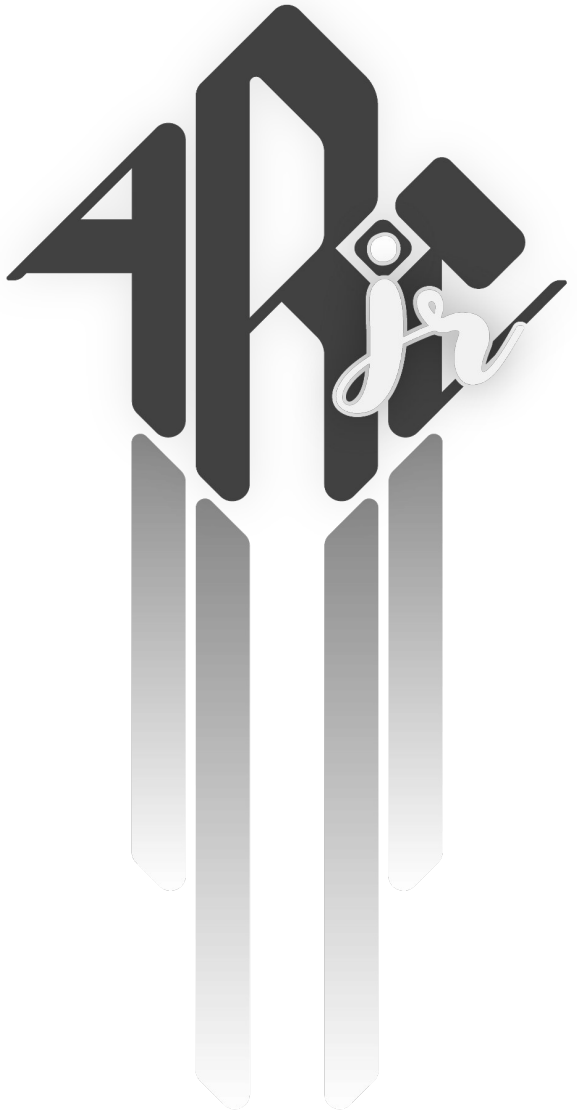

Anatolian Rover Challenge Junior

2025 Manual

Version Information

This file is the ARC Jr. Manual v.2 released on 25.01.2025.
For the planned updates, check **Calendar**.
Written by the ARC Jr. Committee. Digitally distributed.

Changelog

ARC Jr'25 Manual v.1 release date: 25.12.2024.
ARC Jr'25 Manual v.2 is the second released version of the ARC Jr'25

Information Channels and Contacts

The ARC website is the main source of information on the event.
Questions regarding the rules can be directed through the ARC website.

ARC Website: www.anatolianrover.space
ARC Jr. Mail Address: arcjunior@anatolianroverchallenge.com

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1. Introduction

The Space Exploration Society (UKET) is an association established by young space professionals who come together with the goals of contributing to space studies, carrying out practical training activities in this field, and being the planners and stakeholders of extraterrestrial exploration activities. The main goal of the association is to create opportunities that will unite the scientists, technocrats, students, and enthusiasts working in the space industry. Anatolian Rover Challenge Junior (ARC Jr.) is organized by the Space Exploration Society (UKET).

The Anatolian Rover Challenge Junior (ARC Jr.) is a competition for junior rovers open to participants of any nationality and age. Participants will send their application for their junior rover on the website to qualify. Finalist junior rovers will be chosen based on readiness and announced before the event. Junior rovers will complete various tasks during the finals, held on a challenge field created to simulate space exploration and investigation scenarios. Judges will score according to the ARC Jr. Manual, and prizes will be given according to the scoring. The ARC Jr. event provides an opportunity for individuals and teams to showcase their ability to solve complex engineering and scientific problems by designing, manufacturing, and equipping their vehicles.

