



3D Modeling: Photogrammetry Student Activity Sheet

Extend your left thumb in front of an object. Close your left eye. Draw what you see. Where is your thumb in relation to the object? Now close your right eye. Draw what you see.

Drawing with Left Eye Closed	Drawing with Right Eye Closed
Where is your thumb in relation to the object?	Where is your thumb in relation to the object?

Why do you think that the 2 drawings are different?

What you have experienced is **parallax**. Parallax is the apparent shift in position of an object due to a shift in the position of the observer. Parallax is important in photogrammetry because it is used to extract 3-D information from a 2-D image. Elevation points are extracted from photographic measurements.

parallax = p

$$p = x - x_1,$$

where x = x - coordinate of the point in the image and

x_1 = x - coordinate of the same point displaced.

Task 1:

Point A can be seen in both photographs in Figure 1 below. In the photograph on the left the coordinates of A are (15.75619 in, 17.36512 in). In the photograph on the right the $x_1 = 3.71413$ in.

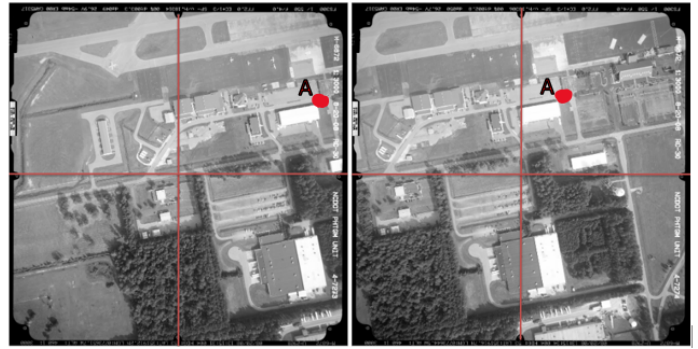


Figure 1

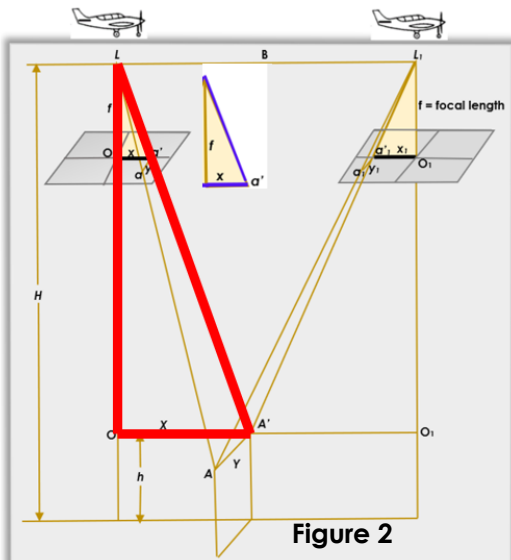
- a) What represents the flight path in each photo?
- b) Find the parallax.

c) If you measured the parallax for another point, would you get the same value? Explain.

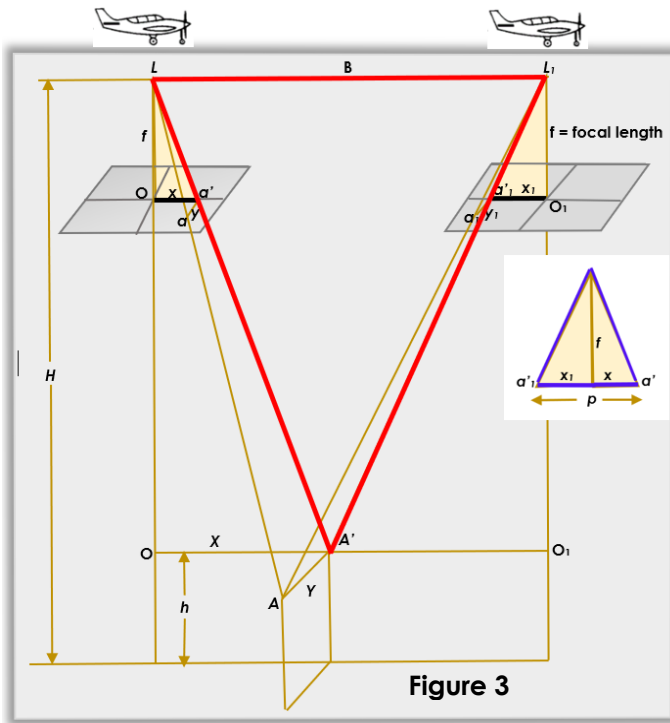
The North Carolina Department of Transportation, NCDOT is sending out its photogrammetry plane to survey a stretch of road with an embankment. The plane will be sent out to take a series of pictures. These pictures will be used to create a 3-D model of the road.

d) How does the actual size of an object compare to a photograph of the object?

A point, a' has coordinates x and y in the 2-D image (photograph represented with the horizontal grid that is a vertical distance f (camera focal length) below the airplane line of flight). To make the 3-D image we need a third coordinate, which is the elevation of the point above sea level.



- e) What represents the distance the plane flew in Figure 2?
- f) What represents the parallax in this diagram?
- g) What does H represent?
- h) What does h represent?
- i) What does $H - h$ represent?



j) What is the relationship between the two outlined triangles (in red and blue) in **Figure 3**?

k) Based on the relationship between the triangles in Figure 3, complete the following expressions:

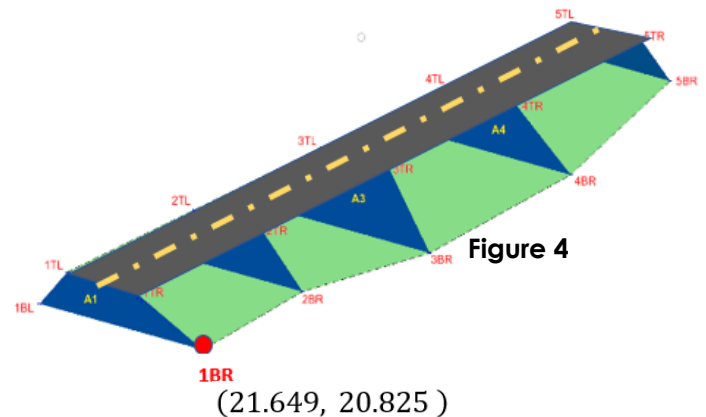
$$\frac{p}{f} =$$

$$\frac{x}{f} =$$

*You will use the results of k) in Task 2.

Task 2

NCDOT wants to make a 3-D image of a road with an embankment. The aircraft took overlapping photos of the road pavement and the embankment. All photos were taken with an air base of 900 feet apart from each other. The focal length of the camera was 6 inches, and the flying height of the aircraft was 4000 feet above sea level. On overlapping pairs of photographs image measurements at section intervals of 50 feet along the pavement and embankment are taken. Point 1BR on the ground can be seen from overlapping photographs and the image space coordinates of that point in photo 1 is (21.649 in, 20.825 in) and the x-coordinate of the point in photo 2 is 19.794 in.



- Find the parallax.
- Find the elevation, h , of point 1BR.
- Find the ground coordinates of 1BR, (X, Y)

Task 3

Using the data in the Excel [spreadsheet link](#), find the parallax, ground coordinates and the elevation of points along the road.

Task 4

Using [Geo Gebra](#), graph the 3D coordinates from the spreadsheet.