EE/Ae 157a
Homework #2
Due Date: Wednesday October 30, 2019
Bring to class or place in the mailbox in Moore Building

Problem 1 (20 points)

A telescope is orbiting the earth at 705 km altitude. The telescope lens diameter is 40 cm, the focal length is 120 cm, and the square focal plane is 20.916 cm on a side. The solar power density at the surface of the earth is 1.37 kW/m^2. Ignore losses in the atmosphere.

(a) Calculate the power density at the lens if the earth albedo is 50%. Calculate this power density per unit area in the scene, *i.e.* assume that we collect the reflected power from a 1m x 1m area in the scene.

(b) Calculate the total *energy* intercepted from a 30m x 30m ground pixel if the shutter stays open for 0.1 millisecond. (Hint: Energy is power x integration time)

(c) Calculate the field-of-view and the swath width of the telescope.

(d) If the instrument is a framing camera, calculate the number of detectors required to acquire a square image with each side as large as the swath width filled with 30m x 30m pixels on the ground. Also, calculate the integration time if we assume that we use a scanning mirror to stare at the same area with a 75% duty cycle. This means we integrate the signals for 75% of the time it takes the projection of the focal plane on the ground to move the distance equal to the total size of the image in the along-track dimension.

(e) In the pushbroom configuration with a single line of detectors, calculate the number of detectors required for a pixel size of 30m x 30m on the ground to cover the entire swath. Also calculate the integration time and total energy per pixel assuming that image smearing is to be minimized by limiting the integration time to 1/3 of the total possible integration time for a pixel.

(f) For a scanning mirror system (wiskbroom configuration), calculate the mirror scan rate, the integration time per pixel, and the total energy intercepted from each pixel assuming that we use an array of 16 detectors arranged in the along-track direction.

(g) Now assume that we place a filter in the focal plane with a 1% transmission bandwidth centered at 0.5 microns, i.e. only 1% of the incoming energy passes through the filter. Calculate the number of photons received from a pixel for each of the three cases above.

(h) Calculate the data rate in bits/second for each of the three cases, assuming we digitize the data from each pixel to 8 bits.