Mission Objective 5

ROV-ing Under the Moon

Summary

Humans aren't the only ones who will be working on the Moon--robotic rovers will be there before us and working alongside human crews. How will your rover assist the astronauts? Your team will design a lunar lava tube explorer that can autonomously navigate a lunar lava tube and take measurements along the way.

Materials Needed

- Lego SPIKE Robot or Lego Mindstorm Robot
- A compatible laptop or computer
- Foam board, cardboard, or card stock to make lava tubes
- A printed or homemade Artemis ROADS III Challenge Map
- (High school and middle school) Printable color blocks or a challenge map with a colored grid

Resources from Companion Course Lesson 5:

- Engage Section: An introduction to how nature inspires the design of NASA robots.
- Explore Section: Slides, activities, and worksheets to learn how to build and program their rover to drive a simple path.
- Elaborate Section: Slides and activities on how to use ultrasonic sensor help the robot make decisions.
- Extend Section: Slides on color mixing and the RGB scale and the Lego "Line Graph and More Sensors Extension."

Additional Resources:

- Description and options for printing a practice challenge map
- Printable color squares for challenge map
- Video guide: Lego SPIKE Quick Start
- Video guide: Decision Branching with the Ultrasonic Distance Sensor
- Video guide: Getting real-time data from your Lego SPIKE robot

Getting up to Speed

Lava tubes on the Moon and Mars formed billions of years ago when lava moved under the surface and then drained away, leaving empty lava tubes. Lava tubes might be useful for Artemis crews because they may contain resources like water and could provide natural protection from extreme temperatures, radiation, and micrometeorite impacts. NASA is supporting the development of lava tube exploration robots that can roll, walk, hop, and crawl through the challenging lava tube terrain. Many of these robots have features inspired by animals and insects on Earth. Can your team design a lava tube exploration rover inspired by nature?

To learn more about how NASA is preparing to explore lava tubes, caves, and skylights on the Moon, check out the resources in the Getting up to Speed with Artemis document.

Mission Guidance

In this mission, your team will design a rover to help astronauts explore lunar lava tubes. Because we don't know much about the lava tube your rover will explore, it needs to use ultrasonic sensors to find its way through the twists and turns. It will also use a color sensor to figure out the color of the lunar surface. The goal is to collect enough information to help astronauts make a map of the lava tube.

Before you start building your rover, download the software you need and get to know the robot, sensors, and how to program them. If you're new to robotics, you can find useful tips in the Explore section of Companion Course Lesson 5.

This year's challenge map is a 100 cm x 150 cm course with a 20 cm wide lava tube that your rover needs to navigate all by itself. The rover should use its distance sensors to find walls and open spaces. For example, if it runs into a wall, it should stop and look for an opening to the sides. When it finds an opening, it should turn and go through it. Remember, your rover must be programmed to move and make decisions on its own—no remote control allowed. The lava tube's layout will be a surprise during the final mission (check MO-8 for more details), and your rover should be ready to handle up to eight 90-degree turns as it moves through the tube.

High school and middle school teams should also use the rover's color sensor to measure the color of the surface. Use the "Line Graph and More Sensors" extension for LEGO robots to show and plot the red, green, and blue (RGB) light intensities. If your rover can't plot RGB data, you can use audio signals to share the color information.

Since you won't know exactly what the final lava tube will be like, test and improve your rover by creating practice courses with different turns and surface colors. Check the challenge map for ideas on building your practice tube. Good luck!"

Explore caves near you or in an area you are curious about. How has life adapted to live and move in those caves? Do you think any of these biological feature would be helpful to include in a robot designed to explore the same environments? Explain how your robot was inspired by creatures that sense and move in the darkness! See the Engage portion of the associated Companion Course lesson for more information about how NASA's robot are inspired by nature.

Deliverables

As they work, teams should keep track of their results in a science and engineering notebook. At the end of the challenge teams will be asked to submit a Mission Development Log (MDL) to NESSP to that shows how the students worked through the Mission Objective and summarizes their results. NESSP provides a Mission Development Log Template to help guide what teams should include in their MDL. Please see this document for guidelines on the format and length of the MDL.

Heads up! This MO is part of the team's final mission! If your team plans to attend a NESSP Expo event (MO-8a), you will launch your rocket at the event as described in MO-8a. If your team does NOT plan to attend a NESSP Expo event, you will submit a video of your rocket launching (maximum of 5 minutes) as described in MO-8b.

MO-5 What must be in your Mission Development Log (MDL)?

Every MDL must include:

- At least one example of how nature (sensing capabilities or the body of insects or animals) has inspired the design of a NASA rover or robot or a robot of the students own imagination or creation.
- A picture or drawing of the rover, labeling important components like the motors and sensors that allow the rover to correctly navigate the lava tube.
- Pictures of the teams practice lava tubes, corners, or map; that allowed them to correctly navigate their tube.
- An image of the team's Word Block or Python code or a flow chart diagram describing the logic of the code.
- A summary of the challenges the team faced and how the team overcame them.

High school and middle school MLD's must also include:

- A graph of the RGB color intensity measured by the rover as it navigated a lava tube.
- A map of the surface color of the lava tube constructed based on the RGB color intensity graph or data. Teams can use the Lava Tube Color Detection Worksheet to draw a map of their tunnel.