NASA HERA Moonscape and Robots Planning Phase v1.01

Title: NASA HERA Moonscape and Robots Planning Phase 1v0.1

Please create a requirements document being sent from the “NASA HERA” team to talk about their moonscape and Robotics project this requirements document should be in two or three major parts the first part would be the planning phase the second part would be a prototype stage being done by students and the third part would be an actual build of the project or a VR of the project.

Since this document is originating from the NASA HERA team that runs the 45-day simulation, please ensure references to the material and experiences of participants is included in this document to help set the stage for students to better understand the requirements for this project

The requirements document must be divided into multiple parts and should be 10 pages plus a signature page and a one-page executive summary. The first part will be a summary of the total project of about one page maximum. The second part should be the Planning stage, a summer activity to gather as much data and requirements as possible to inform students of the overall requirements. Detailed collection of information to set up the landscape this includes potential placement of 3D printed rocks excuse me other craters a lighting where the creases and the Bendy Parts have to go for the modal lunar landscape and then once those are derived then the actual physical structure that has to be developed including the weight support areas and other mechanical requirements. Note that this could be a virtual reality option as well, and also note that during the school year, the students will work on a Model that is 2 ft by 2 ft plus the height they need and have to scale the robots to smaller sizes. Specifications for the moonscape take into account that it needs to have the ability to be portable during one of the missions and easily set up and taken down, and the actual specifications for the landscape will have to be derived during the initial planning phase. This planning phase will produce a requirements document to be used by students in the second phase of this project.

The second phase will take place during the school year, where students will create a Prototype as a scaled model fitting on a surface of 2 ft square or a VR project with the realistic lunar landscape.

The 3rd phase will also take place during the school year, where Students will design Prototypes of at least 4 robots using Arduino-like robots for the project. Remember to revisit the specification from Phase 1 and reinforce the requirements to lift ½ pound 10 cm square ardusat and carry and unload these robots. Since these are operating in an 8th square lunar scape, the scale and dimensions of these robots.

The fourth phase will be the building to specifications of a portable lunar landscape, taking the best parts the student teams have created and preparing an 8th square lunar landscape model.

The final five is a testing phase that can take place after the next summer.

Additionally, in this requirement document, key dates have to be outlined, specifically the Mission dates and backing off the time to finish each project. Note that the Start date should be May 15, 2025, for the planning state, the requirement document needs to be completed by July 31, 2025, and a Project presentation needs to be completed and on the website by August 8, 2025.

This requirements document I should include the dimensions of the moonscape it should include a specific phase for up to four different robots and a place for the functionality of the robots as they operate on the moonscape the moon scape should be based on a crater South End of the Moon and the best version would be a crater within a crater on the South Side of the Moon the landscape also must be built in such a way that when the robots are driving on the lunar landscape they cannot see above to the outside world it's essential that with Hera they stay within character of each of their scenarios that means the Heranaughts cannot see any earth-based information. The dimensions of the lunar Escape should be 8 ft by 8 ft it should be made of material so that it could be folded up in convenient sizes so potentially 4 ft squares it needs to be easy to install or set up there must be space to put a lunar side view on all four sides that have to be at least 3 ft tall that will ensure that the robots cannot see above the lip of the moonscape but be aware when we are experimenting and testing with the robots we will have to view and may have to adjust this to be higher depending on how the cameras work on the robot artificial lighting for this moonscape may have to be placed so that there are no Shadows on the lunar landscape or Moonskape And if we have a night time option we will have to provide lighting on the robot as it moves around this 8 ft by 8 ft space.

A small note must be made to determine if the robots need to work in daytime and night time in addition the functionality of the robots must Encompass the following one they must be mobile and they must be able to carry a 10 cm by 10 cm by 10 cm Cube they also must have a robot that can place the cube on another robot so one will be a transportation robot one would be a movement robot and that implies that there's some sort of lifting mechanism or arm they can put the robot on the device or take it off and bring it somewhere else all robots must have a camera and we have the option of an infrared camera a traditional camera and there should be an option to actually store that data on an SD drive additionally all the robots must be remote control initially the thought is to use a Bluetooth Style to control it from inside of hair up and on my initial estimate was or is that they should be within a hundred meters of the hair module and they should be inside the building and having no worries about . A a note must be made that we should have to the robots that can carry an article and to the robots that can lift in place the artist which is 10 cm by 10 cm by 10 cm Cube and this is not a hard Dimension but close to that the best estimate would be that this way half a pound but no more than one pound that's too high

NASA HERA is a simulation in which participants will be enclosed in a simulated lunar capsule for up to 45 days. As part of this process, to stay in character with the scenario, we want to make sure that there are activities, including some stressors, that will allow the participants to

get a better feel for what it is like to live on the moon for 45 days. The scope of this project will also include the Preparation of information for Phase II.

One of the additions would be a lunar landscape that allows the participants to control robots and potentially place ArduSAT Cube or many on a lunar landscape. The HERANAUTS would retrieve the cubes or robots that are exploring on their behalf remotely while they're in their lodging and lab.

