Rover Propulsion in Frozen Environments

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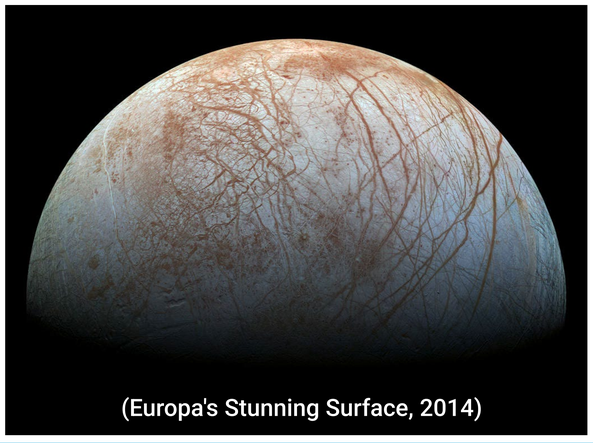
ABSTRACT

The goal of this study is to find the optimal propulsion system for a rover on snowy terrain. The purpose of the study is to test multiple methods of driving a rover in deep fresh snow to later be used when designing a rover intended to traverse steep snowy terrain on other planets. The exploration of this topic is important for our study of other celestial bodies. A significant portion of the planets and moons in our solar system has a surface covered in frozen substances like carbon dioxide, methane, and oxygen. This research will help create a rover to study the surface of those planets and moons. Multiple different designs will be created varying from standard wheels to screw designs with variations on the tread and width. These designs will be tested on several different slopes to see the maximum angle they can handle before back sliding or tipping. Using the data from the tests we can then conclude the optimal design for the propulsion of a rover on frozen terrain.

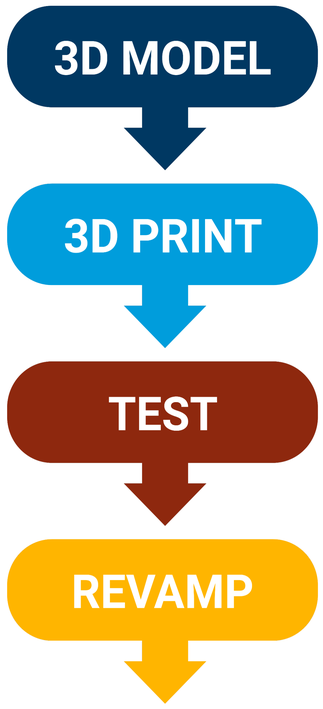


(Europa's Stunning Surface, 2014)

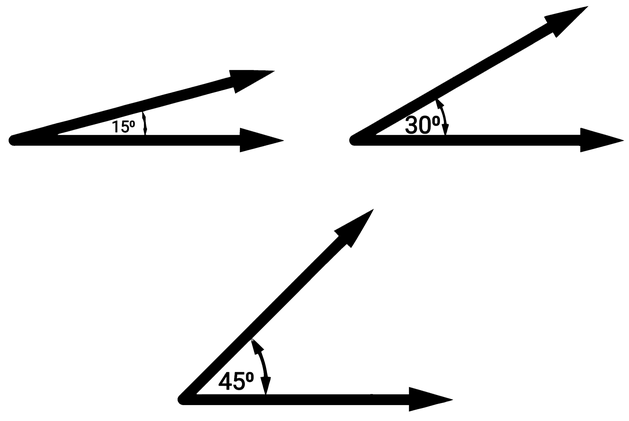
BACKGROUND & OVERVIEW

Exploring icy planets and moons such as Europa and Neptune has been a long-standing ambition of NASA, as it presents a unique opportunity to understand the conditions of early planetary formation and the possibility of extraterrestrial life. Rovers are the primary tools for planetary exploration, and their success depends largely on their ability to traverse and collect samples on the planet's surface. One crucial factor that affects rover mobility on icy surfaces is the design of its drive system. The drive system must be optimized to provide enough traction and minimize slippage, to ensure smooth and efficient movement across the planet's surface. For this research project, we investigate the optimal drive system design for a rover on an icy planet by evaluating the performance of different designs in simulated icy environments. We aim to provide insights into the development of rovers that can navigate and explore icy planets with greater efficiency and accuracy.

METHODS & MATERIALS

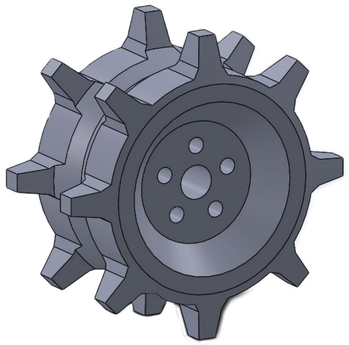


The method I will use to test the different designs will follow the flow chart on the left. To test these designs, I will need to wait until winter so I have the proper environment which will give me proper time to manufacture everything. I have created a few basic 3D models for the three main designs I want to test. I will need to create a rover chassis with a modular mount for the drive system in order to test each wheel. Once I have the chassis made I can them 3D print each design in PETG. For testing each drive system, I will test a few different terrain variable. Each system will be tested on slopes with angles of 0, 15, 30, 45 degrees. I will also test a few variations of snow conditions, that is packed, frozen over, and fresh powder.

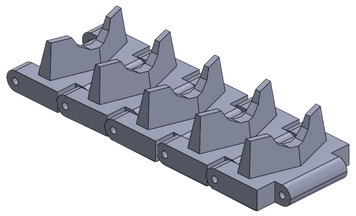


Once I gather data from the tests, I can revamp the designs to hopefully improve its performance. Once I tried a few iterations of each design I should have enough data to decide on which of the three designs I will focus on to make a final optimal design.

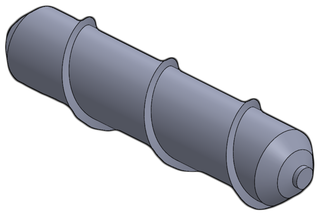
DESIGNS



Wheel Design



Track Design



Screw Design

CONCLUSIONS

- There is interest in exploring icy planets
- Proper traction is needed
- Finding the optimal drive system is essential
- Testing three general designs
- Varying from 0°,15°, 30°, and 45° slope
- On packed, solid, and fresh snow

REFERENCES & ACKNOWLEDGMENTS

•NASA (2014). *Europa's Stunning Surface* [Photograph]. NASA. https://www.nasa.gov/sites/default/files/thumbnails/image/pia19048.jpg

•Chat GPT for giving me a basis for my background & overview

•Special thanks to Connor Nygard for assistance with the visual aids