A Conceptual Design Approach for a Multi-Rover Lunar Exploration Mission in Marius Hills Region

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9th Mission Idea Contest

Table of Contents

Introduction

- Lunar skylights by SELENE mission [Haruyama et al., 2009]
- Moon’s geological history & future human habitation
- Natural shielding against harsh lunar conditions

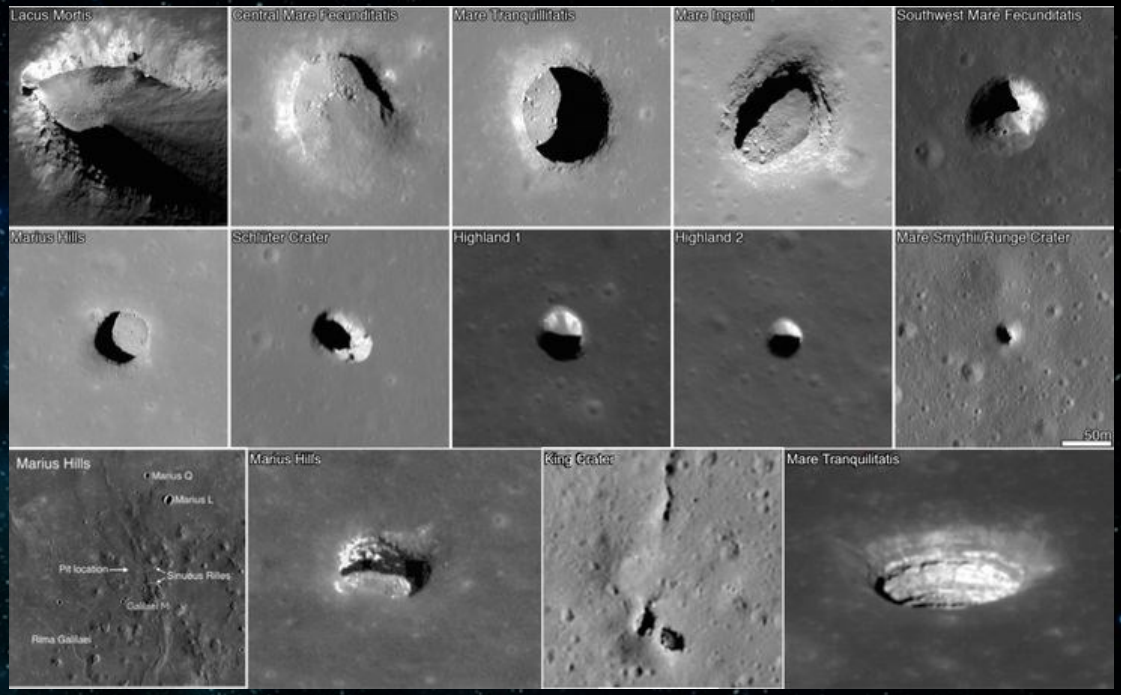


Figure 1 : Lunar skylights

Introduction

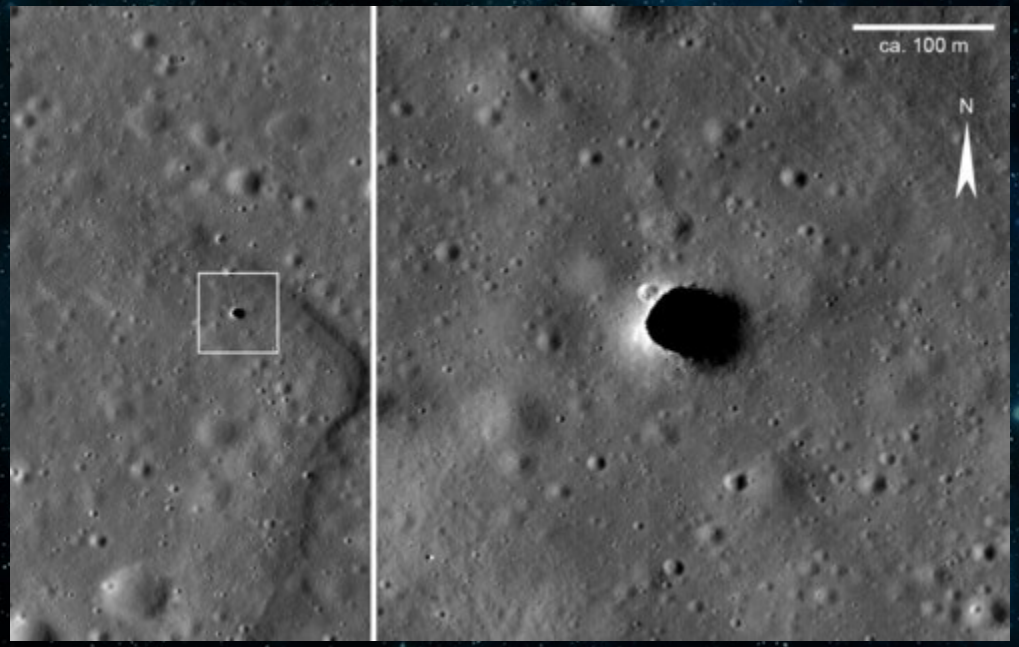


Figure 2 : Marius Hills Region

Mission Step #1 :

A thorough examination of the pit area near the Marius Hills region

Mission Step #2 :

Entering the lava tube to conduct in – situ exploration

Introduction

Multi – Rover System is realistic and economical because of:

- Distinct payload configuration
- Minimizing weight and volume
- Significantly less expensive
- Able to navigate in challenging lava tube terrain

Mission Objectives

1. High – Resolution 3D Mapping
2. Multi – Robot Localization and Autonomous Driving
3. Temperature and Radiation Assessment for Habitat and Agricultural Suitability
4. Magnetic Survey
5. Detection and Characterization of Seismic Events

Mission Requirements

1. Multi – Rover Coordination and Data Fusion
2. Rover Mobility and Terrain Passableness
3. Lava Tube Entry Survivability
4. Autonomous Navigation and Mapping Accuracy

Concept of Operations

- Four structurally identical small rovers
- Approximately 2.5 kg
- All equipped with LiDAR for navigation and high – resolution 3D mapping
- Specialized payload for scientific objectives

Concept of Operations

1. Magnetometry Rover (MagRover)
2. Seismic Rover (SeisRover)
3. Environmental Assessment Rover (EnviRover)
4. Communication Relay Rover (ComRover)

