

Stereoscopic Vision, Stereoscope, Selection of Stereo Pair and Its Orientation

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Abstract: Stereoscope is to deflect normally converging lines of sight, so that each eye views a different image. For deriving maximum benefit from photographs they are normally studied stereoscopically. Instruments in use today for three dimensional studies of aerial photographs. If instead of looking at the original scene, we observe photos of that scene taken from two different viewpoints, we can under suitable conditions, obtain a three dimensional impression from the two dimensional photos. This impression may be very similar to the impression given by the original scene, but in practice this is rarely so. A pair of photograph taken from two cameras station but covering some common area constitutes and stereoscopic pair which when viewed in a certain manner gives an impression as if a three dimensional model of the common area is being seen.

Keywords: Remote Sensing (RS), Aerial Photograph, Pocket or Lens Stereoscope, Mirror Stereoscope. Stereopair, Stere. pair's orientation

1. Introduction

A stereoscope is a device for viewing a stereoscopic pair of separate images, depicting left-eye and right-eye views of the same scene, as a single three-dimensional image. The function of a stereoscope is to deflect normally converging lines of sight, so that each eye views a different image. Instruments in use to-day for three dimensional study of aerial photographs are of two types i.e. Lens Stereoscope and reflecting or mirror stereoscope. Stereoscopic vision is also called space vision or plastic vision, is a characteristic, possessed by most persons of normal vision and is important for ability to conceive objects in three dimensional effects and to judge distances. Stereoscopic vision is the basic prerequisite for photogrammetry and photo interpretation. Stereoscopy is defined as the science or art which deals with stereoscopic or other three dimensional effects and methods by which these effects are produced. Human beings can distinguish depth instinctively. However, there are many aids to depth perception, for Instance, closer objects partly cover distant objects or distant objects appear smaller than similar objects nearby.

2. Stereoscopic Vision

Stereoscopic vision is also called space vision or plastic vision, is a characteristic, possessed by most persons of normal vision and is important for ability to conceive objects in three dimensional effects and to judge distances. Stereoscopic vision is the basic prerequisite for photogrammetry and photo interpretation. Stereoscopy is defined as the science or art which deals with stereoscopic or other three dimensional effects and methods by which these effects are produced. The close objects are larger, brighter, and more detailed than distant object, and that the close object obstructs the view of distant object. Monocular vision means seeing with one eye. Binocular vision means using both eyes simultaneously. The degree of depth perception is called as "Stereoscopic acuity." Normal Stereoscopic acuity is possible when images on retina have certain

characteristics. Two eyes must see two images, which are only slightly different in angle of view, orientation, colour, brightness, shape and size. (**Figure: 1**) Human eyes, fixed on same object provide two points of observation which are required for parallax. A finger held with the arm stretched and alternately viewed with left and right eye appears to move sideways. Thus movement or displacement is the horizontal parallax.

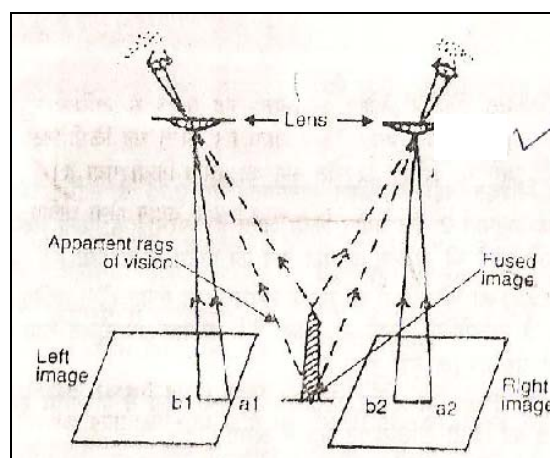


Figure 1: Stereoscopic Vision

3. Depth Perception

Human beings can distinguish depth instinctively. However, there are many aids to depth perception, for Instance, closer objects partly cover distant objects or distant objects appear smaller than similar objects nearby. These aids apply to monocular vision. For short distances binocular vision is more important and is of interest to photogrammetrists, for it is binocular vision which enables us to obtain a spatial impression of a model formed by two photographs of an object (or objects) taken from different viewpoints. Normally, our eyes give us two slightly different views which are fused physiologically by the brain and result in sensation of seeing a model having three dimensions. This three dimensional effect due to binocular vision is very

limited, however, decreasing rapidly beyond a viewing distance of one meter. Thus it may be concluded that binocular vision is primarily an aid in controlling and directing the movements of one's limbs.

