Robotics: Creating a Roving Science Lab

Identify the problem

The Mars Science Laboratory rover, Curiosity, carries a tool it uses to study Martian rocks called the Chemistry and Camera instrument, or ChemCam. It works by firing a series of laser pulses at the target rock, exciting electrons and causing them to emit light that reveals their chemical composition. ChemCam then collects the light, directs it to a spectrometer and identifies the elements in the rock. It is able to image and determine the composition of rocks that are between one and seven meters away.

To simulate this analysis technique, you will program a rover to drive near a scientific target of interest and identify the nature of the target via a light and/or sound alert.

Criteria for success

For this challenge:

- You must program the rover to travel in a straight line while identifying colors
- You must program the robot to use the color sensor. The rover must identify all colors correctly with minimal pauses.
- The program and rover should turn at the boundary of the map.
- Measurement devices, like metric rulers, measuring tapes or meter sticks are not permitted.
- The rover will make three, parallel, random passes across the map.
- During specified hardware practice times, users may perform off-course test runs, calculate changes as needed and determine when turns are needed to navigate the official challenge.
- Another portion of time may be provided for software programming only.

Engineering constraints

- Once the challenge begins and the program has begun, users may not touch the rover without penalty until it finishes the third sweep.
- Color sensors are to be used for identification.

Points for this challenge will be as follows:

Rover drives continuously across the map in without retracing steps	4 points
Colored tape is correctly detected and identified	5 points for each instance
Colored tape detected without identification	2 points for each instance
Rover stays within map boundary	2 points

Colored tape is detected, but identified incorrectly	-1 point for each instance
Sweep lines not parallel	-3 points
Pause in motion during announcement of color	-2 points for each instance

Brainstorm possible solutions

Consider each of the criteria and constraints of the challenge. Every team member should draw upon their own background, prior knowledge, experience, and strengths to contribute throughout the challenge.

Select a design

Now, consider the programming needed to navigate the challenge successfully.

Build and program your rover

Once the programming has been identified, users should input the programming design and download it to their rover. Once the programming for the rover is complete, begin testing.

Test the rover and evaluate

Perform a test run with your rover. If the rover is not identifying colors correctly, check your programming. If the prototype is pausing for an extended time, consider what changes you might make to your programming and the logic flow of the program. If the rover is not travelling in straight lines, check your steering option and consider changing the control block.

Refine the program design

Record any changes to your designed program in writing, such as in a journal or notebook, and be sure to include why you decided to make the changes. Re-program your rover and prepare to complete the challenge for an official score.

Share the solution

Present your solutions to the class using photo or video evidence with supporting sketches and justifications for your programming design. You may use audio-visual equipment and technologies to enhance your presentation. Be sure to express how teamwork and the engineering design process played a role in your group's experience with this challenge. Use the reflection questions below to guide your presentation development.

Reflection Questions

About the engineering design process:

- What did you try that didn't work out? How many times did you try it?
- What did you do when things didn't work out like you expected?
- If given access to more parts or sensors, how would it change your design?
- If given more time, what would your next step look like?

About your thinking during the challenge:

- What obstacles did you or your group face in this challenge?
- How did you and/or your group confront these obstacles?
- What was your favorite part of designing, building and testing your robot?
- Did you observe any benefit to blueprinting your design first? Did you need to make any revisions to your blueprint after your first series of tests?