IMAGE PARALLAX

The term parallax refers to the **apparent change in relative position of stationary objects caused by a change in viewing position**. As applied to aerial photos, the parallax of a point is the apparent difference in position of the point on two consecutive photographs.

This phenomenon is observable when one looks at objects through a side window of a moving vehicle. With the moving window as a frame of reference, objects such as mountains at a relatively great distance from the window appear to move very little within the frame of reference. In contrast, objects close to the window, such as roadside trees, appear to move through a much greater distance. In the same way terrain features close to an aircraft (i.e. at higher elevation) will appear to move relative to the lower elevation features when the point of view is changes between successive exposures. These relative displacements form the basis of three-dimensional viewing of overlapping photography. In addition, they can be measured and used to compute the elevations of terrain points.

The parallax can be resolved in two components one in the direction of flight and is known as **X-parallax or absolute parallax** and the other perpendicular to the flight direction known as **Y-parallax**.

Y- parallax is zero if the photos are tilt free and have taken from the same altitude.

The absolute stereoscopic parallax is the algebraic difference, in the direction of the flight, of the distance of the two images of the object from their respective principal points.

The parallax difference can be used to determine the height of the objects and the dip and slope from the stereo pairs.

Determination of height

The difference in elevation also produces the difference in parallax; therefore measurement of height is possible from stereo pairs. To measure the height of an object above or below a reference point from stereo-pair of aerial photograph following data is required: -

i) Flying height above the reference point
ii) Photo base – Which can be measured from the stereo-pair
iii) Parallax difference – It is measured by the use of a set of measuring marks (sometimes called locating marks). These measuring marks are identical and when viewed stereoscopically in conjugation with a photographic overlap, combines to form a single image and occupies a definite position in three dimensional model space. If the marks have a different parallax from that of the surroundings in the photographs, it will appear higher o lower but if no parallax exists between the marks and the object image, the fused dot appears in contact with the fused image. **Parallax differences are measured by parallax bar (also known as stereometer) having two floating marks engraved on two glass plates. The separation of these marks can be varied with the help of a micrometer screw which gives reading up to 1/100 mm and parallax difference between two points can be determined.**

Now by using following (parallax) formula the height of the objects can be measured.

$$h = \frac{Z.x\ \Delta P}{b + \Delta P}$$

For smaller heights e.g. trees, embankments, buildings the formula is further simplified to

$$h = \frac{Z.x\ \Delta P}{b}$$

Where **h** is height of object, **Z** is flying height above the reference point, **b** is photo base, **ΔP** Parallax difference

This formula gives correct result when the photographs are truly vertical.

Determination of dip and slope

The true slopes and dips can be measured by measuring the parallax difference **ΔP** between the top and bottom points of a given slope with a parallax bar and substituting it in the following formula:

$$\tan \text{slope} = \frac{f}{d} x \frac{\Delta P}{P_R}$$

Where '**f**' is the focal length, '$\mathbf{P_R}$' is the parallax of the bottom point of the slope and '**d**' is the horizontal distance of the slope on photo scale.

The value of '**d**' is determined as follows:

1) A piece of tracing paper is placed on one of the photos and the flight line and rays to the top and bottom (say **a** & **b**) point on the given slope are marked. In theory the direction of flight should correspond precisely to the fiducial x-axis. But, there use to be slight offset due to changes in aircraft orientation. The true flight line axis may be found by first locating on photograph the points that correspond to the image centers of the preceding and succeeding photographs. These points are called the conjugate principal points. A line drawn through the principal points and the conjugate principal points defines the flight axis.
2) The tracing is placed on the second photo so that flight lines coincide and the point '**a**' falls on the ray to '**a**'.
3) Then the rays to '**a**' and '**b**' are dawn.
4) The principal point of the second photo is marked on the flight line.
5) The distance between the intersections of rays to '**a**' and '**b**' gives the horizontal distance '**d**' between the points '**a**' and '**b**' on photo scale.

The distance between the principal points of the left and right photos marked on the flight line gives the value of '$\mathbf{P_R}$'.

Easy and quick determination of dips from the photographs can be done by converting the apparent dips as visualised in the photographs to the true values by working out personal exaggeration factor and using graph for reading the true dip values.

Determination of thickness of beds: -

By measuring parallax difference the thickness of the strata/beds can be determined if the beds are clearly seen on the photographs.

In case of horizontal beds the thickness can be determined by measuring the parallax difference between the top and bottom of the bed.

In case of low to moderate dipping beds, first the dip of the beds is determined then the parallax difference between the two points, one at the top and other at the base of the beds is determined. The following formula can give the thickness of the bed:

$$\mathbf{t = h \cos\theta + d \sin\theta}$$

Where '**t**' is the thickness (true/stratigraphic), '**h**' is the difference in elevation between a point on the lower contact of the bed and a point vertically above this point on the upper contact of the bed, '**d**' is corrected horizontal distance between the upper and lower points measured, and θ is the angle of dip of the beds.

In case of moderate to less steeply dipping beds the thickness can be computed using following formula:

$$\mathbf{t = d \sin\theta}$$

Where '**t'** is the thickness (true/stratigraphic), '**d**' is the horizontal distance measured in dip direction between given points, and θ is the angle of dip of the beds.

The inclination of steeply dipping beds is not measured from the aerial photographs because usually only a small bedding surface is exposed on the surface. This in tern will give a small horizontal distance, and any error in its measurement will result in a large percentage error in the determination of thickness.

ORTHOPHOTOS

Photographs having the properties of an orthographic projection is known as orthophoto. It is derived from a conventional perspective photograph by simple or differential rectification. Like maps orthophotos have one scale (even in varying terrain), and like photographs, they show the terrain in actual detail (not by lines and symbols). Hence orthophotos give the resource analyst the best of both worlds- a product that can be easily interpreted like a photograph, but one on which true distances, angles and areas may be measured directly.

Orthophotos are generated from overlapping conventional photos in a process called *differential rectification*. The result of this process eliminates the scale variation and image displacement due to relief and tilt. The instrument used to prepare orthophotos is called *orthophotoscope*. In this equipment all points of the stereo model are photographed onto an orthophoto negative, which is then used to print the orthophotograph.

Orthophotos may be viewed stereoscopically when they are paired with stereomates. These products are photographs made in an orthophoto instrument by introducing image parallax as a function of known terrain elevations obtained during the production of their corresponding orthophoto.

In geological studies, orthophotos can be used efficiently either alone or as a supplement to the topographic map for compiling geological details and field data.