2. General Information and Rules

Anatolian Rover Challenge Junior (ARC Jr.) 2025 will be held on 23-27 July 2025. The challenge is organized by the ARC Jr. Organizing Committee, which is a subcommittee of the Space Exploration Society (UKET) that was established to contribute to space studies in Türkiye.

2.1. Participation Conditions

1. Applications **must be submitted electronically** through the online application system on Apply ARC Jr I Anatolian Rover Challenge Junior.
2. Any changes to application information **must be** reported to the ARC Jr. Organizing Committee.
3. **No** age, nationality, or profession limitation exists on ARC Jr. competitions.
4. ARC Jr. competition welcomes participation both from **individuals** and **teams**.
    a. A participant may compete either as an individual or as a member of one team only. Participants are not allowed to represent more than one junior rover.
5. All underage participants **must deliver** a signed consent form from their legal guardian on the registration and orientation day. Otherwise, they **will not be permitted** to participate in the competition. Underage participants must be accompanied by an advisor with a higher educational background of legal age (21 or older) in the challenge field.

2.2. Application

An application must include the following:

1. A single video of the junior rover consists of the following:
    a. Introduction of the junior rover, robotic arm design and its capabilities, sub-walk system design, wheel design, etc.
    b. Illustration of the competition readiness, problem-solving approach to the tasks given on different challenges, the strategies planned for different challenges, etc.
    c. Status of the manufacturing, problems faced, foreseen solutions to those problems, etc.
    d. The video will be uploaded **online via YouTube**. The link to the video will be submitted to the application form. Make sure the video content is **publicly accessible.**
    e. The video length must be between **2–3 minutes.**
2. **Photos** taken from **5 different** perspectives of the junior rover.
    a. 1 isometric photo,
    b. 1 front-side photo,
    c. 1 right-side photo,
    d. 2 free-angle photographs
3. A photo of the participants/team **alongside** the junior rover.
4. Design & Cost Report
    a. A **design report** must detail your team's junior rover design. It should include a brief history of your team and provide a comprehensive overview of the rover design, covering all subsystems—mobility, electronics and power, manipulation, science payload, and ground station. Each subsystem should be described in terms of its

purpose, technical specifications, unique aspects, and adequacy for the competition missions. Visuals such as photos, diagrams, and 3D models must accompany the text to illustrate the systems. Teams are expected to provide thoughtful **insights** into their design choices, including their strengths, weaknesses, and inspirations. This report will serve as a crucial component in evaluating your team's readiness and innovative approach.

b. A **cost report** for the rover must be prepared, ensuring that the total expenses do not exceed **USD 1,000**. All information provided in the report must be supported by official documents and may be subject to verification on the challenge day. Submission of the financial report is **mandatory** for eligibility to participate in the final stage of the competition.
c. The cost & design report templates will be shared on further versions on ARC Jr. website.

2.3. Finalists

The finalist teams will be selected by the judges based on **competition readiness** presented in the reports, photos, and videos submitted by the teams. The finalists will be announced on the date specified in the calendar.

2.4. Junior Rover Design Requirements

1. A **Junior rover** is a small unmanned ground vehicle that is remotely controlled or autonomous. Wireless communication, including sound or radio waves, is allowed to control the rover, with the participant standing within a few meters of the rover and **maintaining visual contact** or using the **onboard camera.**
2. Junior rovers **must be designed** to withstand local weather and terrain conditions, including gravel, loose or hardened soil, and fine particle sand. The Organizing Committee is **not responsible** for any damage to hardware or software during the challenge.
3. The missions of the challenges are designed for rovers with maximum dimensions of **40cm x 40cm x 40cm.** For instance, the airlock of the lunar dome is a restriction for designs with a 40cm x 40cm rectangular cross-section.
4. **No weight limitations** apply.
5. The total cost of the rover systems cannot exceed USD 1,000. Check the Application section for the details.
6. Each rover will be given a **restart option,** when decided, the rover will be carried to the starting point and the timer will be **reset**. In case of use, the scores gained from the prior run will be **ignored**, and only the second run points will be **taken into account.** The restart option can be used on **each challenge once.**
7. The challenge will take place on a simulated lunar surface with loose soil and potentially cratered or sloped sections, approximately 9 meters **radius** circle, including a Lunar dome with 4 meters in diameter and a 1.5m rectangular Lunar greenhouse.
8. The ARC Jr. Organizing Committee **reserves** the right to change soil particle size and type. It is recommended that rovers be designed to perform the missions given in ground conditions such as gravel, either loose or hardened soil, and fine particle sand.