Launch and Transit System (Lander)***

Mission Phases

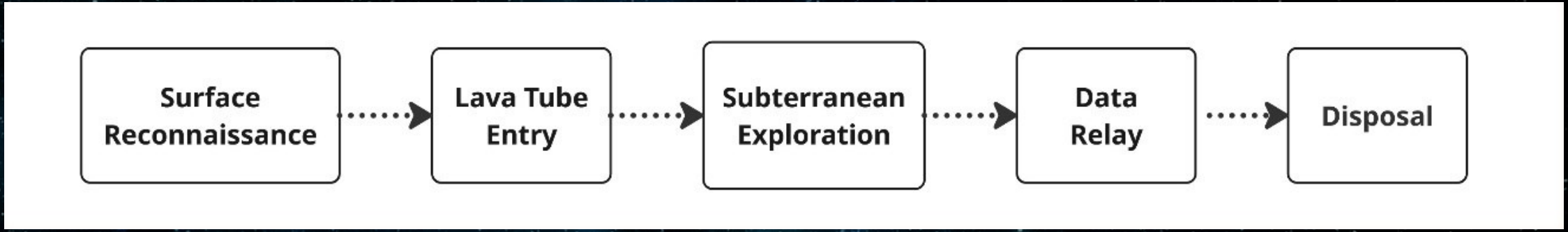


Figure 3 : Operational Mission Phases and Activities in the Marius Hills Region

Mission Phases

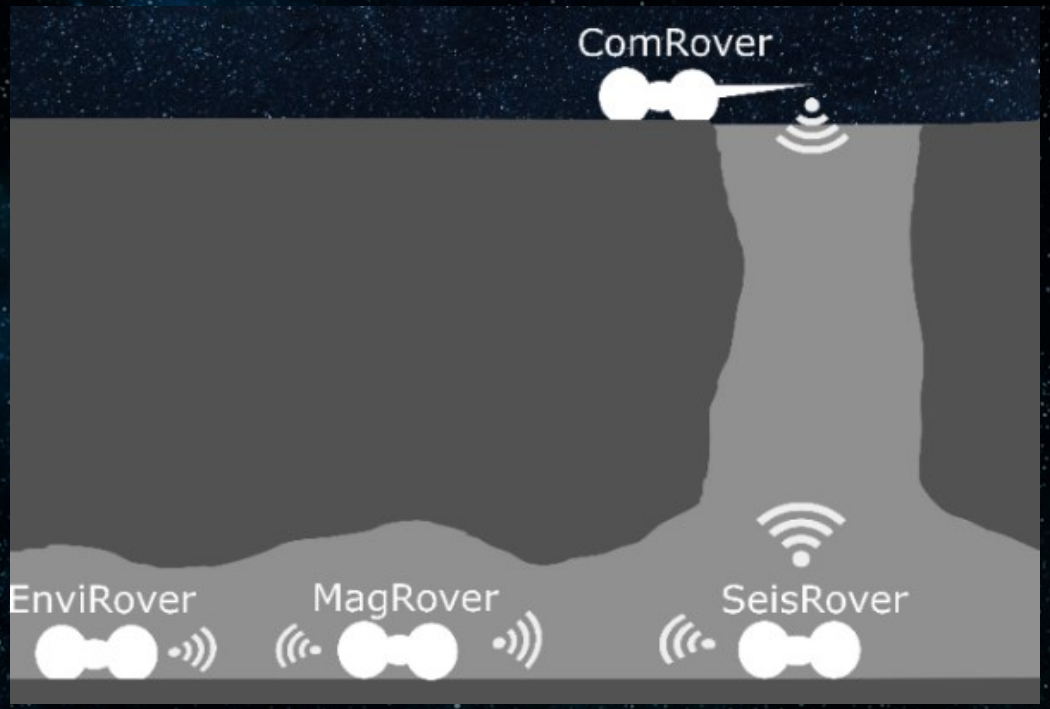


Figure 4 : Subterranean Operation Schematic of an Exploration Phase

Mission Radio Interfaces

1. Rover to Rover Communications
2. Rover to ComRover Communications
3. ComRover to Lander Communications
4. Lander to Ground Station Communications

Mission Radio Interfaces

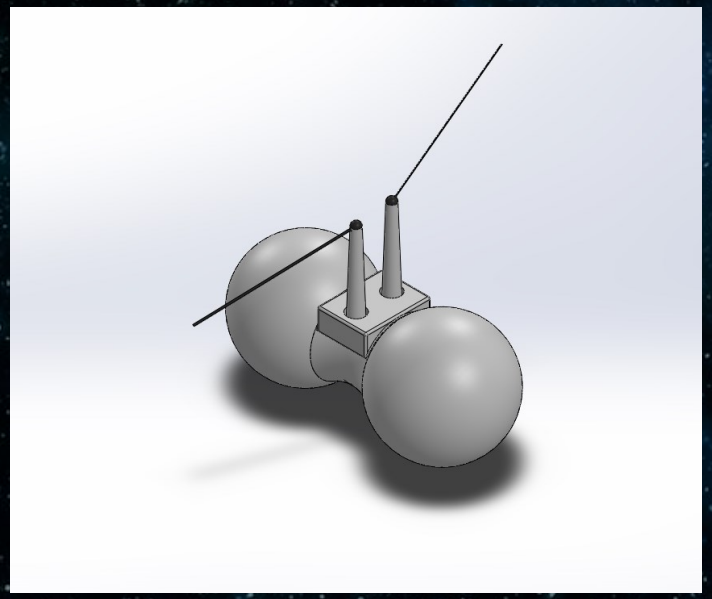
Table 1 : Mission Interfaces

Interface	Interface ID	Description
Rover – to – Rover	IF – 01	UWB
	IF – 02	X – Band
Rovers – to – ComRover	IF – 03	X – Band
ComRover – to – Lander	IF – 04	X – Band
Lander – to – Earth	IF – 05	X – Band or Ka – Band

Conceptual Sketch and Determination of Initial Parameters

- 150 x 150 x 250 mm
- Carbon fiber composite – Hexcel AS4C Carbon Fiber (3000 Filaments)
- Shock absorption – Sorbothane
- Thermal protection – White space-qualified thermal paint

