Geog 115A

Lab 3: Photogrammetry

Section: M 9AM **Name: Ian Hinds**

Homework Assignment/Answer Sheet (31 points)

What to turn in:

- This answer sheet!

In this lab, we will work with an aerial photograph (600301977) that was obtained **on September 29, 2007**. For all measurements, you can **assume that the flight line is the upper border of the image and the principal point is the upper right hand corner** (in reality, it is slightly off the page, but for practical purposes, the provided measurements are based off of that point). The measurements provided were taken using a print and digital version of the provided image.

1. Using provided measurements, you will define the scale of the aerial photograph. Measurements of 2 features on UCSB campus taken from the digital and printed photos are provided. Each feature has multiple measurements made by different people. The first feature will be the east wall of North Hall (look at the campus map if you can't locate North Hall). The printed photo was measured in millimeters using a standard ruler and the digital photo was measured using software. Because the digital photo was already georectified, the digital measurements are real-size values given in meters. Calculate and report the scales you find for each feature as both *verbal and representative*.

The provided .tif image is the digital georectified photo with annotations to reference the provided measurements. You will only use the image for visual reference in this lab. The green annotations are for question 1 and the red annotations are for question 3.

(10 points)

Set 1 measurements:

Feature 1: East Wall of North Hall

Length on photo print [mm]: 14 mm

Length on digital photo [m]: 72.56 m

Verbal scale: **1 cm = 51.83 m**

Representative scale: **1:5183**

Feature 2: West Wall of Bren Hall

Length on photo print [mm]: 12 mm

Length on digital photo [m]: 58.22 m

Verbal scale: **1 cm = 48.51 m**

Representative scale**: 1:4851**

Average Set 1 scale = Verbal: 1 cm = 50.17 m **Representative: 1:5017**

Set 2 measurements:

Feature 1: East Wall of North Hall

Length on photo print [mm]: 15 mm

Length on digital photo [m]: 72.24 m

Verbal scale: **1 cm = 48.16 m**

Representative scale: **1:4816**

Feature 2: West Wall of Bren Hall

Length on photo print [mm]: 10 mm

Length on digital photo [m]: 58.47 m

Verbal scale: **1 cm = 58.47 m**

Representative scale: **1:5847**

Average Set 2 scale = Verbal: 1 cm = 53.31 m **Representative: 1:5331**

Compare the scales calculated using the given measurements from the given analog and digital photo lengths. How different is the result? Based on the difference, how much does the accuracy of your photo measurements affect your estimate of the actual size of the building in the real world (explain as a percentage of the real-world size)?

Avg Scale: 1:5174; Hand measurement: 10mm (West Wall of Bren); Real Size = 51.74m vs. 58.47m (original)

Percent error of observed scale and true measurements: ((58.47 – 51.74) / (58.47)) * 100 = 11.51 % difference from real-world size

One way to assess the accuracy of your scale is to look for features that have a standard size and determine the scale using measurements from that feature. Please list some specific features near or around UCSB campus that could help you assess the accuracy of your scale.

Parking spaces (avg width is 9ft) - Olympic Swimming Pool (50m in length) - Soccer Stadium field (100yds)

2. Now that you have calculated the average scale of the photo print using the universal method, use the **aerial photo-based method** to calculate the focal length (in mm) of the camera that was used to make the photograph. Assume that the above ground level (AGL) altitude for this photograph is 2300 ft. (hint: there are 3.28 feet in a meter). Show your work! ***(2 points)***

2300ft = 701.22 m

f = Scale * H ***f = (1/5174) * 7012.2 cm = 1.36 cm***

The UCSB campus covers relatively flat terrain (there are no large mountains in the middle of campus) but the much more rugged Santa Ynez mountain range is located just to the north of UCSB campus. Based on what you know about making photo measurements, what would be the challenges for making accurate measurements from aerial photos over this type of mountainous terrain? ***(2 points)***

Including elevation displacement and considering differences in scale make varying terrain photos challenging to accurately measure.

3. Using both the Displacement and Shadow Length Methods, calculate the height of the two buildings given the corresponding lengths and distances**. For the displacement method, assume that the image resolution corresponds to a camera elevation of 8000 ft. AGL.**

For the **shadow method**, use this handy website http://www.esrl.noaa.gov/gmd/grad/solcalc/ to calculate the solar angle of the sun and specify your parameters below. Click on Los Angeles and then drag the pin to our location at UCSB, then enter other important inputs. **Assume that it is 3:00 p.m., local time on the date the image was captured, and solar elevation angle is designated as El (in º) on the website and will be less than 90º.**

Shadow Method Inputs: ***(3 points)***

Latitude: **34.407** Longitude: **-119.847**

Time Zone: **America/Los Angeles** Daylight savings (y/n): **N**

Shadow Method Output:

Altitude Angle ("solar elevation angle") in degrees: **19.36º**

Be sure to double check your altitude angle before continuing on with the lab!

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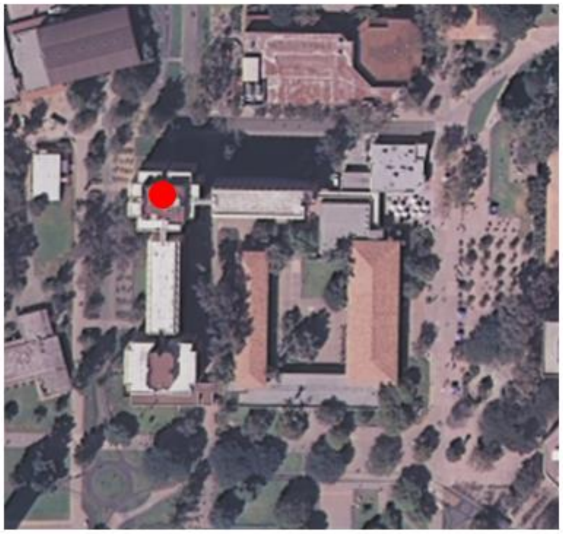
Use the building designated with a red dot for measurements. Note the units for displacement (mm) and shadow (m) methods. *The Red Dot is there to help you identify the part of the structure to be measured. It does NOT indicate the point from which you should be measuring the displacement length.*

South Hall ***(5 points)***



Displacement length (mm):__1 mm____________________

Radial distance from Principal Point (PP) (mm): _132 mm______

Height measured by the displacement method:

8000ft = 2349.02 m

H = (Ha * D) / R = (2,349,020 mm * 1mm) / (132mm) = 17.795 m

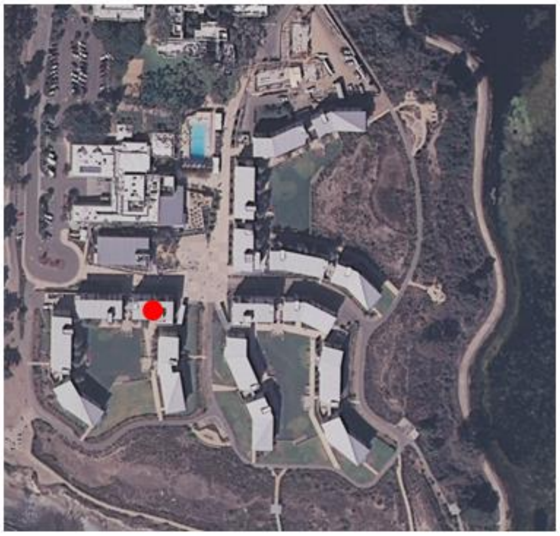
Length of shadow (m): ___22.5 m__________________________

Height measured by the shadow method:

H = L * tan(θ) = 22.5 m * tan(19.36º) = 7.905m

Manzanita Village

(5 points)



Displacement length (mm):___1 mm____________________

Radial distance from Principal Point (PP) (mm): _261 mm_____

Height measured by the displacement method:

H = (Ha * D)/R = (2,349,020 mm * 1mm) / (261mm) = 9.0 m

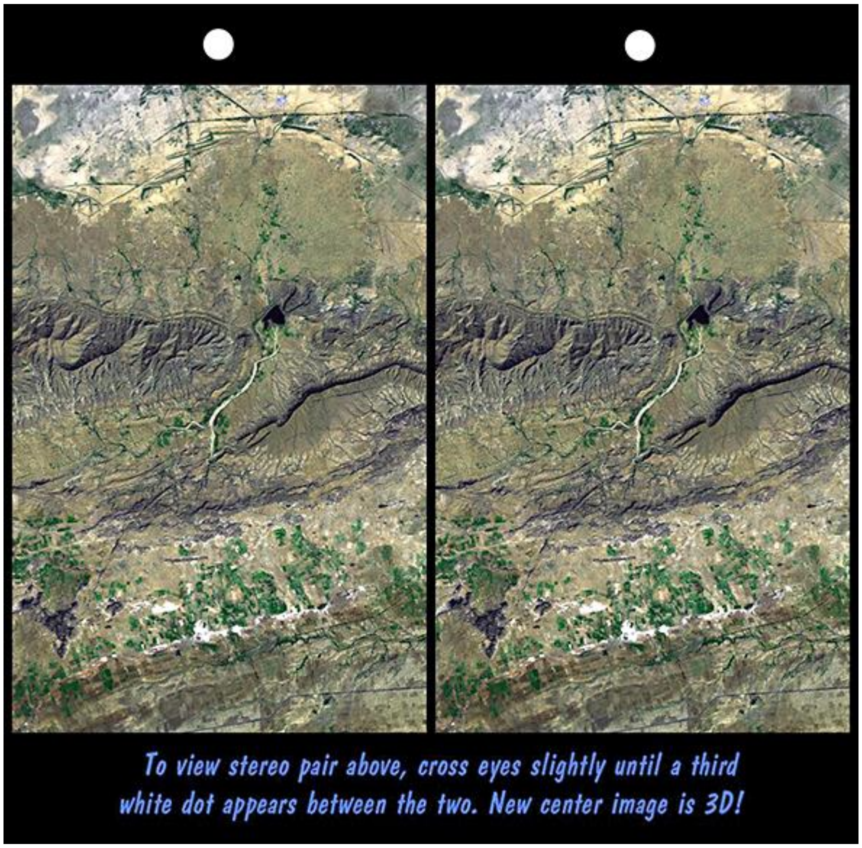
Length of shadow (m): __13.5 m____________________________

Height measured by the shadow method: ____________________

H = L * tan(θ) = 22.5 m * tan(19.36º) = 4.74 m

On your own, write a substantial paragraph exploring the reasons for the discrepancies between the results from the two methods. Be sure to include which method is more likely to be correct. ***(4 points)***
The displacement method appears to be more accurate than the shadow method in this example. The shadow method is dependent mostly on sun angle at a specific time of day. The displacement method, however, is focused on aircraft altitude, scale of the image, and the radial distance from the principal point. The discrepancy between the two is that the photo in the example was not taken at 1500 local time, but at solar noon instead. This offset of time/shadow length could reason why the shadow calculations are much smaller.

4. Stereoscopy is a technique used in photogrammetry that uses multiple images to give the perception of three-dimensional depth. If we acquire two aerial photographs of the same ground area from two adjacent positions along the same flightline, we can create a stereo pair or stereogram. Stereo pairs provide another option for measuring heights and is a way to extract topographic information such as contour lines. Photogrammetrists use different tools like stereoscopes, or even just their eyes, to combine the images into one 3-D view. Below are a couple examples of stereo pairs. This section is just for you to enjoy some stereograms—there are no questions to answer.



Right image:

https://www.jpl.nasa.gov/spaceimages/details.php?id=PIA02738
Left image: https://www.jpl.nasa.gov/spaceimages/details.php?id=PIA02776