

GEOG 361/651

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Lab Exercise 4 – Understanding the Basic Principles of Photogrammetry

This lab is a combination of labs originally developed by Drs. Klein and Liu with help implementing the labs in ENVI from Songgang Gu.

Introduction

In this lab, we will examine some basic principles of **photogrammetry** using stereo-photographs and a digital ortho quarter quadrangle (DOQQ) acquired over Aggieland “The Best Place in the World.” Actually Aggieland is good for an introductory exercise in photogrammetry. The terrain is flat, and buildings are not so close that making measurements from an aerial photograph is not too difficult.

Photogrammetry is the science of determining the position and shape of objects from photographs. The main use of photogrammetry is for surveying and topographic mapping, namely, to derive 3D geometric information about objects from 2D photographs for making topographic maps, either as line maps or as ortho-photo maps. Topographic map compilations, map revision, DEM generation and contouring, and ortho-image creation are common metric applications of traditional photogrammetry. It is widely recognized that most of the concepts, principles, theories and methods developed in the traditional aerial photo-based photogrammetry still hold true and can be transferred more or less unchanged to satellite remote sensing.

This lab will develop your understanding of the basic concepts and techniques used in photogrammetry and appreciate how metric attributes of geographic features can be derived from remotely sensed imagery. The specific tasks you will undertake include:

- Determining the aerial photograph scale based on an aerial photograph and the measured ground size of objects;
- Determining the ground coverage of an aerial photograph and the spatial resolution of a scanned image of aerial photograph;
- Determining an aircraft’s flight altitude based on the scale of an aerial photograph and the focal length of the camera;
- Determining the height of selected objects using the relief displacement method on a single aerial photograph;
- Determining the height of selected objects using the shadow method on a single aerial photograph;
- Determining the height of selected objects using the parallax method on an aerial photograph stereo pair.

Lab Instructions

While the lab could be accomplished using hardcopy images, we will use ENVI to perform the necessary measurements. This will entail that you employ pixel (x,y) positions and a little geometry to calculate the necessary measurements.

When writing up your answers please be sure to show all your work and use metric units unless otherwise indicated.

It might also be beneficial to print out hardcopy versions of the two images to aid in locating features. As the images are in excess of 200 MB, it might also be useful to copy the images to the hard drive on the local computer (C: drive) to speed up access.

About the aerial photographs used in the lab

The requisite images are in the lab04 folder and are labeled `ap_1-9-148` and `ap_1-9-149`. The numbers are not random. Instead they represent the numbering convention used to number the aerial photographs collected over Brazos County on 1/11/1988.

In addition, a digital orthoimage (`college_doq`) is also available. The terrain distortions and other geometric distortions (such as are present in the other images) have been removed in the orthorectification process. The image was referenced to UTM (zone 14) coordinate system and referenced to the datum NAD83.

Lab Exercises

Task 1 – *Determination of the scale of aerial photographs*

In this portion of the exercise you will determine the scale of the aerial photograph using two different methods. The photograph you will use as the basis of the calculations is `1-9-149.bsq`.

First you will use the measured size of some objects in the aerial photograph (ab) and their size in the real world (AB). Image scale can be calculated as a ratio between the two:

$$s = \frac{ab}{AB} \quad (1)$$

So to calculate the scale of the aerial photograph we must use objects whose distance we can measure both on the ground and in the aerial photograph. To determine the scale, you will need to identify 3 objects in the image whose distance can accurately be measured.

Question 1. Measure the size of objects in the image and in the real world and compute the pixel spatial resolution of pixels (m).

Measuring the size of objects can be done in one of two ways

- 1) Using a tape measure or GPS unit, directly measure the object
- 2) Measure the size of an object on the College Station DOQQ (`college_doq`).

Calculate the spatial resolution of a pixel can be done by dividing the measured ground distance (meters) by the photo pixel length (pixels).

You might wish to take a few minutes to ponder the advantages of both methods, especially if you examine the relative pixels sizes of the scanned aerial photograph and the DOQQ. Once you have decided on which method you will use, please complete the following table.

Object	Size in of object in aerial photo (pixels)	Actual Size of object in real world (m)	Computed Pixel Size (m)

Determining Distances in ENVI

On main image display window, click **Tools->Measurement Tool** In the **Display Measurement Tool** dialog window, click **Units->Pixels** and click the window option where you will measure the object. On that window, click the start point and end point and then right click to stop the measurement; the distance is displayed on the **Display Measurement Tool** dialog window. Right click again to remove the previous measurement.

Now that we have these measurements please make the following calculations:

Question 2. Determine the height and width of the scanned aerial photograph in real world. This can be done by simply multiplying the image size (columns or rows) by the pixel size in meters.

Question 3. Calculate the Representative Fraction Scale of the scanned aerial photograph. A representative fraction scale (e.g., 1:10,000) means that one unit (say mm) on the printed photograph equals how many units (mm) in the real world.

Determining Representative Fraction

You can compute the representative fraction using the size of the image you calculated in **Question 2** and knowing that the size of a typical aerial photograph is 9 inches by 9 inches. Just remember that in a representative fraction scale the units on the photograph (or map) have to be the same units as in the real world.

Question 4. From the photograph determine the focal length (in millimeters) of the camera used to take the picture. If you are unsure of where to find this information you can refer to Figure 4-12 in your book. The information may not be in the exact same place, but you should be able to figure it out.

Question 5. What is the approximate resolution of the scanner in terms of dots-per-inch (DPI) or microns per dot, which was used to scan the original positive film of the aerial