2.5. Organization Rules

1. All the junior rover participants present in the on-site challenge will be given a certificate of participation.
2. The scores from all three missions will be combined to create **a single ranking**, and rewards will be given on this **cumulative ranking**.
3. The Timetable showing the fielding time of the junior rover will be announced by the ARC Jr. Organizing Committee on the website after **online check-in.** The timetable may be subject to change at the discretion of the Organizing Committee.
4. Participants must **adhere** to the changes regarding the rules, calendar, or timetable published on the website.
5. Participants must **obey** the set timetable. The junior rover must take the field with a **maximum delay of** 5 minutes from the appointed time, otherwise, the rover is disqualified from that day's competition. Time limitations and timetable are **not** a matter of debate.
6. Watching the mission fields while other junior rovers are competing **will not be allowed.**
7. During the entire event, no rover
8. **damage or interfere** with other teams' systems. Any reports of such violations will be investigated independently by the judges or organizers, and any violation of this rule may result in the team's disqualification from the challenge. The ARC Jr. Organizing Committee will not be held responsible for any of the damage caused to teams' systems.
9. Causing any **damage** to the placed items or structures on the field **deducts 10%** of the mission score.
10. Participants are allowed to manipulate or touch the junior rover **only within the lunar dome**. Touching or manipulating the junior rover **outside the lunar dome** during the challenge is strictly **prohibited**. Any violation of this rule will result in a **30% deduction** from the challenge score.

2.6. Questions and Answers

A frequently updated Questions and Answers section is provided on the website. Teams are encouraged to ask questions through this section. The **FAQ** and **Q&A** sections override the ARC Jr. Manual.

2.7. Ethics

1. Any kind of **inappropriate behavior** will be noted by The Organizing Committee and related authorities will also be informed immediately if necessary. These behaviors can be summarized as follows;
   1.1. Insulting, swearing, threatening, etc. actions against other participants, people, or organizations through social media or in the challenge area during the challenge period.
   1.2. Provocation, disturbing other participants, being involved in fights, etc.
2. Language, religion, belief, political opinion, race, age, and gender discrimination will not be tolerated in the **challenge area**, as well as behaviors and practices that **may jeopardize equal opportunity**.

2.8. Calendar

An up-to-date calendar of the challenge and important dates are shown in the table below. The ARC Jr. Committee reserves the right to change the calendar.

Date	Event
22.12.2024	ARC Jr'25 Manual V1
25.01.2025	ARC Jr'25 Manual V2
25.02.2025	ARC Jr'25 Manual V3
25.02.2025	Start of ARC Jr'25 Applications
20.06.2025	Last Day for ARC Jr'25 Applications
01.07.2025	Announcement of Finalists
02.07.2025	Online Check-in Start
20.07.2025	Online Check-in Deadline
23.07.2025	Timetable Announcement
23.07.2025	Challenge Registrations and Orientation
24.07.2025	Lunar Cultivation Mission
25.07.2025	Autonomous Pathfinding Mission
26.07.2025	Lunar Drilling Mission
27.07.2025	Awards Ceremony

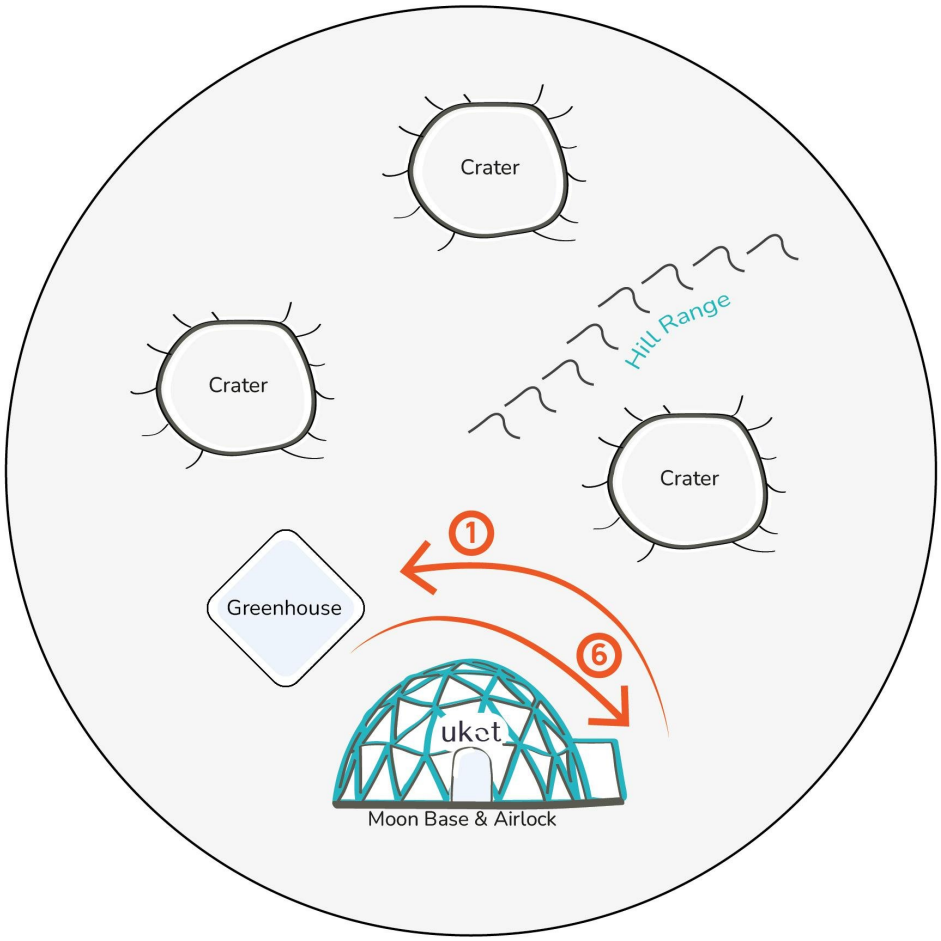
3. Missions

3.1. Lunar Cultivation Mission

Purpose: Junior rover must collect various measurements and strawberry samples from the greenhouse and deliver them safely to the scientific team.
Scenario: The journey toward sustainable space exploration begins with groundbreaking advancements in extraterrestrial agriculture. Scientists have successfully engineered a resilient strawberry DNA variant capable of thriving in the harsh conditions of space. To test its potential, a lunar greenhouse was established, simulating farming conditions on the Moon. Within this controlled environment, explorers collect strawberry samples, analyze critical parameters such as size, color, and structural integrity, and deliver them to the lunar base for detailed scientific study. This mission not only advances agricultural science but also lays the foundation for cultivating crops in space, a critical step in supporting long-term human habitation beyond Earth and ensuring the viability of extraterrestrial ecosystems.

3.1.1. Challenge Map

The Lunar Cultivation Mission map is shown below.



3.1.2. Phases

This mission consists of three phases.

3.1.2.1. Fieldwork

Time Limit: 10 minutes

1. The rover proceeds from the starting point to the greenhouse.
2. The rover reached/entered the greenhouse.
3. The rover conducts research inside the greenhouse. During this research:
    a. Measurements are conducted inside the greenhouse.
    b. Sensor measurements are collected from the greenhouse.
4. Photos of the greenhouse and strawberries are taken.
5. The rover collects a strawberry sample.
6. The rover returns to the base and delivers the collected samples to the astronaut scientists.