Conceptual Sketch and Determination of Initial Parameters



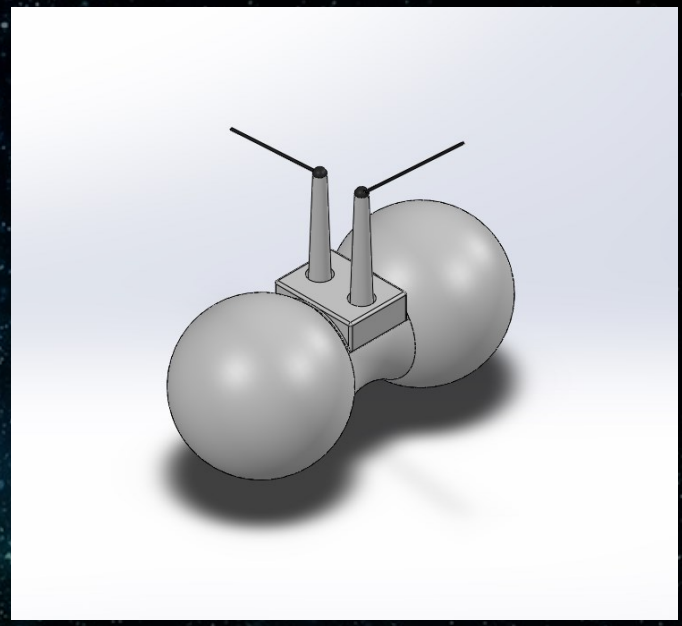
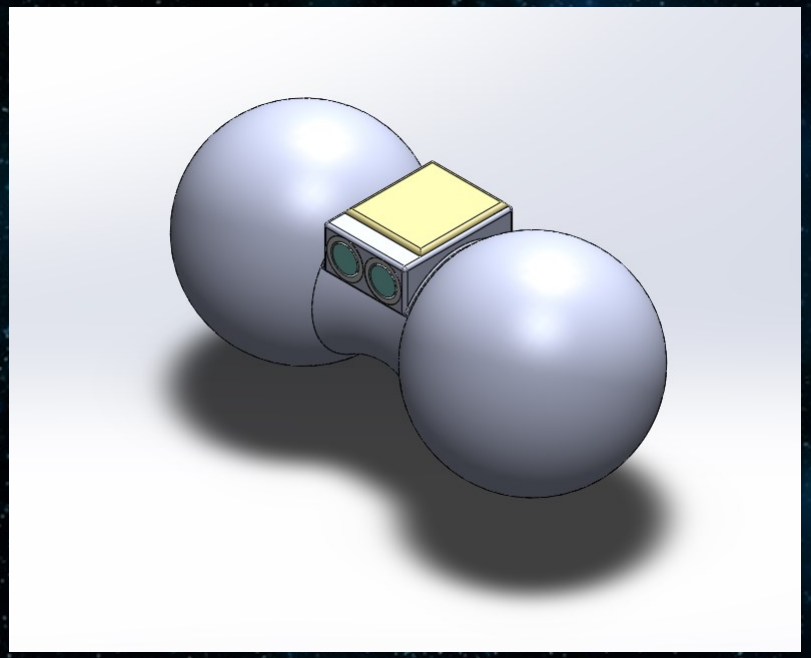


Figure 5 : Front and Back CAD Drawings of ComRover, respectively

Conceptual Sketch and Determination of Initial Parameters



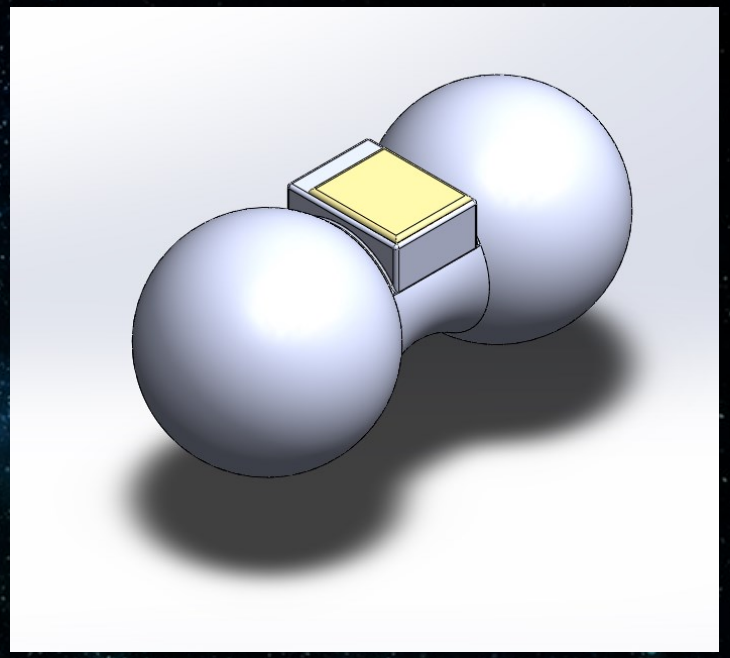


Figure 6 : Front and Back CAD Drawings of MagRover, SeisRover, and EnviRover, respectively

Conclusion

- ✓ A framework to explore feasible Rover configurations, subsystem interactions, and mission – level trade – offs

- ✓ Demonstrating a coherent path toward a viable exploration mission

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Thank you for your time.

Any Questions?