Micro-g NExT Lunar Contact Sampling Device

By: Abdullah Nazzal, David Patino, Michael Schoppa
Mechanical Engineering Program – College of Science and Engineering
Email: SchoppaM5315@uhcl.edu

University of Houston Clear Lake

ABSTRACT

The Moon has greatly impacted Earth's environment and life, and ongoing research, including NASA's Artemis program, continues to explore its mysteries. Artemis Mission III will focus on the lunar south pole, where astronauts will collect geological samples to study the Moon's history. To ensure these samples are safely stored and transported, the "Ram Rod Sampling Device" was developed by Team Space Cowboys, combining features from various existing soil sampling technologies. This device will be crucial for analyzing lunar regolith and advancing lunar research.

Project Background

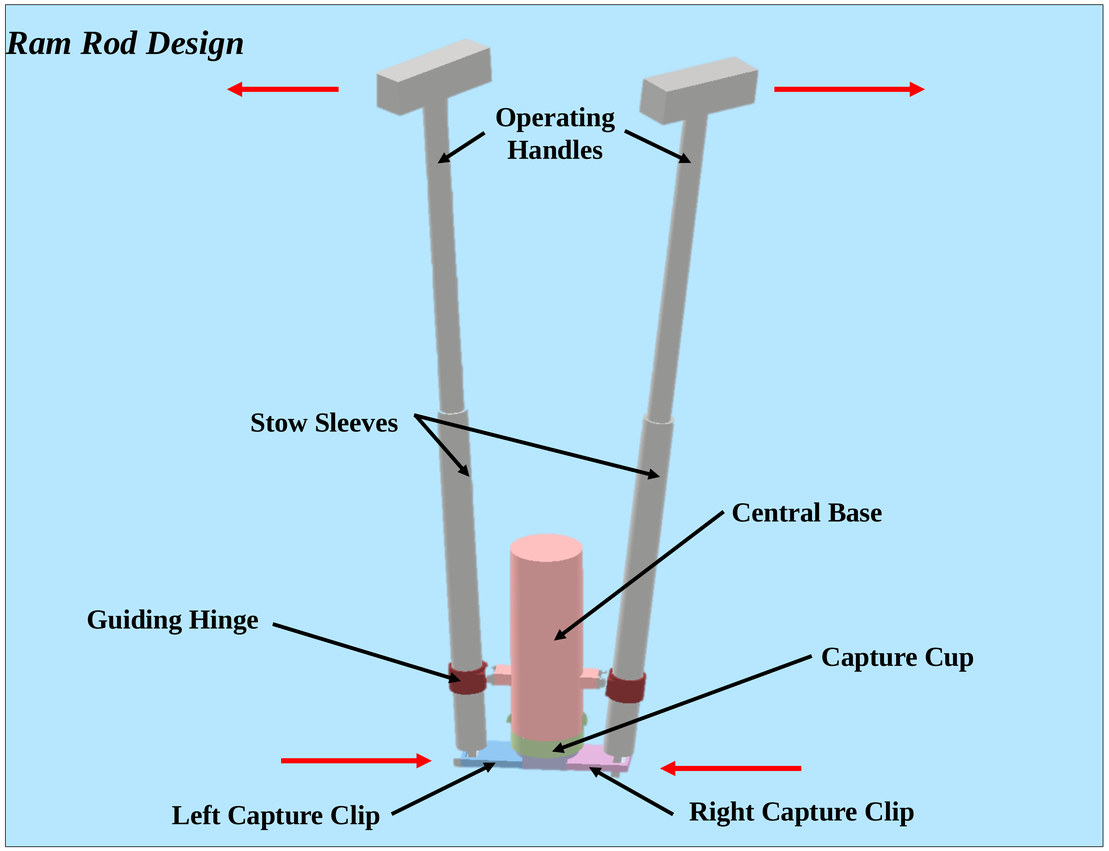
Lunar regolith is a fine, powdery soil composed of a mixture of dust, small rocks, and glassy particles [1]. The collection of this lunar regolith sample without disturbing its grain structure is the key to the in-depth research of the sample of space weathering processes and the history of the Moon. This Artemis Mission is requiring an ergonomically and effective device that will collect 1–5 mm without disturbing the top layer of the geological samples to discover the unknown mysteries humans have yet to solve about the Moon.

Objectives

This sampling contact device will require a small frame, be lightweight, and be easily operational for a fully suited astronaut to collect 1–5 mm of regolith on the lunar surface to capture the grain orientation of the surface particles. The device shall be lighter than 5 pounds and fit within a volume of 8x8x16 inches, while being fully mechanically operational.

DESIGN, RESULTS, DISCUSSION

Ram Rod Design

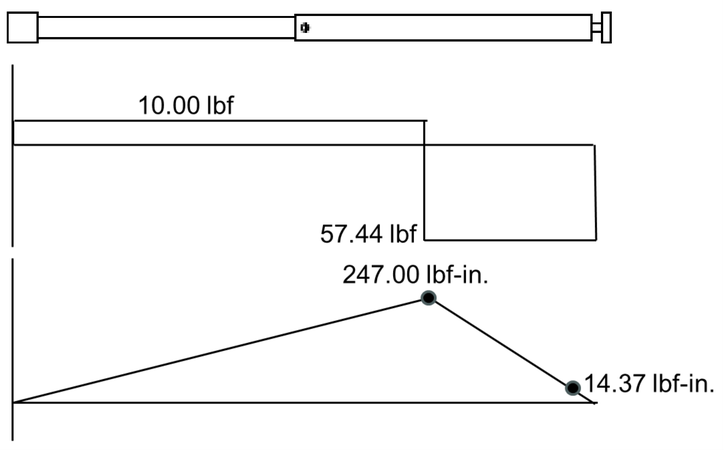


Design Specifications	
Weight (lbs.)	4.73
Stowed Volume (in.)	3 x 7.5 x 15.5
Material	6005 T6 Aluminum Tough PLA
Minimum Factor of Safety (M.S.S. Theory)	2.0 (Hinge)
Sample Volume (in.^{3})	2.62
Cost ($)	213.52

The Ram Rod design will revolve around the frozen interface of the Central Base. Geometrically complex components will be manufactured through 3D-printing to allow for relatively inexpensive rapid prototyping.

Simplified stress analysis was conducted for primary structure and functional components to prove feasibility. All components passed the safety factor requirement of 2.0.

$$n = \frac{\sigma_{yeild}/2}{\tau_{max}} = \frac{18.17\ \text{ksi}}{5.12\ \text{ksi}} = 3.55$$



FUTURE WORK

Team Space Cowboys plan on performing finite element analysis (FEA) on the ram rod concept to identify possible failure in design or alter the devices materials to meet the desired strength and reliability. Next semester will include manufacturing the device and creating multiple prototypes to perfect the design.

CONCLUSIONS

The Ram Rod is a distinctive and efficient tool specifically designed to support the Artemis Mission (III), particularly in the critical task of safely collecting and storing lunar samples. Its lightweight and compact design, along with its user-friendly features, make it well-suited for the rigorous challenges astronauts face during Extra Vehicular Activities (EVA) on the Moon. The Ram Rod's unique design takes into account the limited mobility of astronauts, ensuring that it can effectively meet the demands of the mission while standing out among other sampling devices previously designed and manufactured.

Acknowledgements

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References

{1} *Lunar Regolith*, www.nasa.gov/wp-content/uploads/2019/04/05_1_snoble_thelunarregolith.pdf. Accessed 10 Nov. 2024.