NC STATE UNIVERSITY

Department of Mechanical
and Aerospace Engineering

Wandering Observer of Lunar Features

Aerospace Engineering Capstone Senior Design 2020 – 2021
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WOLF Mission Overview

- The WOLF Rover will explore a lunar lava tube candidate to further the understanding lava tube characteristics.
- WOLF will:
  - Verify the existence of a lunar lava tube
  - Use a LiDAR sensor to map segments of the lunar lava tube candidate
  - Demonstrate CubeRover capabilities

Lunar Lava Tube Background

- Subsurface tubes leftover from the moon's cooling process
- There exists an increasing need to characterize lunar lava tubes
  - Characteristics are unable to be studied via satellite missions due to the subterranean nature of lava tubes
  - Potential lunar habitat site that offers protection from harmful radiation environments, impact debris, and lunar surface temperature fluctuations

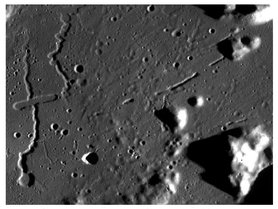
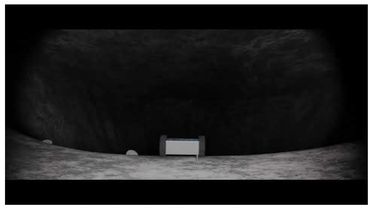
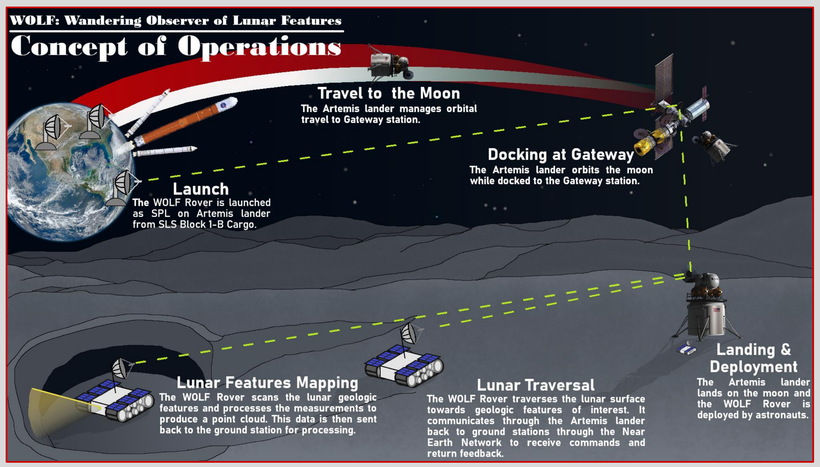


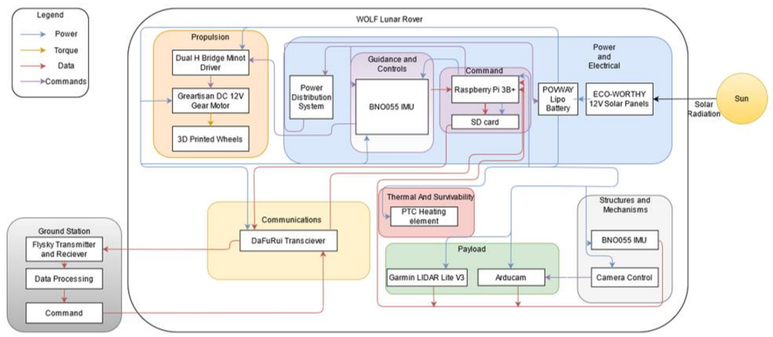
Image from Lunar Reconnaissance Orbiter Camera



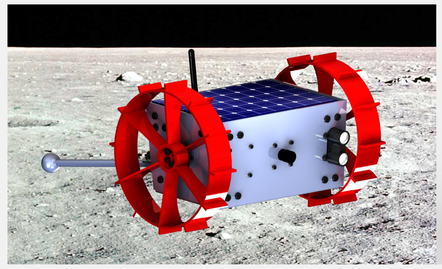
Lunar Lava Tube Exploration Simulation

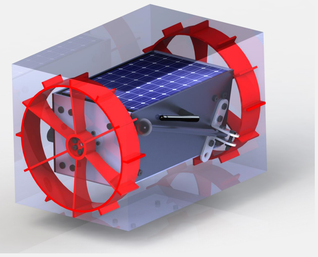


Functional Block Diagram

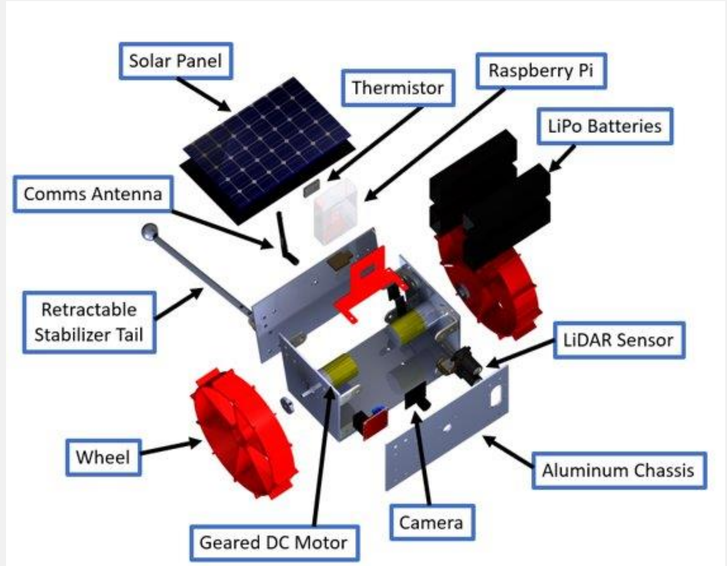


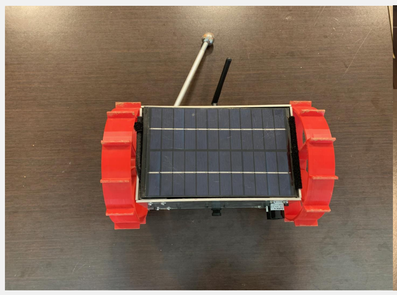
Design

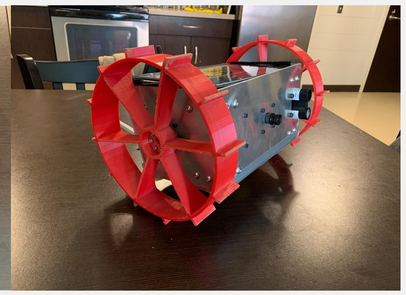




The WOLF Rover prototype meets the 12U CubeSat requirements, which entails that the CubeRover will fit within a 200x300x200mm volume. The WOLF Rover's stability tail is retractable, allowing it to sit flush against the aft side of the chassis. The figures above highlight the WOLF Rover prototype meeting the 12U CubeSat dimensional constraints.





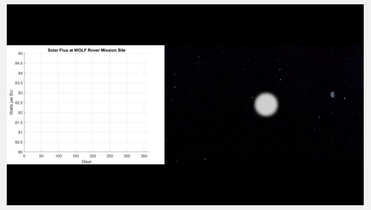


To adhere to 12U CubeSat standards, the WOLF Rover must weigh less than 20kg. Many components are nested within one another, so the WOLF Rover's total volume is not indicative of its envelope relative to the 12U standard. The WOLF Rover weighs 3638.61 grams, with a spare mass of 16,361.39 grams. Its volume is 1,933.28 cm^3. The wires of the prototype fill the interior of the chassis. The SD card also has no notable volume, as it sits within the WOLF Rover Raspberry Pi. Velcro and tape have negligible volume.

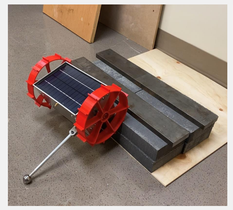
VV&T

Test Videos!

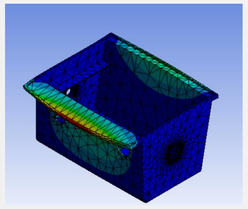
Final Drive Test



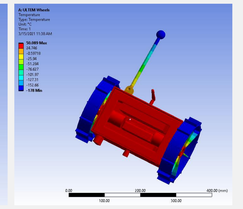
Solar Flux Simulation



Scaling Test



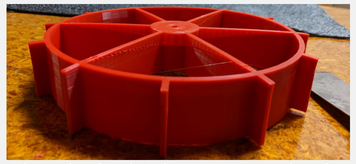
Structural Simulation



Thermal Simulation

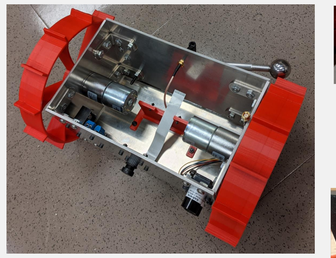
Manufacturing

The WOLF Rover prototype consists of the COTS design components, a modular chassis of 3003 and 5052 aluminum, a tail of 3003 aluminum and stainless steel, and wheels and mounting structures of 3D printed PLA. The electrical system was integrated using lever wire nuts and quick disconnect wires to aid in configuration changes.



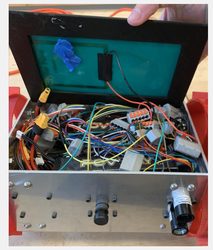
The wheels, interior mount, and solar panel mount were 3D printed on the ASME Student Section printer. Shown above is one wheel with support structure.

The chassis was assembled from three aluminum panels made in the ME Shops, one bent at 90 degrees into a u-shape. These were then attached with L-brackets and bolts.



The system was test integrated multiple times while VV&T was still ongoing. Design components were either bolted through the chassis, mounted to the internal mount, or adhered with adhesive tape or hook-and-loop fasteners for easy removal.

The tail was manufactured from an aluminum rod and a COTS stainless steel ball nut. One end of the rod was threaded, and perpendicular holes were drilled in the ME Shops.



The electrical system consisted of the batteries wires, connectors, and wire nuts. Labels were used to ensure that junctions were connected properly, and all components were protected from accidental shorts on the aluminum chassis. The solar panel was secured as the final step before use.