The objective of this phase of the project is to gather the requirements and potential requirements plus scenarios that the Hera facilitators may be interested in setting up for their participants in the simulation. This project will include the following major components.

1. Testing a single Arduino robot with a Bluetooth remote control and a camera.

2. Define the visual scope that the robots would have that ensures that the product will always remain within the scenario. Specifically, when the robots are moving around, they will not see the outside world. Questions we will have to ask include the impact of the Sun on the facility both from a scenario perspective and from a survivability in the human in the human elements or the outside elements of this project additionally are there concerns about lighting that may take them outside of the scenario and do they have to endure both day and night in a lunar landscape.

3. The initial scenario proposed is for all the robots to work inside a crater and that would be the physical limitations the actual size sounds like it could be 8 ft by 8 ft but actual dimensions must be considered also things like when a robot hits a rock or another small divot in within the crater or comes out of another smaller crater will the camera reflect higher and hit the earth's sky with a visual. Hence, this project has to include potentially a backdrop that will hide the Earth from the view of the HERANAUTS another aspect is once the dimensions and the overall scope of the sandbox has been defined then the cad drawings for the outer frame should be defined Any other requirements such as stones and rocks and positioning of pieces the takeoff zones or placement zones of the robot so that we know that it'll stay within that environment.

4. The final deliverable will be a comprehensive report and drawings of the external aspects. That would be given to the requesters and sent to NASA hunt students so they may work on phase two during the school year.

1. Executive Summary

The NASA HERA Moonscape and Robots project aims to enhance the realism and engagement of the Human Exploration Research Analog (HERA) program by incorporating a remotely operated robotic lunar exploration component. This project will develop an 8ft × 8ft portable lunar landscape model or a VR model with accompanying robotic systems that HERA participants (HERAnauts) can operate during their 45-day isolation missions. The project leverages NASA HUNCH program capabilities for development and implementation, ensuring educational value while meeting mission requirements. This may be an actual model or a VR Model.

This initiative will enhance the psychological fidelity of HERA missions by providing participants with realistic lunar exploration activities while maintaining mission protocols and communication delays.

2. Planning Stage

The planning stage is crucial as it establishes the foundational requirements for both the lunar landscape and robotic systems. The lunar landscape specifications detail the exact dimensions (8ft × 8ft) and construction requirements, including portability considerations and the need for visual barriers to maintain mission immersion. The robotic system requirements outline the need for four specialized robots with specific capabilities in transportation and manipulation, all controlled via Bluetooth within a 100-meter range. This phase ensures that all technical specifications, from camera systems to power requirements, are thoroughly defined before moving to implementation.

3. Project Overview

The project overview section establishes the fundamental framework for the entire initiative. Its purpose is to enhance HERA missions by providing participants with realistic lunar exploration activities that maintain their psychological immersion in the space environment. The scope encompasses not just the physical construction of the moonscape and robots but also the entire ecosystem of control systems, protocols, and integration requirements necessary for successful implementation.

4. Scope

The project encompasses:

- Development of an 8ft × 8ft portable lunar landscape
- Creation of four specialized robotic units
- Implementation of remote control systems
- Development of mission scenarios and testing procedures

1.3 Planning Timeline

- Planning Phase Start: May 15, 2025
- Requirements Document Completion: July 31, 2025
- Project Presentation Website Launch: August 8, 2025

5. Lunar Landscape Requirements

5.1 Physical Specifications

- Dimensions: 8ft × 8ft (2.44m × 2.44m)
- Height of Side Walls: Minimum 3ft (0.91m)
- Design Concept: Foldable into 4ft × 4ft sections for portability
- Surface Features: If possible, based on actual lunar south pole crater formations
- Lighting: Integrated system for both day and night operations

5.2 Environmental Features

- Crater-within-crater design based on South Pole region topology
- Integration of 3D printed rocks and surface features
- Scaled representation of actual lunar surface materials
- Visual barriers to prevent external world visibility
- Portable design for easy assembly/disassembly

5.3 Robotic System Requirements

5.3.1 General Specifications

- Quantity: 4 specialized robots
- Control System: Bluetooth-enabled remote control
- Operating Range: 100 meters from HERA module
- Camera Systems: Standard and infrared options with SD card storage
- Power Requirements: TBD during planning phase

5.3.2 Robot Types and Functions

1. Transportation Robot:
    - Payload capacity: 0.5-1.0 lb
    - Ability to carry 10cm³ cube
    - Mobile platform with stable base
2. Manipulation Robot:
    - Lifting mechanism/arm
    - Precision placement capabilities
    - Cube transfer functionality

3. Support Robots:

- Specialized functions TBD during planning
- Complementary capabilities to primary units

4. Communication and Control Systems

- Bluetooth control interface compatible with HERA systems
- Video feed storage and transmission capabilities
- Mission control monitoring interface
- Data logging and analysis capabilities