A small percentage of the people do not have the facility of binocular vision and no amount of training will give it to them. Unfortunately, there is no known physical aid to provide stereoscopic sight to such persons who do not possess it naturally, but training can help those having weak fusion.

3.1 Types of Stereoscopic Vision

Stereoscopic vision can be of two types:

- Natural Stereoscopic Vision
- Artificial Stereoscopic Vision

3.1.1 Natural Stereoscopic Vision

Natural Stereoscopic vision is possible due to the Monocular Vision which is possible due to the relative size of the objects, overcutting convergence and accommodation of eyes, haze of atmosphere etc. And Binocular Vision is responsible for perception of depth. Two slightly different images, seen by two eyes simultaneously are fused into one by brain, giving the sensation of a 'model' with three dimensions. The three dimension effect is reduced beyond viewing distance of one meter. So also the distance between two eyes, called 'Eye base, affects stereoscopic vision. Wider the eye base, better is the three dimensional effect.

3.1.2 Artificial Stereoscopic Vision

Artificial stereoscopic vision can be achieved with certain aids and a two dimensional photograph can provide a three dimensional effect. This image obtained is comparable to the image that can be obtained if two eyes are placed at two points of exposure stations on a flight line. Here the distance between two exposure stations is called the 'airbase'.

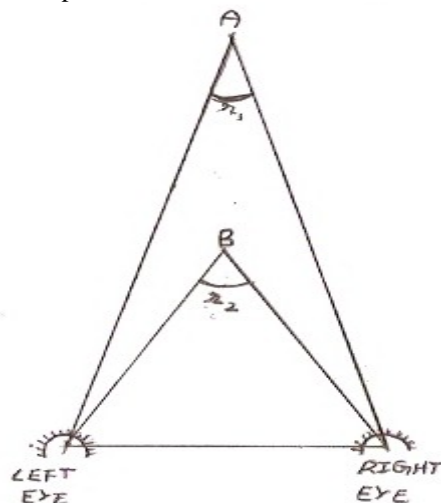


Figure 2: Converging Angle in viewing object at different distance

Relationship of accommodation i.e. changes of focus, and convergence (**Figure: 2**) or divergence of visual axes is important. As the eyes focus on an object, they also turn so that lines of sight intersect at the object. Angle of convergence of nearer object is larger than the angle at object with longer distance. Proper association between

accommodation and convergence are necessary for efficient function of eyes. This association can be weakened or destroyed by improper use of eyes. Visual illusion, colour vision and defects of focus, coordination defects in depth perception etc. are important factors affecting photo interpretation.

Stereoscopic vision thus, is the observer's ability to resolve parallax differences between far and near images. Stereoscopic acuity depends upon ability to perceive smallest but significant amounts of parallax. 'Brains' ability to convert parallax differences into proper perception of depth depends upon ability of right side eye to see object form rightside and of the left eye to see same object from leftside. If this order is reserved, as happens when relative position of aerial photograph is reserved, closer objects appear close, and this phenomenon is called 'pseudo' stereo vision.

4. Requirements of Stereoscopic Photography

If instead of looking at the original scene, we observe photos of that scene taken from two different viewpoints, we can under suitable conditions, obtain a three dimensional impression from the two dimensional photos. This impression may be very similar to the impression given by the original scene, but in practice this is rarely so.

In order to produce a spatial model, the two photographs of a scene must fulfill certain condition:

- Both photographs must cover same scene, with 60% overlap.
- Time of exposure of both photographs must be same.
- The scale of the two photographs should be approximately the same. Difference up to 15% may be successfully accommodated. For continuous observation and measurements, differences greater than 5% may be disadvantageous.
- The brightness of both the photographs should be similar.
- Base height ratio must have an appropriate value. Normally the 'B/Z' or Base height ratio is upto 2.0. Ideal is not known but is probably near to 0.25. If this ratio is too small, say 0.02, the stereoscopic view will not provide depth impression better than when only single photo is viewed.

In the base height ratio- B/Z

Where

B = is the distance between two exposure stations

Z = is the distance between an object and the line joining two exposure stations.

Base height ratio increases when overlap decreases and larger viewing angle corresponds with larger base height ratio. Short focal length wide angle lens cameras give better base height ratio which is important in natural resource survey. (**Figure: 3**)

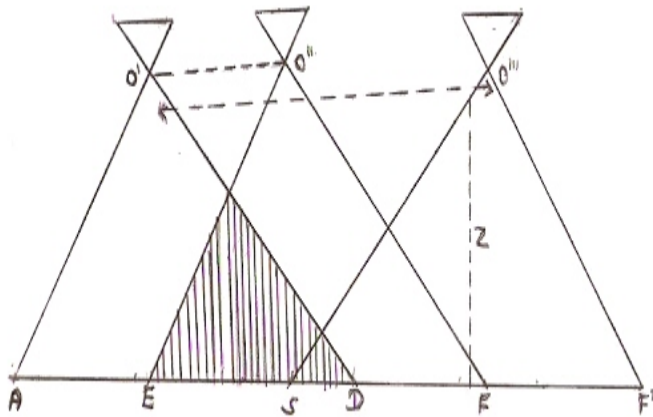


Figure 3: Base Height Ratio

Base height ratio B/Z is also = b/c

Where

b = photo base is the distance between two principal points of consecutive photographs.

c = principle distance of camera.

If photo base is larger than the eye base and image is viewed stereoscopically without enlargement, depth impression becomes exaggerated. Enlargement of images, by binoculars, telescope etc; enlarge parallaxes also and thereby increases depth perception is better when aerial photographs are positioned in such a way that the shadows of the objects fall towards observer.

5. Types of stereoscope

The function of a stereoscope is to deflect normally converging lines of sight, so that each eye views a different image. Instruments in use to-day for three dimensional study of aerial photographs are of two types i.e. Lens Stereoscope and reflecting or mirror stereoscope. Two types of stereoscope;

1. Lens stereoscope
2. Mirror stereoscope

5.1 Lens Stereoscope

Lens Stereoscope is also called as pocket stereoscope because of its size and easy transportability. Eye base was fixed. Lens is used in pocket stereoscope is Plano-convex lens. Pair of magnifying lenses are used to keep eyes working independently and there line parallel. The height of pocket stereoscope is 10 centimeters. It has Plano convex lenses with upper side flat and focal length 100mm. (Figure:6) Since, normal viewing distances is 250mm, a view at 100mm, under pocket stereoscope gives 2.5 times magnification. The distances between two lenses is either fixed at 65mm which is the average eye base or are adjustable to distance between users' eyes. Distance between legs of the stereoscope and focal length of lenses are so adjusted that the images are located at the focal planes of lenses.

Lens stereoscopes are handy, cheap and are good for study of small format aerial photographs. Larger photo sizes, need

folding while viewing. However, they have limited magnification afford limited illumination because of limited distance between observer and photos and afford small viewing field because image points in a stereo pair have to be kept apart by distance equal to eye base. (Figure: 4 & 5)



