Lunar Terrain Vehicle (LTV)

Tarleton State University | Mayfield College of Engineering | RELLIS Campus
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Background

This project focuses on revolutionizing the way we transport astronauts and supplies across the lunar surface by introducing the Lunar Terrain Vehicle (LTV). The lunar environment is characterized by extreme changes in elevation, temperature, low gravity, and abrasive regolith.

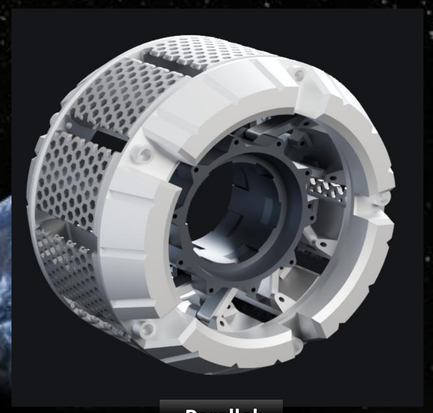
Objective

The primary objective for the Lunar Terrain Vehicle (LTV) project is to research, design, and develop an efficient, durable vehicle tailored for use on the lunar surface for extended periods of time. The goal is to provide a vehicle that can reliably withstand the Moon's harsh environment under payload.

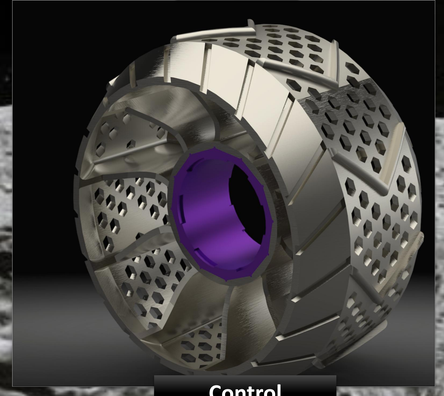
This semester's objective is to design an adaptive torque actuated wheel for the LTV, specifically looking at different actuation and hub geometries. The goal is to ensure the designs have optimal traction, durability, and stability. By achieving these targets, the project will lay a foundation for further development of the LTV. Our project will deliver a complete prototype ready for the lunar terrain.

Wheel Designs


Cross Bar


Parallel


Sliding Arrow


Control

Conclusion

In the development of the compliant transforming wheel, there was careful consideration of regolith control, materials, and mechanical mechanisms. Physical terrain testing and finite element analysis conclusively identified the Cross Bar Wheel as the optimal architectural configuration for the LTV. This design demonstrated superior mobility metrics over the other prototypes, minimizing loose regolith sinkage and executing a steep 20° incline. By utilizing a flexible, compliant linkage network to isolate loads rather than a rigid wheel, the parallel design combines efficiency and durability. Thus, providing us with the foundation of our LTV.

Future Considerations:

-Implement the deformable property to our wheel designs
-Refine central motor interfaces
-Lengthen our test bed for future testing
-Execute dynamic impact simulations
-Mitigate regolith lofting
-Optimize Sliding Arrow Wheel fabricability

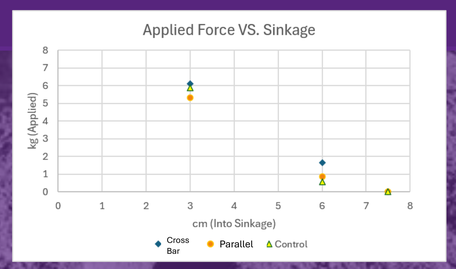
Testing

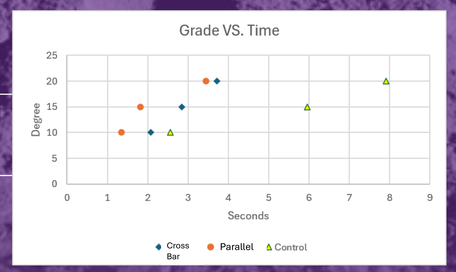
Applied Mass: 3 kg, 6 kg, 7 kg

Crossbar Design Sinkage: 6.1 cm, 1.66 cm
Parallel Design Sinkage: 5.3 cm, 0.85 cm
Control Design Sinkage: 5.866 cm, 0.566 cm

Degree of Incline: 10˚, 15˚, 20˚

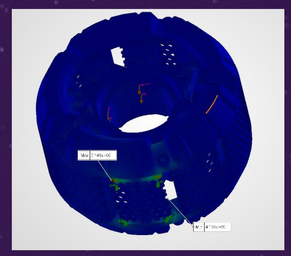
Crossbar Design Time: 2.07 sec, 2.84 sec, 3.71 sec
Parallel Design Time: 1.35 sec, 1.81 sec, 3.45 sec
Control Design Time: 2.57 sec, 5.96 sec, 7.91 sec



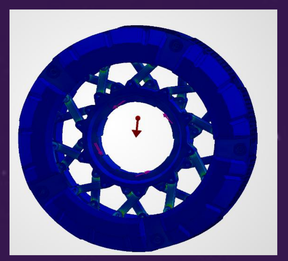


Results - FEA (Finite Element Analysis)

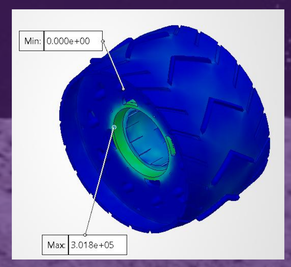
Weight under lunar gravity on all wheels: (8.1 N), torque on all wheels: (6 Nm) (Resulted displacement shown for all wheels).



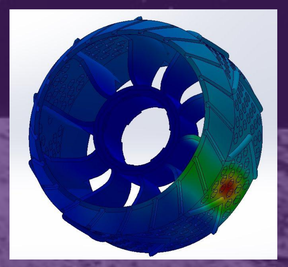
Parallel Design
-Maximum Displacement: 0.006 mm
-Maximum Stress: 5.148x10^6 N/m^2
-Maximum Strain: 4.306x10^-5



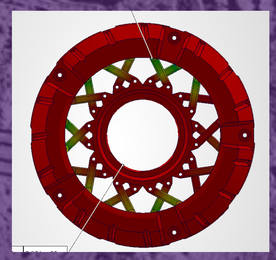
Cross Bar Design
-Maximum Displacement: 1.822x10^-4 mm
-Maximum Stress: 4.709x10^4 N/m^2
-Maximum Strain: 4.175x10^-7



Sliding Arrow Design
-Maximum Displacement: 7.645x10^-5 mm
-Maximum Stress: 3.005x10^5 N/m^2
-Maximum Strain: 2.671x10^-6



Control Design
-Maximum Displacement: 0.2385 mm
-Maximum Stress: 8.076x10^6 N/m^2
-Maximum Strain: 1.429x10^-3



Thermal FEA
High Exterior Temperature: *120*℃
Hub interior Temperature: -50℃
-Maximum Displacement: 0.246 mm
-Maximum Stress: 1.109x10^9 N/m^2
-Maximum Strain: 6.080x10^-3

Acknowledgements

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Test Apparatus







Tested Wheel Prototypes







**The Sliding Arrow Wheel was structurally unfeasible to fabricate for physical testing within this project cycle.

LTV Design