6. Goal for requirements of: Student Prototype Development (2025-2026 School Year)

6.1 Scaled Model Development

- 2ft × 2ft prototype landscape
- Scale factor: 1:4 of final design
- Integration with NASA HUNCH program guidelines
- Student team collaboration framework

6.2 Robot Prototype Development

- Arduino-based control systems
- Scaled robot designs
- Testing and validation protocols
- Documentation requirements

6.2 Outline Mission Scenario Testing

- Day/night operation verification
- Communication system validation
- Emergency procedure testing
- User interface evaluation

Approval and Signatures

See NASA HUNCH REQUEST FORM

Requirements Checklist

NASA HERA Lunar Landscape Data Collection Checklist

A. Lunar Surface Specifications

1. Crater Topography Documentation

- [ ] Identify specific South Pole crater to model (e.g., Shackleton Crater)
- [ ] Calculate scaling factor from actual 21km crater to 8ft space
- [ ] Document elevation changes and depth requirements
- [ ] Map out crater-within-crater features
- [ ] Identify key surface landmarks for navigation

2. Surface Material Analysis

- [ ] Document lunar regolith composition requirements
- [ ] List acceptable simulant materials for surface texture
- [ ] Record color variations needed for realistic appearance
- [ ] Identify materials for creating realistic rock formations
- [ ] Document surface reflectivity requirements

B. Physical Structure Requirements

1. Base Structure

- [ ] Measure exact dimensions (8ft × 8ft)
- [ ] Calculate load-bearing requirements for surface materials
- [ ] Document folding/portability requirements (4ft sections)
- [ ] Specify assembly/disassembly procedure requirements
- [ ] List structural support specifications

2. Visual Barrier System

- [ ] Document minimum barrier height (3ft)
- [ ] Select appropriate curtain material specifications
- [ ] List mounting system requirements

- [ ] Specify light-blocking capabilities
- [ ] Document installation/removal procedures

C. Lighting System Requirements

1. General Lighting

- [ ] Document LED specifications for day/night simulation
- [ ] Calculate power requirements for lighting system
- [ ] Map lighting placement for minimal shadows
- [ ] Specify control system requirements
- [ ] List backup lighting requirements

2. Special Effects

- [ ] Document shadow simulation requirements
- [ ] Specify lunar day/night cycle timing
- [ ] List emergency lighting requirements
- [ ] Document light intensity requirements
- [ ] Specify color temperature requirements

D. Robot Specifications

1. General Requirements for All Robots

- [ ] Document maximum dimensions for each robot
- [ ] Specify minimum separation distances between robots
- [ ] List camera system requirements
- [ ] Document Bluetooth range requirements (100m max)
- [ ] Specify battery life requirements

2. Individual Robot Requirements

Transport Robot #1

- [ ] Document payload capacity (0.5-1.0 lb)
- [ ] Specify ArduSat carrying mechanism
- [ ] List mobility requirements
- [ ] Document camera positioning
- [ ] Specify wheel system requirements

Manipulation Robot #2

- [ ] Document arm reach requirements
- [ ] Specify lifting mechanism capabilities
- [ ] List precision placement requirements
- [ ] Document sensor requirements
- [ ] Specify control system requirements

Support Robots #3 & #4

- [ ] Document specialized function requirements
- [ ] Specify auxiliary equipment needs
- [ ] List backup capability requirements
- [ ] Document communication requirements
- [ ] Specify sensor package requirements

E. ArduSat Integration

1. Physical Requirements

- [ ] Document exact dimensions (10cm cube)
- [ ] Specify weight requirements (0.5-1.0 lb)
- [ ] List handling procedures
- [ ] Document storage requirements
- [ ] Specify safety protocols

2. Operation Requirements

- [ ] Document loading/unloading procedures
- [ ] Specify transfer protocols between robots
- [ ] List emergency handling procedures
- [ ] Document maintenance requirements
- [ ] Specify testing protocols

F. Control Systems

1. Communication Requirements

- [ ] Document Bluetooth specifications
- [ ] List range testing procedures
- [ ] Specify interference prevention measures
- [ ] Document backup communication systems
- [ ] List security requirements

2. Data Collection

- [ ] Specify camera data storage requirements
    - Colour
    - Black and White
    - IR
- [ ] List sensor data collection needs
- [ ] Document data transmission protocols
- [ ] Specify data backup procedures
- [ ] List analysis requirements

G. Safety and Maintenance

1. Safety Requirements

- [ ] Document operational safety procedures
- [ ] List emergency shutdown protocols
- [ ] Specify maintenance schedules
- [ ] Document inspection requirements
- [ ] List safety equipment needs

2. Maintenance Procedures

- [ ] Document cleaning protocols
- [ ] Specify repair procedures
- [ ] List spare parts requirements
- [ ] Document calibration procedures
- [ ] Specify storage requirements

H. Constraints and Critical Requirements

- [ ] List of Constraints (Physical, Time, Functionality, etc.)
- [ ] Software
- [ ] Reliability
- [ ] Realism