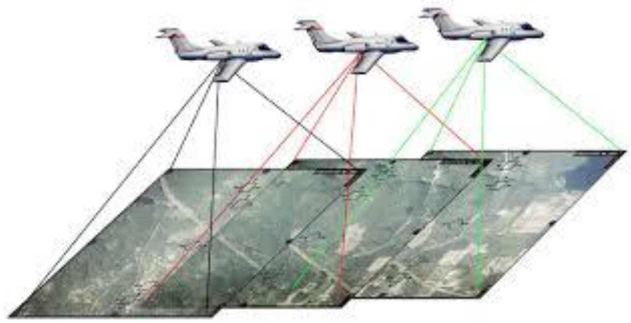
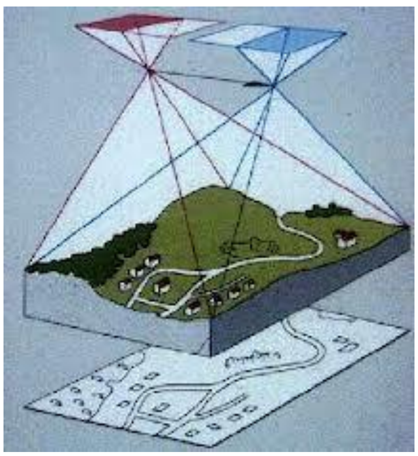
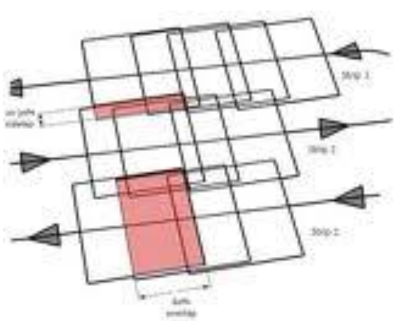
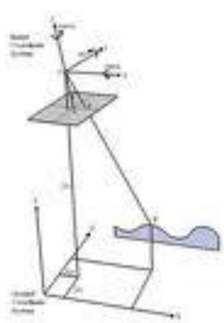


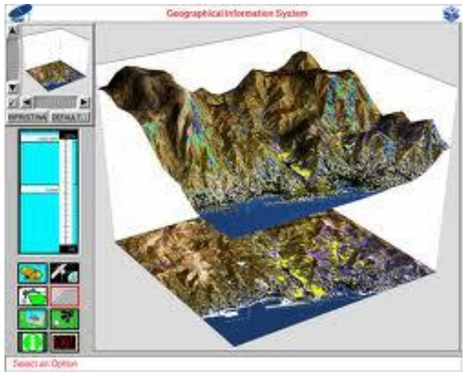
CE 474

Chapter (4): Photogrammetry









Dr. SaMeH S. Ahmed

College of Engineering – MU 18-19/1

CE 474

Chapter 4 Geometry of Aerial Photography

4.1 Introduction

The geometry of a single vertical photograph is shown in Figure 4.1. The photographic negative is shown for completeness, but in practice it is typical to work with the photographic positive printed on paper. The front nodal point of the camera lens is defined as the exposure station of the photograph. The distance measured from the rear nodal point to the negative principal point or from the front nodal point to the positive principal point is equal to the focal length *f* of the camera lens.

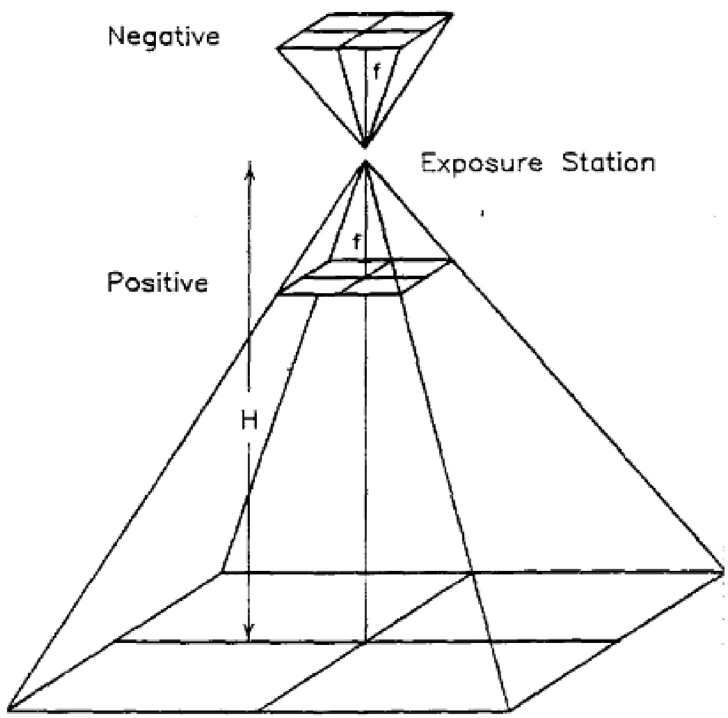


Figure (4.1): Single vertical photograph geometry

4.2 Single Vertical Aerial Photography

4.2.1 Photographic scale

The scale of an aerial photograph can be defined as the ratio between an image distance on the photograph and the corresponding horizontal ground distance. Note that if a correct photographic scale ratio is to be computed using this definition, the image distance and the ground distance must be measured in parallel horizontal planes. This condition rarely occurs in practice since the photograph is likely to be tilted and the ground surface is seldom a flat horizontal plane. Therefore, scale will vary throughout the format of a photograph, and photographic scale can be defined only at a point.

