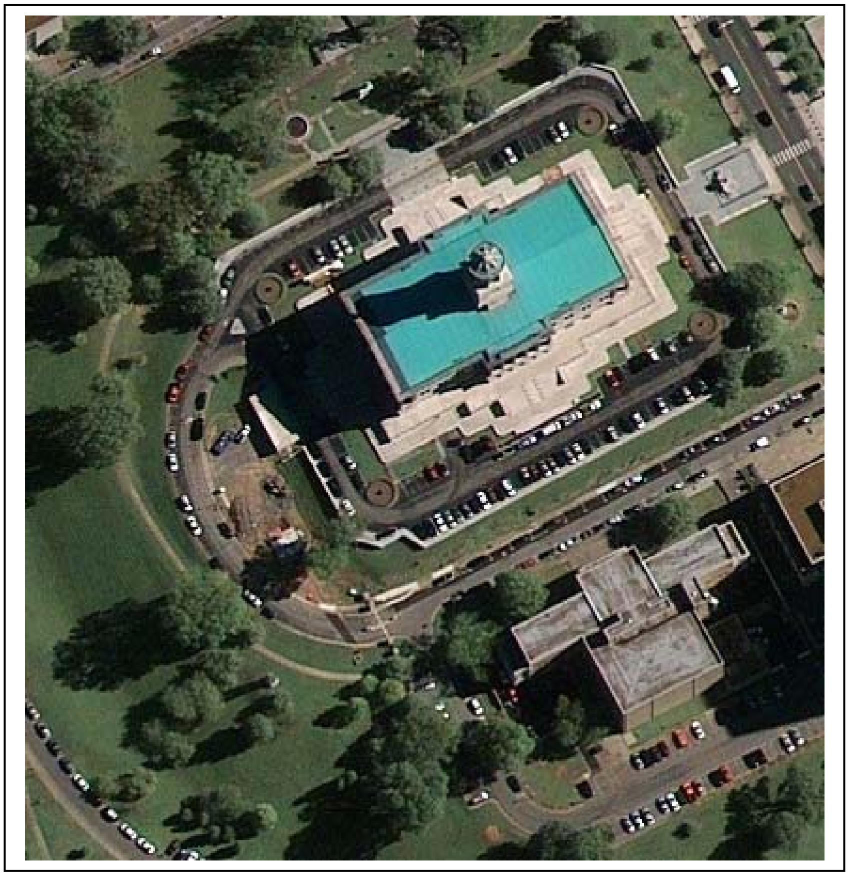
A High-Resolution Satellite Photo

The Lunar Reconnaissance Orbiter (LRO) will take photographs of the lunar surface at a resolution of 0.5 meters per pixel. The 425x425 pixel image below (Copyright © 2009 GeoEye) was taken of the Tennessee Court House from the GeoEye-1 satellite with a width of about 212 meters.



Problem 1 - What is the scale of the image in: A) meters per millimeter? B) meters per pixel?

Problem 2 - How does the resolution of the expected LRO images compare with the resolution of the above satellite photo?

Problem 3 - What are the smallest features you can easily identify in the above photo?

Problem 4 - From the length of the shadows, what would you estimate as the elevation of the sun above the horizon?

Answer Key

Problem 1 - What is the scale of the image in: A) meters per millimeter? B) meters per pixel? Answer: A millimeter ruler would indicate a width of 105 millimeters, so the scale is A) 212 meters/105 mm = 2 meters/millimeter and B) 212 meters/425 pixels = 0.5 meters/pixel.

Problem 2 - How does the resolution of the expected LRO images compare with the resolution of the above satellite photo? Answer: The resolutions are identical and both equal to 0.5 meters/pixel, so we should be able to see about the same kinds of details at the lunar surface with LRO.

Problem 3 - What are the smallest features you can easily identify in the above photo?
Answer: With a millimeter ruler you can determine that the smallest features are comfortably about 0.5 millimeters across or 1 meter. Examples would include the parked cars, the widths of the various footpaths, and the lane and street markings stripes. Some of the smaller spots may be the shadows of people!

Problem 4 - From the length of the shadows, what would you estimate as the elevation of the sun above the horizon?

Answer: This is a challenging problem for students because they first need to estimate what the height of the object is that is casting the shadow. From this they can construct a triangle and determine the sun angle, or use trigonometry.

For example, suppose that the large tree in the lower left corner of the picture has a height of 50-feet (17 meters). We can measure the shadow length with a millimeter ruler to get 20 millimeters or 20 mm x 2 M/mm = 40 meters. Then tan(theta) = 17 meters/40 eters = 0.45, and so theta = 24 degrees above the horizon.

This problem shows students one of the problems encountered when studying photos like this. We can easily measure the widths of objects, but measuring their heights can be challenging, especially when the objects in question are unfamiliar.