    Note: The restart option for this mission only applies for fieldwork.

3.1.2.2. Experiments

Time Limit: 10 minutes

1. Astronaut scientists conduct their experiments.
    a. Teams will be provided with kits required to isolate DNA from strawberries.
    b. Teams are also expected to research and apply their own experiments.
    c. The materials needed for the experiments to be conducted must be procured by the teams themselves.
    d. Teams may contact us via email for support regarding their planned experiments.

3.1.2.3. Presentation

Time Limit: 10 minutes

1. The captured photos should be explained, highlighting key observations and details.
2. The outcomes measured by various sensors should be discussed, supported by the provided data and analysis.
3. The experiment results and steps taken during the experimentation process should be presented.
4. Support your presentation by researching a mission-related article, such as agriculture in space.

3.1.2.4. Score Table

No	Parameter	Detailed Explanation	Score
1	Reach to greenhouse	Rover reaches to greenhouse	15
2	Conduct the measurements	Rover conducts the measurements inside the greenhouse	10/unique sensor reading (max 50)
3	Take photos of the strawberry and the greenhouse	The rover photographs the greenhouse and strawberries collected	10
4	Collect a strawberry sample	The rover collects a strawberry sample	25
5	Deliver the samples to the base	Rover safely delivers the samples to the base	20
6	Complete the experiments	Astronaut scientists conduct the DNA isolation experiment.	10
		Astronaut scientists conduct the experiment determined by the teams.	10
7.1	Complete the presentation	Discussion of the captured photos	5
7.2		Discussion of the measurements	10
7.3		Discussion of the experimental findings	10
7.4		Discussion of the mission-related article.	15
8	Design Bonus	Extra points will be given to rovers designed according to the task and have performed innovative solutions to the problems faced during the mission.	20
TOTAL			**200**

