Lesson 4: Remote Sensing Mars

Summary
This learning module and related laboratory exercise exposes students to remote sensing techniques utilized on Mars.

Learning Goals

Students will be able to:

- Apply the concepts of scale and context in remote sensing imagery.
- View THEMIS and HiRISE images and interpret major geomorphic features using Google Mars and associated homework activities.
- Understand how MOLA generates its image data by applying the fundamental equations in an experiment.

Context for Use

This learning module is meant for adaptation in an introductory earth science course and/or planetary science course. It is advised that the teacher compare Earth-based remote sensing instrumentation for context/reference such as LandSat 7.

Description and Teaching Materials

In-Class Activity

In-Class Activity 1: Scale and Context
In-Class Activity 2: MOLA simulation

Homework/Lab

Homework 1: Google Mars-Following Opportunity
Homework 2: Mars Image Analysis

Teaching Notes and Tips

1. The *In-Class Activities* can be utilized as homework as well. Students will have a lab-write up associated with the *MOLA simulation*.
2. For a large class size >20 you may either have a separate lab time/class for different sections or demonstrate the lab with the entire class and employ student participation.
3. We advise instructors to compare Earth-based remote sensing packages such as Landsat 7 for context.
4. In preparation for the MOLA simulation *In-Class Activity* instructors must gather a few materials (see the *MOLA simulation* for further clarification).

Assessment

- The *MOLA simulation* Lab write-up will assess the student's understanding of the MOLA instrument and MOLA's utility.
- The *Google Mars* homework will assess whether or not students can successfully navigate the Google Mars software and begin to interpret the data provided by Google Mars.

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References and Resources

1. THEMIS images url: http://themis.asu.edu/
2. LANDSAT 7 images url: http://landsat.gsfc.nasa.gov/images/
3. HiRISE 13 April 2011 YouTube video: http://www.youtube.com/watch?v=-U6-uYDtuSg
4. MRO/HiRISE All HiClips revisited (Feb 2012) YouTube Video: http://www.youtube.com/watch?v=YVDUQjJbjyc
5. MOLA images url: http://mola.gsfc.nasa.gov/index.html
6. Ping-Pong Lab (NASA): http://mola.gsfc.nasa.gov/pingpong.html

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In-Class Activity 2

Remote Sensing_ REVISED (*Note: This is a shorter version of the previous activity. Instructors may choose either version depending on time constraints.)

*MOLA Simulation**

Since we ran out of time, we're simplifying the ping pong exercise to just 3 "topographies"- 1) a base datum (floor), 2) a medium level, and 3) the highest level.

For each topography level, the students should have had several timings to ensure that they have a consistent value. Just report the averages here. Transfer data in shade boxes to Data Table III for another group to calculate.

Data Table I (D1 Baseline , datum),

Level	Distance Ball Traveled	Ave. Time (Seconds)	Velocity (distance/time)
Base			

Data Table II

Level	Time Average (secs)	Calculated Distance Ball (cms) Traveled = (velocity*average time)	Your known measured height of placed block topography (cm) (keep as your "answer")
2- med			
3- high			

-------------------------------- *tear here to give Table III to blind student group* --------------------------------

Transfer the data shown by the shade areas so they can make the calculations.

Data Table III (share with other "blind" student group)

Group _______

Give the {D1} Ave Vel. =

*R Interval	Time Average (secs) of "topographies"	Original Distance Ball Traveled (Baseline From Data Table I) {D1}	Distance Ball Traveled = (velocity*average time) (cm) {D2}	Calculated Altitude (cm) {D1-D2=Altitude}
2- med				
3- high				

After students calculate the altitude of the "unknown" topography heights 2 & 3, **check their calculated altitude answers with their measured known values the group had actually measured (their far right column of Table II)**.

If the calculated doesn't match the measured values, explain why the results might be so different:

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Part 4

The Laser Rangefinder aboard NEAR sends out a laser beam and "catches" it as it returns from being reflected by the surface of 433 Eros. The instrument records how long it takes the beam to reach the surface and bounce back. The scientists know how *fast* the beam is traveling; therefore, they can calculate how *far* it traveled. By measuring this time and multiplying by the velocity of the beam, they calculate how far the laser has traveled. They must then divide the distance the beam traveled in half.

1. Ask the students why they did not divide in half to find the distance to the object in *their* topography model.

Next, the scientist must compare this distance to a "baseline" distance we will call zero. On Earth, we might use sea level as the baseline. Another way to set the baselines is to start at the center of the planetary body being studied and draw a perfect circle as close to the surface of the body as possible. Using this baseline, the altitude compared to zero can be calculated and graphed. (Here on Earth, we often say that some point is a certain number of feet above or below sea level).

1. Why do we not use the term "sea level" for Mars and other planets?

2. The students will now calculate the altitude of the points along their model. To do this subtract the distance the ball traveled at each interval (from Data Table II) from the distance the ball traveled in Step 1 (column B, Data Table I). The number students come up with will be zero or greater. Use Data Table III to do the calculations. The number in column B in this table should be the same for every interval. Remember, it is the baseline altitude and does not change.

*This exercise was adapted from Goddard Space Flight Center:
http://mola.gsfc.nasa.gov/pingpong.html