1) **The scale at a point** on a truly vertical photograph is given by:

$$S = \frac{f}{H-h} \quad \text{.....................................(4.1)}$$

Where:

S = photographic scale at a point
f = camera focal length
H= flying height above datum
h = elevation above datum of the point

Equation 4.1 is exact for truly vertical photographs and is typically used to calculate scale on nearly vertical photographs.

2) In some instances, such as flight planning calculations, approximate scaled distances are adequate. If all ground points are assumed to lie at an average elevation, an average photographic scale can be adopted for direct measurements of ground distances. **Average scale** is calculated by:

$$S = \frac{f}{H-h_{av}} \quad \text{.....................................(4.2)}$$

Where: h_{av} is the average ground elevation in the photo.

Then referring to the vertical photograph shown in Figure 4.2, the approximate horizontal length of the line AB is:

$$D = \frac{d\,(H - h_{av})}{f} \quad \text{………………………………….(4.3)}$$

Where:
D = horizontal ground distance
d = photograph image distance

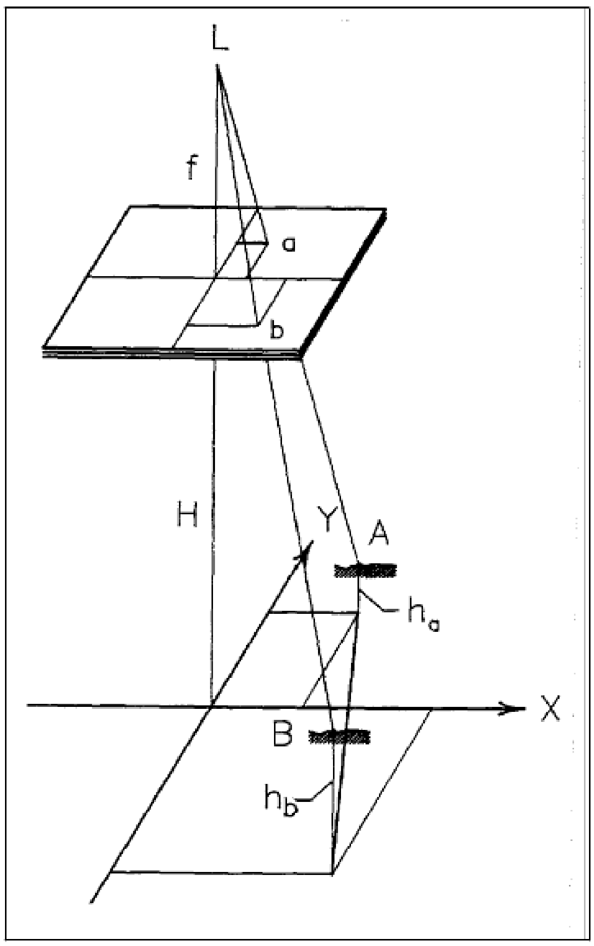


Figure (4.2): Horizontal ground coordinates from single vertical photograph

4.2.2 Horizontal ground coordinates

Horizontal ground distances and angles can be computed using coordinate geometry if the horizontal coordinates of the ground points are known. Figure 4.2 illustrates the photogrammetric solution to determine horizontal ground coordinates.

1) **Horizontal ground coordinates** can be calculated by dividing each photo-coordinate by the true photographic scale at the image point. In equation form, the horizontal ground coordinates of any point are given by:

$$X_g = \frac{x_p(H - h_p)}{f}$$

$$Y_g = \frac{y_p(H - h_p)}{f}$$

Where:

X_g, Y_g= ground coordinates of point p
x_p, y_p = photo-coordinates of point p
h_p = ground elevation of point p

2) The equations for horizontal ground coordinates are exact for truly vertical photographs and typically used for near vertical photographs.

3) After the horizontal ground coordinates of points A and B in Figure 4.2 are computed, the horizontal distance is given by:

$$D = \sqrt{(X_a - X_b)^2 + (Y_a - Y_b)^2}$$

Solved Example:

If the elevation of point (A) is 50 m above MSL and the elevation of point (B) is 25 m above MSL. It is required to determine the distance between points A and B if their distance on the photo are (26.78 , 14.27) ‘ (15.24 , 26.27) mm. the photo was taken by a camera of 100 mm focal length and the flying height is 1500 m above MSL.

Solution

Given:

Point A: (26.78 , 14.27) mm and 50 m above MSL

Point B: (15.24 , 26.27) mm and 25 m above MSL

f = 100 mm

H = 1500 m

$$X_g = \frac{x_p(H - h_p)}{f}$$

$$Y_g = \frac{y_p(H - h_p)}{f}$$

$$X_A = \frac{26.78(1500 - 50)}{100} = 388.31\, m$$

$$Y_A = \frac{14.27(1500 - 50)}{100} = 206.92\, m$$

$$X_B = \frac{15.24(1500 - 25)}{100} = 224.79\, m$$

$$Y_B = \frac{16.27(1500 - 25)}{100} = 239.98 m$$

$$D = \sqrt{(X_a - X_b)^2 + (Y_a - Y_b)^2}$$

$$AB = \sqrt{(388.31 - 224.79)^2 + (206.92 - 239.98)^2}$$

= 166.83 m