NC STATE UNIVERSITY

Department of Mechanical and Aerospace Engineering

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Remote - Operated Vehicle for Regolith Retrieval by Wolfpack Inflatable Lunar Design

Aerospace Engineering Capstone Senior Design 2023 - 2024
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System Test

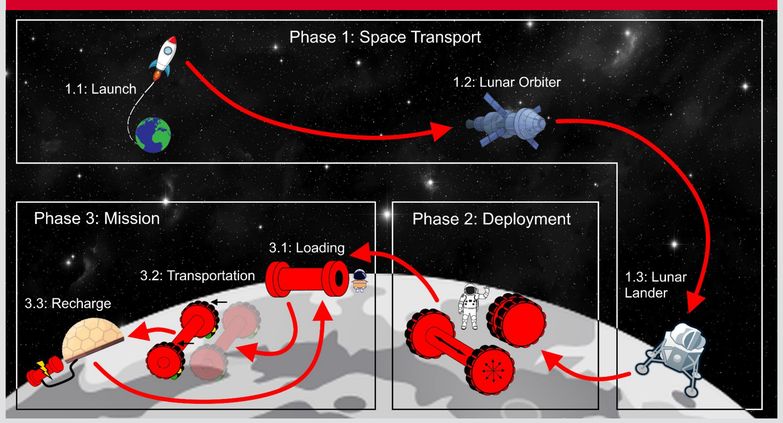
Mission Overview

- The WILD ROVRR will employ inflatable soft robotics to transport bulk regolith on the lunar surface while mitigating risk and reducing launch volume
- Inflatable Soft Robotics
  - Inflatable technology allows for much smaller size when not in use
    - Payload size reduced during launch
  - Soft robotics are safe for astronauts to work closely with
    - Greatly reduced risk of injury during handling or in a collision
- In-Situ Resource Utilization (ISRU)
  - Transportation of materials from the Earth to the Moon is slow and expensive
  - Lunar regolith contains titanium stock, helium-3, and oxygen gas, presenting several opportunities for ISRU.