3.2. Autonomous Pathfinding Mission

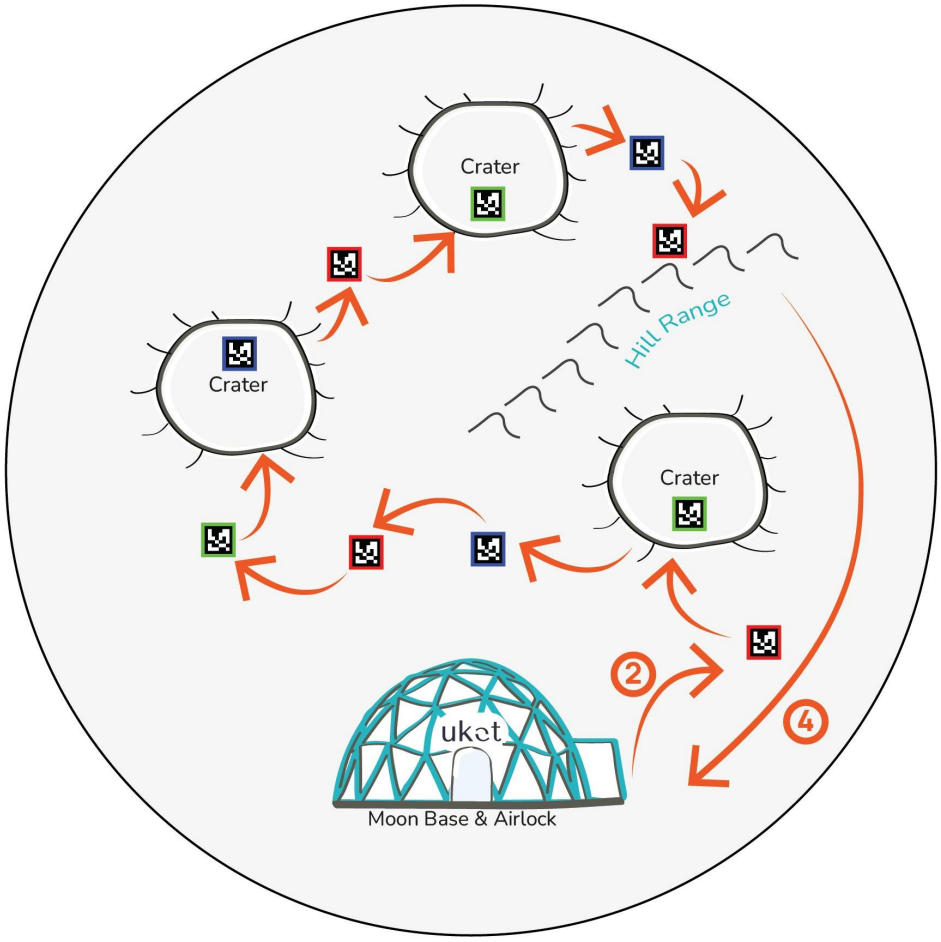
Time Limit: 15 minutes

Purpose: The mission aims to demonstrate precise autonomous navigation and identification of key locations using visual markers, essential for future lunar exploration and resource mapping.

Scenario: To further expand the potential for lunar agriculture, identifying optimal farming locations across the Moon's vast surface is essential. Scattered across the terrain are 10 key sites, each marked by unique beacons, representing promising zones for soil analysis. Explorers navigate these beacons autonomously, following a precise sequence to ensure efficient scouting and data collection. These sites are believed to harbor nutrient-rich regolith and water reserves, essential resources for establishing future greenhouses. This mission highlights the critical role of autonomous navigation and mapping technologies in exploring challenging terrains, advancing the search for sustainable agricultural zones, and unlocking the Moon's potential as a self-sustaining environment.

3.2.1. Challenge Map

The Autonomous Pathfinding Mission map is shown below.