Figure 4: Lens or Pocket Stereoscope

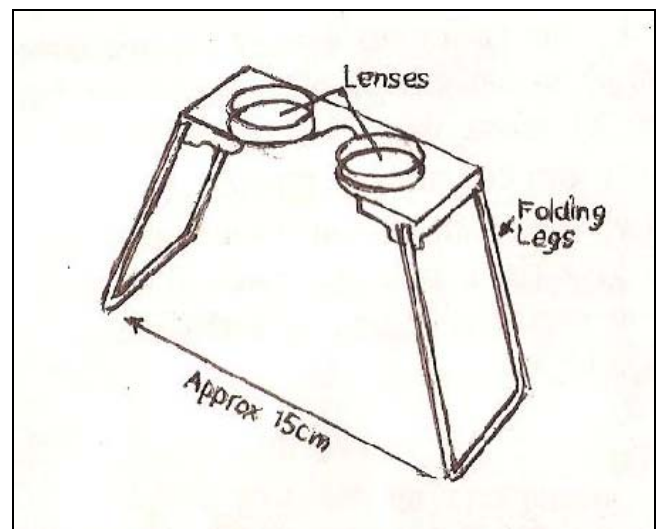


Figure 5: Lens or Pocket Stereoscope

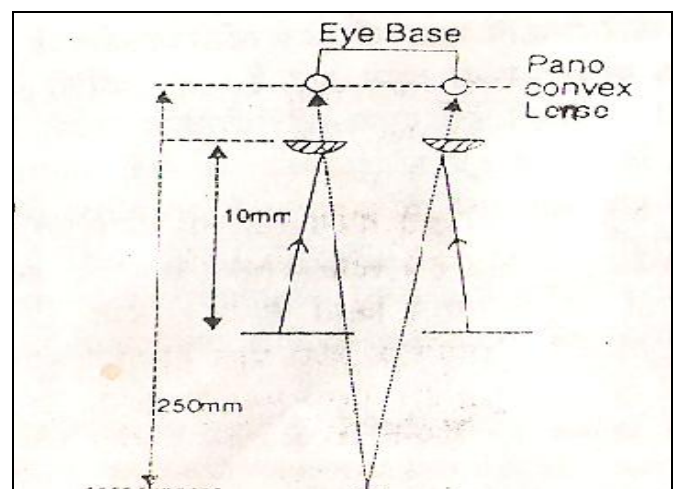


Figure 6: Lens or Pocket Stereoscope

5.2 Mirror Stereoscope

Mirror Stereoscope is also called as reflecting stereoscope. It provides view of entire overlap by an arrangement of prisms

and mirrors with increased distance to about 15 to 20cms. (Figure: 7) In addition, binoculars, attached with the mirror

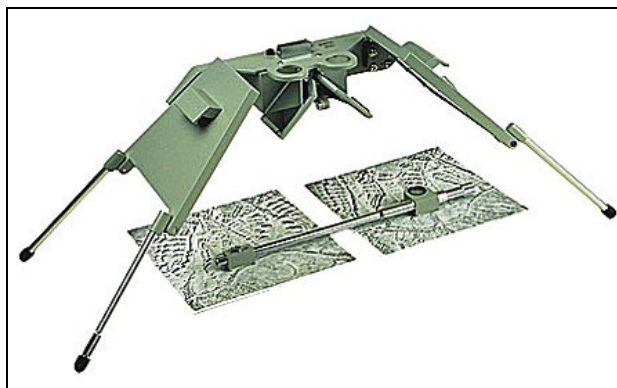


Figure 7: Mirror Stereoscope

stereoscope, provide 3X to 8X magnification. The mirror stereoscopes are most widely used in photo interpretation and in photo measurements, in combination with parallax bar. Mirror stereoscopes can be used for larger format sizes of aerial photographs because the visual base in this is enlarged by double reflections.

6. Stereo pair and its orientation

A pair of photograph is known as Stereoscopic pair. Stereoscopic study is beneficial to the eyes. There will be no eye strain or headache if aerial photographs are aligned properly during such study. Following steps detail correct alignment of photopairs under mirror stereoscope:-

6.1 Measure instrument base-

- First focus binoculars and adjust them to the eye base.
- Draw a line, approximately 30 cm. long on a paper and mark a point A on one end. Put stereoscope over this paper and line in such a way that point A is in the centre of field of view when viewed by left eye. Using right ocular only, mark a point B on the line, in the centre of field of axes.

6.2 Two identical images of photograph of different points by Pocket or Lens Stereoscope:

6.2.1 Steps

- First of all, we took a point with a pencil on a plane paper. Than we see the point with the help of pocket stereoscope and touch the point with pencil. Than we see that the point of seen with the help of pocket stereoscope and the point of plane paper not come the same place.
- On paper, we see two lines but when we see it with the help of pocket stereoscope. We see one line. Or first two lines merge two from one straight line. In second and third lines are little tiled. (Figure: 8)

