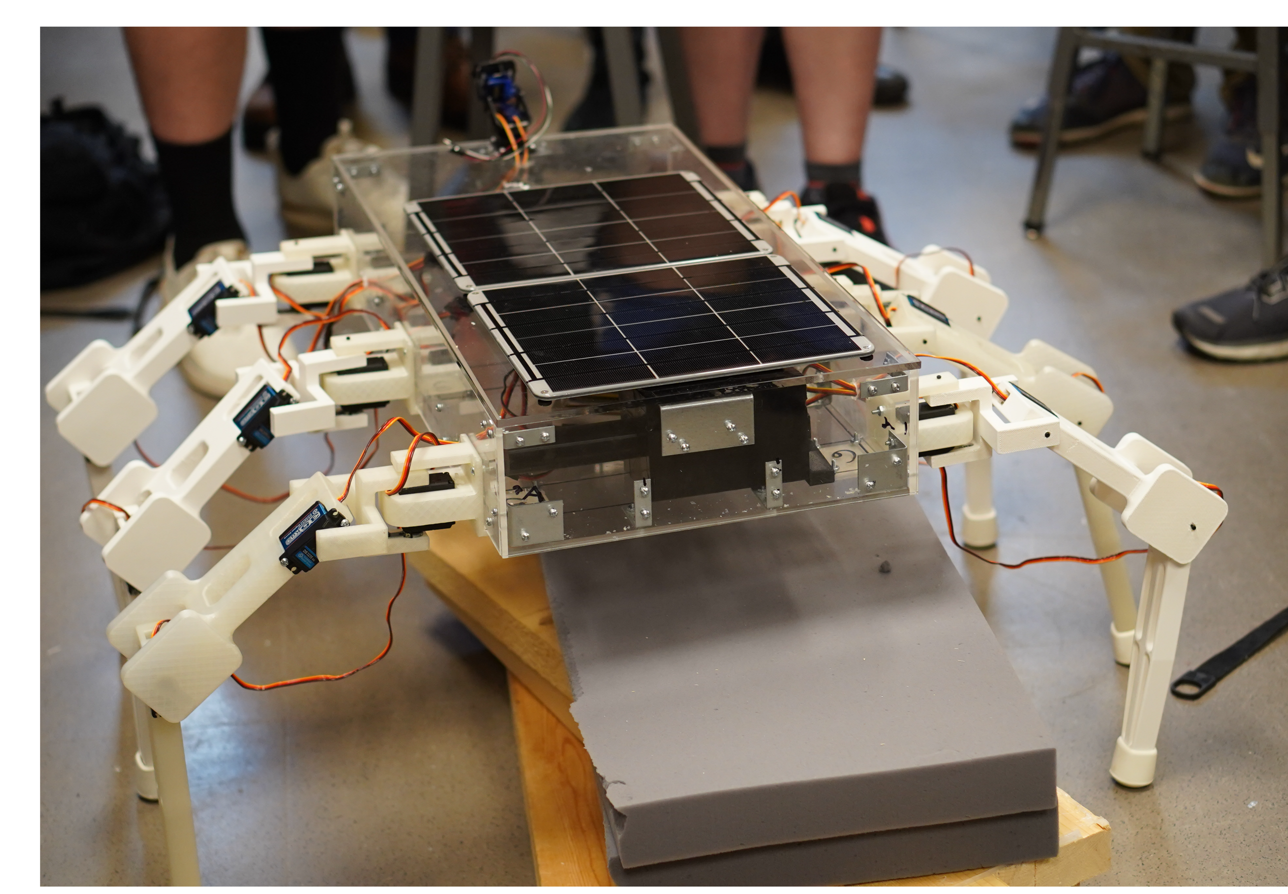
Thermal Test: ANSYS was used to test the thermal constraints of the rover internals under extreme conditions similar to those found on the moon.

Manufacturing

The body of the rover is constructed from acrylic panels that were water jet cut in the MAE fabrication lab. These panels were connected to each other using steel angle brackets and machine screws. The legs were 3D printed using PLA filament that allowed for rapid prototyping and easy replacement in the event a part became damaged. The joints are controlled by high torque servos that provide 18 degrees of freedom and full articulation. All of the electronics were connected via adapters or breadboards to allow for easy prototyping and modularity.

Final Prototype



The final prototype, dubbed "LOBaby" as it is a half scale version of LOBOT, is 12 in x 24 in x 5 in and weighs 26.4 lbs fully loaded. Its hexapedal locomotion and 18 degrees of freedom allow it to traverse a variety of obstacles and hazardous terrain.

If there were more time to continue development, the team would like to incorporate a quadrupedal configuration for faster walking over smooth terrain and an autonomous obstacle avoidance system to control the rover's movement.