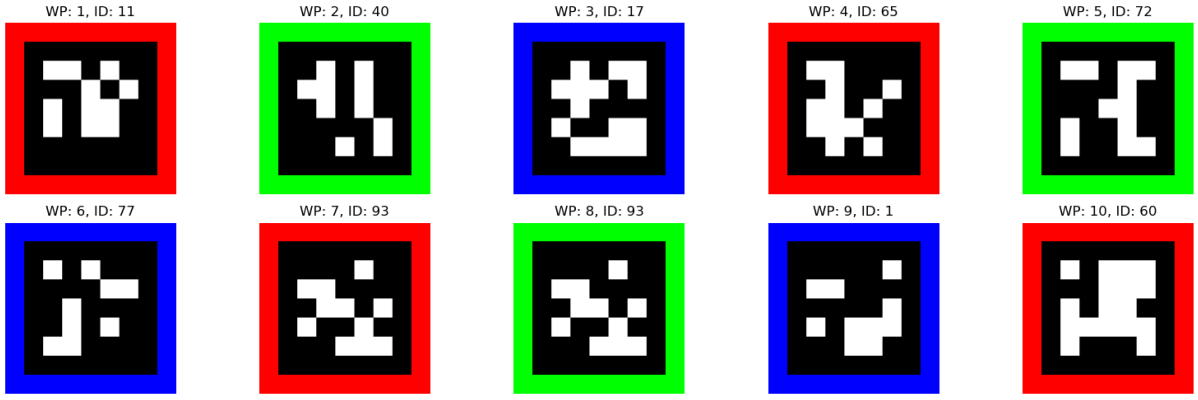


3.2.2. Tasks

1. The rover begins at the Moon Base and manually exits the lunar base to start **autonomous pathfinding** (autonomy is not required for this step).
2. The rover must have a functioning **indicator light** that shows the vehicle control mode during the challenge. The indicator light **must** work throughout the entire task, and its proper functionality is crucial. The indicator light colors must be;
    a. **Red:** Autonomous mode.
    b. **Yellow:** Detection mode.
    c. **Green:** Manual mode.
3. The rover will **autonomously** navigate through the given 10 **GPS locations** on the map and detect ArUco Tags. The **colored-sequenced rectangles** around the ArUco Tags will serve as **auxiliary information** to enhance detection and navigation. For further details, refer to the specifications of ArUco Tags.
    a. The rover must reach within a **50 cm perimeter** of each waypoint for it to count as reached.
    b. Upon reaching a waypoint:
        i. The rover **stops**, and the indicator light changes to **yellow** during the identification process.
        ii. The rover displays the detected **ArUco index** on its display screen, visible by the referees.
    c. Reaching and completing **the last waypoint** awards extra points to encourage full mission execution.
4. After visiting all waypoints, the rover autonomously **traverses back to the lunar dome**.
    a. **Extra points** are awarded to rovers that follow their **traversed path in reverse** during the return journey.

3.2.3. ArUco Tags

1. The ArUco Tags will be taken from the **5x5_100** predefined dictionary.
2. Each waypoint will be tagged with a **unique** arUco tag.
3. Each arUco tag will be in a **colored rectangle** of red, blue, green sequence.
4. Each arUco tag will be printed on cardboard with dimensions of **20x20cm**. And the height of the center of the arUco tag will be around **50 cm**.
5. An **example** waypoint/arUco sequence is shown below.



3.2.4. Score Table

No	Parameter	Detailed Explanation	Score
1	Exit the Moon Base	The rover navigates to the designated autonomous starting point	5
2	Indicator Light Penalty	If the indicator light is not turned on during the mission, the rover incurs a 10% penalty for the mission.	-10%
3.a	Traverse through the given waypoints.	The rover successfully reaches within a 50 cm radius of each waypoint on the field	5 / waypoint
3.b		The rover successfully identifies the ARTag at each waypoint, the indicator light turn yellow and the ARTag index is displayed, visible by the referees.	5 / waypoint
3.c		Reaching the last waypoint awards additional points.	25
4	Return Journey to Moon Base	The rover successfully returns to the Lunar Dome autonomously.	25
		The rover follows the same path in reverse during the return journey.	15
5	Save waypoint information	The rover saves waypoint / ArUco Tags sequence to local memory. Astronaut scientists hand the SD card to the referees at the end of the mission.	10
5	Design Bonus	Extra points will be given to rovers designed according to the task and have performed innovative solutions to the problems faced during the mission.	20
TOTAL			**200**

