Programming

Rover Races

National Aeronautics and Space Administration

Programming with verbal commands | **Suggested Grades: 5-9**

Activity Overview

In this activity, students experience the processes involved in engineering a communication protocol. Students become the model rover, following communication protocol to the appointed destination. To reach their goals, students must create a calibrated solution within constraints and parameters of communicating with a rover on Mars. This activity continues to build students' understanding of engineering design in pursuit of scientific objectives through basic programming.

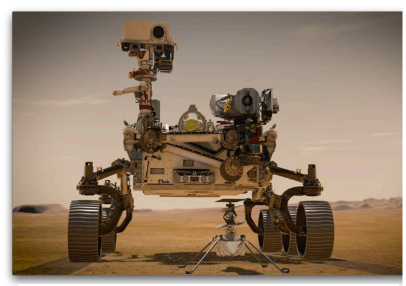
Steps

1. Create course with painters tape, rock samples and obstacles prior to beginning.
2. Introduce rovers on Mars and ask students which rovers they know (Curiosity, Opportunity, Spirit, Sojourner, Perseverance).
3. Watch the video at https://www.youtube.com/watch?v=Ki_Af_o9Q9s and ask how the scientists got the landing to be so precise. Edge the students into the answer "computer programming!" by asking, if the students could do that with a joystick. Human error is another clue that you can give students. Computers don't make mistakes.
4. Ask the teacher to divide students into groups of 6. Each group will be one rover team consisting of: 1 rover driver, 3 rover students, 1 timer, and 1 official. If there are an indivisible amount of students, each team can have less rover students.
5. The Rover Driver will walk through the course first, counting the number of steps and listing the turns needed to guide the rover through the course (e.g., 3 steps forward. Stop. 1 step left. Stop. etc.)
6. The balls on the course are rock samples that can be collected if the Rover Driver has included it in their directions. The command would be "Rock Retrieval Right" or "Rock Retrieval Left". At that command, the 3rd Rover Student bends down, still blindfolded, and picks up the ball and hands it to the middle Rover Student to carry.
7. Once the Rover Drivers have recorded their directions on the Command Sheet, the rover races can begin. The rover teams one at a time will line up at the starting line and run the course. Blindfold the 3 Rover Students to pre-vent the rovers from aiding the Rover Driver during the command execution. The 3 Rover Students represent the six wheels of the rover and are sequentially in a line (front to back). The blindfolded Rover Students have their hands placed on the student's shoulders in front of them for stability.
8. The Rover Students will proceed along the course by following the Rover Driver's verbal commands. The commands cannot be changed from the original commands that the Rover Driver wrote down. They must be followed exactly. During robotic missions, usually the commands are sent to the rover all at once.
9. The Timers will start their stopwatch as soon as the teacher says "start" and will time until their rover team crosses the finish line. Their time should then be recorded on the Official Record.
10. The Official will record any time either foot of the first Rover Student crosses out of the track or onto an obstacle as a foot fault. Every foot fault add +1 second to their rover's time. The Official will also record every rock sample that is collected and subtract -1 second from their rover's time for each collected sample.
11. Upon completion, relate it back to how NASA Mission Control has to control their rovers using computer programs just like these, but in "computer languages."

Time: 30-45 minutes

Materials:

- 3 blindfolds per team
- 2 clipboards and pencils per team
- One set of worksheets per team
- Objects to represent rock samples (small traffic cones work well)
- 1 stopwatch per team
- A long enclosed "track" made of painters tape with flat obstacles students will have to avoid and rock samples for them to pick up



Credit: NASA/JPL-Caltech

Background Information

Communication with Rovers

The NASA Deep Space Network (DSN) is an international network of antennas that provide the communication links between the scientists and engineers on Earth to the missions in space and on Mars. The DSN consists of three deep-space communications facilities placed approximately 120 degrees apart around the world: at Goldstone, in California's Mojave Desert; near Madrid, Spain; and near Canberra, Australia. This strategic placement permits constant observation of spacecraft as the Earth rotates on its own axis. The DSN antennas are extremely large: 34 meters (about 37 yards) and 70 meters (about 76 yards). These enormous antennas enable humans to reach out to spacecraft millions of miles away. The larger the antenna, the stronger the signal and greater the amount of information the antenna can send and receive. Each Mars Exploration Rover spacecraft carries multiple antennas used for different phases of the mission and allows it to communicate to multiple places and with other spacecraft at different speeds. The data rate direct-to-Earth varies from about 12,000 bits per second to 3,500 bits per second (roughly a third as fast as a standard home modem). The data rate to the orbiters is a constant 128,000 bits per second (4 times faster than a home modem). The rovers can only transmit direct-to-Earth for at most three hours a day due to power and thermal limitations, even though Earth may be in view much longer.

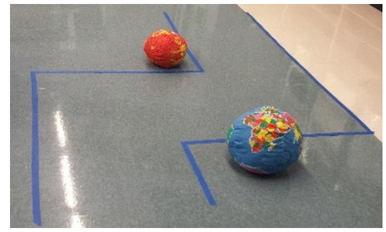
If you would like to learn more about communication with rovers, please visit the following website: https://mars.nasa.gov/msl/mission/communicationwithearth/

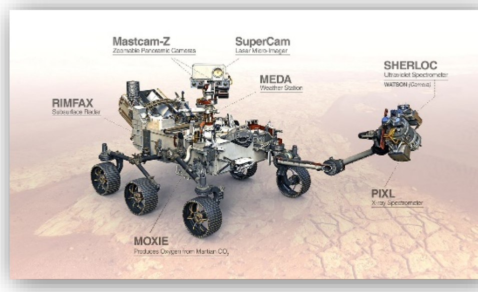
2020 Mission

The Mars 2020 mission is part of NASA's Mars Exploration Program, a long-term effort of robotic exploration of the Red Planet. The Mars 2020 mission addresses high-priority science goals for Mars exploration, including key questions about the potential for life on Mars. The mission takes the next step by not only seeking signs of habitable conditions on Mars in the ancient past, but also searching for signs of past microbial life itself. This mission includes both the Perseverance Rover and Ingenuity, the Mars helicopter. The Perseverance rover introduces a drill that can collect core samples of the most promising rocks and soils and set them aside in a "cache" on the surface of Mars. A future mission could potentially return these samples to Earth. That would help scientists study the samples in laboratories with special room-sized equipment that would be too large to take to Mars. The mission also provides opportunities to gather knowledge and demonstrate technologies that address the challenges of future human expeditions to Mars. These include testing a method for producing oxygen from the Martian atmosphere, identifying other resources (such as subsurface water), improving landing techniques, and characterizing weather, dust, and other potential environmental conditions that could affect future astronauts living and working on Mars. The mission launched on July 30, 2020, when Earth and Mars were in good positions relative to each other for landing on Mars. The mission landed successfully on February 18, 2021 in Jezero Crater on Mars.

If you would like to learn more about Perseverance check out: https://mars.nasa.gov/mars2020/

Example Rover Courses:





Suggested Lithograph: