"Out of sight"
Remote Vehicle Activity

Goal:

- The students will learn about the challenges faced while trying to operate a planetary rover.
- To work within a mission team setting, working together to problem solve and accomplish a common goal.

Objective:

- To operate a robotic vehicle while it is not directly in view of the driver or operations team.

Time Frame: Two 45 minutes periods

Grade Levels: 5th - 9th (can be adapted for other grade levels)

National Science Education Standards:

Standard E: Abilities of technological design

National Math Education Standards:

NM.5-8.1 Problem Solving

NM.5-8.13 Measurement

National Technology Education Standards:

NT.K-12.5 Technology research tools

NT.K-12.6 Technology Problem-Solving and Decision-Making Tools

Items Needed:

- Remote control car for each 4 to 6 member team (borrow from students)
- Measuring devices (meter stick or tape measure - Can change units to yards) - 2 per team
- Rocks or other marking devices to- set up 'way points' in which to drive car
- Background information on planetary rover teleoperation
- Student calibration and mission planning sheets
- Stopwatches
- Compasses
- Popsicle sticks
- Pencils
- Masking tape for marking starting lines
- Calculators (optional)
- Video camera and monitor (optional)

Procedure:

1) Divide the class into teams of 4 to 6 students (smaller groups better if you have enough robotic vehicles).

2) Choose two designated drivers (test driver and calibration driver) for each team. The drivers need to be sequestered away from seeing the vehicle course being set up. (Note: Be aware of making sure that some of the drivers are female. Most likely, the people volunteering vehicles will be male. Maybe selecting male and female as a team of drivers would be the answer).

3) During the time away from the course, the calibration driver (with the test driver helping) will calibrate the remote vehicle as to:

- Distance traveled in 5 seconds (3 distance trials)
- Time needed to turn in 45˚ increments, a full 360˚
- Optional - Whatever other type of calibration test to get information you think might be important.
- The rest of the team (course calibrators) will work on setting up a symmetrical course that the vehicle will drive through (the same course design for each team - multiple courses could be set up all at once to speed up the team testing) using the rocks or other items to serve as waypoints (or targets) that each vehicle will try to navigate to.

4) Have the course calibrating team members measure the distance to each object and record the distance on the course sheet (make sure all the teams are following the same path so that the times and accuracy can be compared).

5) Have the course calibrating team measure the angle of turn needed to point the remote vehicle toward the next waypoint. (Note: The turns should be made in 45˚ intervals for easier measurement.)

6) Once the drivers and course calibrating team members have finished their tasks and recorded all necessary data, all the team members can merge their data sets to create a mission plan scenario. Neither driver should still be allowed to actually see the course that the remote vehicle will be driving. This is to be a "blind" test. The measured distance to each waypoint can be calculated with the speed and time necessary to achieve each waypoint destination. This should give the driving time necessary for the remote vehicle to travel to each waypoint destination. Time and coordinates should be given for each waypoint direction (i.e. 12 seconds straight; stop; left 45˚; 17 seconds straight; stop; right 90˚, etc.)

7) Once the data is calculated, the test driver will have the course calibration team members place the remote vehicle at the designated course starting line. The test driver (who is not in direct eye-contact with the vehicle) will drive the team vehicle according to the mission plan calculations taken from the calibration speed tests

and course measurements. A team member can read out the commands and another member can time the remote vehicle's travel.

8) The calibration team members watching the test will measure the resulting movement of the remote vehicle and record the actual distance traveled by the remote vehicle next to the pre-measured data.

9) After the actual driving results are compared with the precalculated results, determine the adjustments needed to drive the remote vehicle more accurately and repeat the test to see if the changes helped.

Rover Background:

These team operations are much like the real FIDO field tests that took place out in the Mojave Desert in the spring of 1999. The FIDO Rover was calibrated and tested in much the same manner, with the “drivers” operating out of a small mobile trailer, away from actually watching the rover drive during the field testing. High school students from around the country (LAPIS Team Members) drove the rover via the Internet. While these tests were taking place, there were scientists, engineers, and students in the field to measure the actual results of the commands for the rover to move. In doing so, the rover software and responses to the commands could be tested while still here on Earth to see if they were indeed accurate. That way, when the commands are given to the Athena Rover (FIDO is the Earth test rover for the Athena Rover) on Mars, the scientists and engineers can have a better idea of what movement they might expect.

Evaluation:

The students can work in teams or individually. Assessment can be based on completion of student work sheets and team participation.

Team Name:

"Out of Sight" Student Worksheet

Calibration Tests:

Using a stopwatch and measuring tool, record the time or distance of the remote vehicle during the following tests. Make sure that all measurements are taken the same way each time and from the same starting place to insure they are accurate. Mark the starting place with a piece of masking tape.

Calibration Test	Distance or Time
How far did the remote vehicle travel in 5 seconds?	Distance trial # 1= meters
How far did the remote vehicle travel in 5 seconds?	Distance trial # 2= meters
How far did the remote vehicle travel in 5 seconds?	Distance trial # 3= meters
Add the three distances together and divide by 3 (the number of distance trials) to get the average distance the remote vehicle traveled in 5 seconds =	meters
Divide the average distance (answer in box above) by 5 seconds to get the distance per second =	meters/seconds
Time needed to turn 45˚ = Time needed to turn 90˚ =	seconds seconds
Time needed to turn 135˚ = Time needed to turn 180˚ =	seconds seconds
Time needed to turn 225˚ = Time needed to turn 270˚ =	seconds seconds
Time needed to turn 315˚ = Time needed to turn 360˚ =	seconds seconds
Time needed to come to a full stop =	seconds
Other remote vehicle test data: What else do you want to know? Invent your own test. My test is:	

Team name:

Student name:

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Mission Planning Sheet

<u>Directions</u>:

Using your data from the remote vehicle calibration tests and the measurements made by the calibration team, design a mission plan that will get your remote vehicle to each of the targets (waypoints) on the driving course. Use the average speed (meter/second) and the measured course distances (meters) to plan how long your rover will run in each direction to reach each waypoint. Also figure out how many degrees the rover must turn (how many seconds it takes to turn the right distance from the calibration tests) to go to the next waypoint. List your moves on this sheet.

<u>Remote Vehicle Mission Plan</u>

1) Distance to waypoint #1 = _______________meters
   Remote vehicle time to waypoint #1 =__________________seconds

2) Turn_______________degrees for next waypoint
   Remote vehicle time to turn______________degrees = ________________seconds

3) Distance to waypoint #2 =________________meters
   Remote vehicle time to waypoint #2 =__________________seconds

4) Turn_______________degrees for next waypoint
   Remote vehicle time to tum______________degrees =_________________seconds

5) Distance to waypoint #3 = _______________meters
   Remote vehicle time to waypoint #3 =__________________seconds

6) Turn_______________degrees for next waypoint
   Remote vehicle time to turn______________degrees = ________________seconds

7) Distance to waypoint #4 = _______________meters
   Remote vehicle time to waypoint #4 =__________________seconds

8) Turn_______________degrees for next waypoint
   Remote vehicle time to turn______________degrees = ________________seconds

9) Distance to waypoint #5 = _______________meters
   Remote vehicle time to waypoint #5 =__________________seconds

10) Turn_______________degrees for next waypoint
    Remote vehicle time to turn______________degrees = ________________seconds

11) Distance to waypoint #6 = _______________meters
    Remote vehicle time to waypoint #6 =__________________seconds

Team Name:

Student Name:

Student Course Calibration and Actual Results of Remote Vehicle Tests

Directions: Fill in the chart with the data your team collected:

1. Record the waypoint measurements taken along the course before the remote vehicle driving test;
2. Record the actual data collected as the remote vehicle runs the course. Were there any differences between the two measurements? If so, record the difference (in feet, inches, meters, or centimeters) in the "Difference in Results" box.

Actual Measurements to Waypoints	Actual Distance Traveled by Remote Vehicle	Difference in Results
Waypoint #1 measurement		
Waypoint #2 measurement		
Waypoint #3 measurement		
Waypoint #4 measurement		
Waypoint #5 measurement		
Waypoint #6 measurement		

Name:

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Student Questions

<u>Directions</u>: Answer the questions using the results from you remote vehicle test.

1) Did your actual test results differ from the calculated distance results?
If so, how and why?

2) What were the differences in operating the remote vehicle this way (not being able to see the course that the vehicle would have to drive on) versus just driving the remote vehicle the regular way?

3. What changes could you have made that would have given you better results?

4. What do you think would be the hardest challenge about driving a remote vehicle on another planet?

Mars Rover Websites

The Athena Rover Homepage
Mars Sample Return Mission:
http://athena.cornell.edu

LAPIS Student Rover Mission
FIDO Rover
http://wufs.wustl.edu/teamlapis

Mars Pathfinder Mission
Sojourner Truth Rover
http://mpfwww.jpl.nasa.gov/MPF/mpf/rover-ops.html