3.3. Lunar Drilling Mission

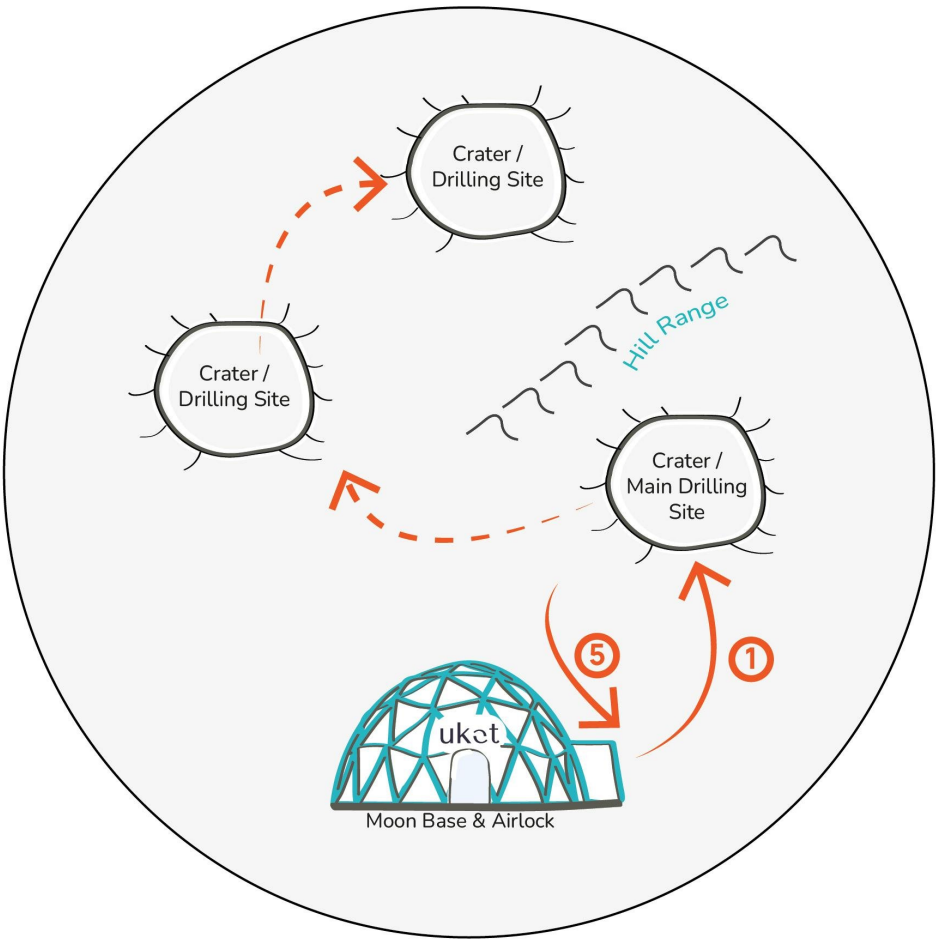
Time Limit: 20 minutes

Purpose: To collect scientific data on the sustainability and potential of lunar agriculture, particularly focusing on identifying water sources essential for sustaining agricultural activities.

Scenario: Once promising agricultural sites are identified, the focus shifts to a detailed examination of the Moon's subsurface. Advanced drilling mechanisms are deployed to excavate the lunar soil, uncovering layers that may contain nutrients or water deposits critical for farming. During these excavations, explorers capture high-resolution imagery and collect soil samples for analysis, seeking to understand the potential of these resources to support agriculture. By integrating insights from drilling with data from the greenhouse and navigation missions, this effort marks a crucial step toward transforming the Moon into a sustainable agricultural hub. These missions collectively demonstrate humanity's ability to innovate and adapt, ensuring the success of long-term space exploration and habitation.

3.3.1. Challenge Map

The Lunar Drilling Mission map is shown below.



3.3.2. Tasks

1. The rover navigates to the pre-designed drilling sites from the starting point.
2. Drilling and loose soil sample collection;
    a. The rover activates its onboard drilling mechanism and begins drilling within the boundaries of the site to a **5cm depth,** where different colored soil will be visible, and collects samples from the pile and places them in containers.
    b. The accumulated pile of excavated lunar soil is photographed and saved to a SD card to be handed to the referees at the end of the mission.
    c. The junior rover returns the samples to the lunar base.
3. The rover drills and collect samples and photographs from the drilling site. Additional drilling sites can be visited, earning extra points progressively based on the number of sites and samples.
4. The samples collected from different drilling sites must not be contaminated by each other. If contamination is not prevented, score deduction will be applied.
5. The rover should return to the base within a limited time with each sample and photographs.

3.3.3. Score Table

No	Parameter	Detailed Explanation	Score
1	Reach the drilling sites	The rover navigates to the designed drilling sites	10/site
2.a	Sample collection and photograph	The rover reaches the drilling site and collects soil sample from 5cm depth and stores them in a container. Minimum 10 grams of soil must be collected.	0.25/gr
2.b		The rover photographs the drilling site.	5/site
2.c		The rover returns the soil samples to the lunar base.	10/site
3	Prevent sample contamination	Samples from different sites must not be contaminated. If contamination occurs, points are deducted from contaminated sample points.	-20%
4	Visit other drilling sites	Scored gained from No 2 will be multiplied by the number of drilling sites visited.	1x, 2x, 3x
5	Complete the mission and return	The rover successfully completes all assigned tasks and safely returns to the base within the allocated time.	20
6	Design bonus	Extra points will be given to rovers designed according to the task and have performed innovative solutions to the problems faced during the mission.	50
TOTAL			**∞**