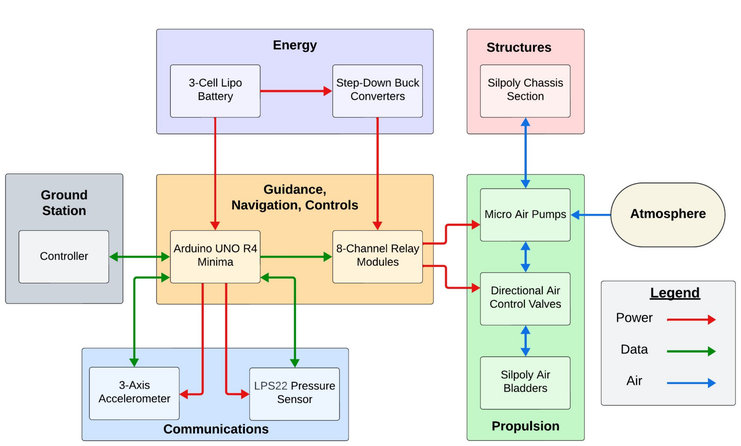

Lunar Regolith


Regolith Simulant

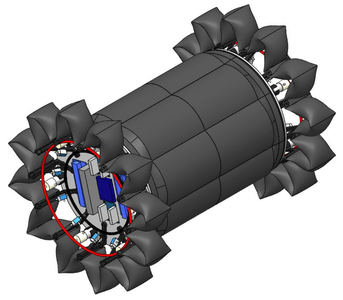
CONOPS

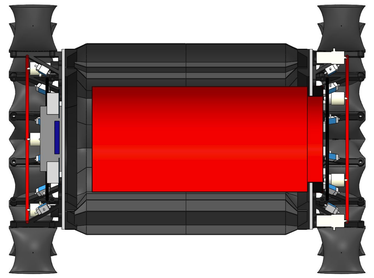


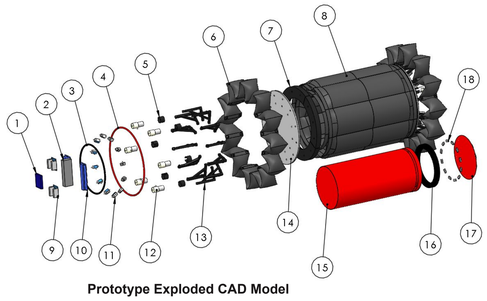
Functional Block Diagram



Design


Prototype CAD Model


Prototype CAD Model Cross Section



Prototype Exploded CAD Model

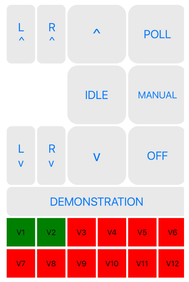
#	Part	#	Part
1	Arduino	10	Relay
2	Battery	11	Directional Valve
3	Low Pressure Line	12	Air Pump
4	High Pressure Line	13	Bladder Mount
5	Pump Mount	14	Aluminum Disk
6	Bladders	15	Payload Compartment
7	Chassis Mount	16	Magnet Ring
8	Chassis	17	Hatch
9	Buck Converter	18	Magnets


Collapsed Prototype ROVRR

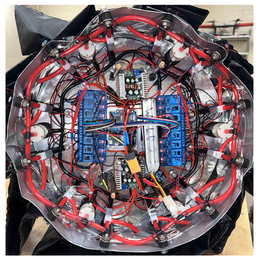

Prototype ROVRR Sand Test

Experimental Parameters

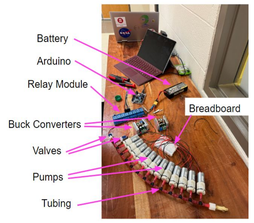
- Max Slope: 5 degrees
- Speed:
  - Sand - 2.65 cm/s
  - Floor - 2.02 cm/s
- ROVRR Mass: 7.932 kg
- Payload Mass: 3.628 kg
- Size (inflated): 0.0768 m^3
- Size (stowed): 0.0298 m^3
- Range: 143 meters
- Battery Life: More than 1.5 hours
- Connection range: More than 73 meters



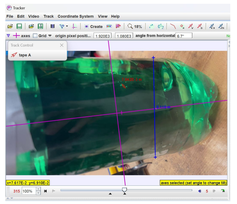
Graphical User Interface

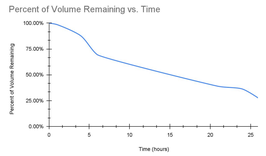

Electrical Housing

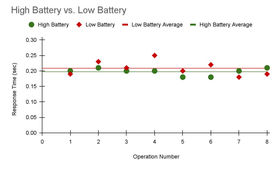
VV&T



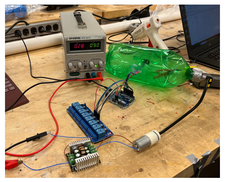
Battery Life Testing

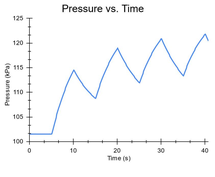

Seal Testing



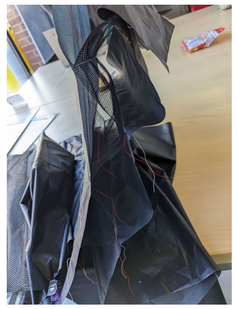


Communications Testing


Sensor Testing



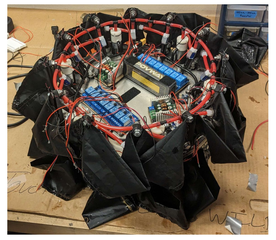
Manufacturing


Drop Stitching
The inflatable chassis section was sewn using both permeable and impermeable fabrics. The chassis was then sealed multiple times.

Bladder Manufacturing
24 inflatable bladders were individually cut, sewn, hole punched, and sealed. All were tested multiple times to ensure a quality seal was created. Grommets were added as mounting points.


Aluminum Disks
2 disks were cut out using a water jet. Additional holes for wiring were made using a drill press. All other components were mounted to these disks.

Bladder Mounts
3D printed out of PLA. Each one has 2 bolt holes for the bladders and 2 for the aluminum disk.


Final Assembly
The bladders were bolted on. Electrical components were attached to the aluminum with velcro. The chassis was secured using hose clamps. The rest of the parts were secured using adhesives.