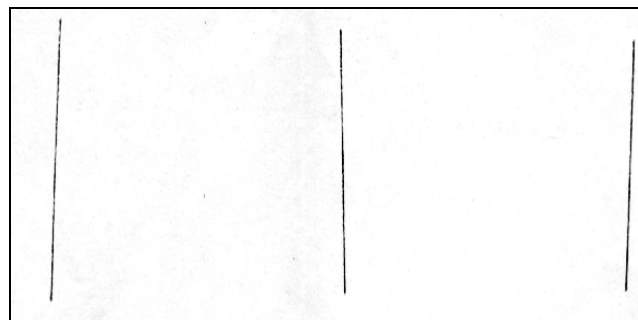


Figure 8

- In the first circle and line, when we see it with the help of pocket stereoscope, we find that the circle is above and the line is beneath the circle. (Figure: 9)

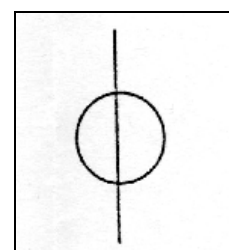


Figure 9

- In the second circle and line, when we see it with the help of pocket stereoscope, we find that the line is above and the circle is beneath the line. (Figure: 10)

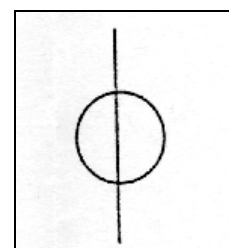


Figure 10

- In the first diagram, when we see it with the help of pocket stereoscope, we find that the bottom is below or dip in center and open outside. (Figure: 11)

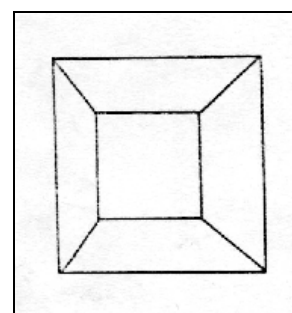


Figure 11

- In the second diagram, when we see it with the help of pocket stereoscope, we find that the bottom is below or dip in center and open outer side. (Figure: 12)

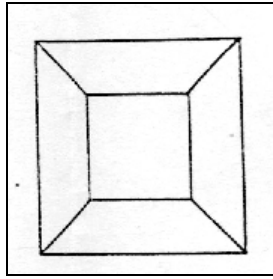


Figure 12

- In the third diagram, when we see it with the help of pocket stereoscope, we find that the bottom is above or center part above lines of corner and outer wall are stretch. (Figure: 13)

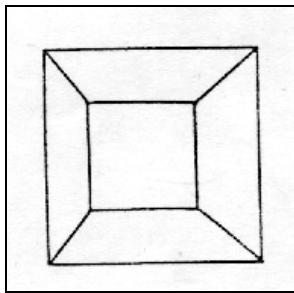
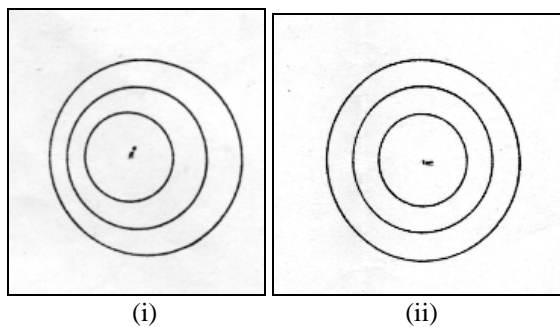


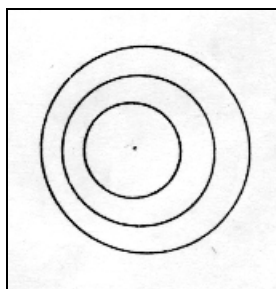
Figure 13

- In the first and second diagram, center dip like a glass or cake and in the second and third diagram, they are like a pole stand. (Figure: 14)



(i)

(ii)



(iii)

Figure 14

7. Use of a Stereopair

A stereo pair consists of two photographs having certain percentage of overlap. The two photographs 1 and 2 should be placed in the order in which they were taken during the mission, otherwise a pseudo – stereoscopy is obtained. The centres A and B of each photograph or their principal points

are marked in Figure: 15. On each photograph, the images a and b corresponding to the principal points are marked and the straight lines are coincident. To achieve good stereoscopic vision the distance Aa and Bb should be equal to the intraocular distance Y.

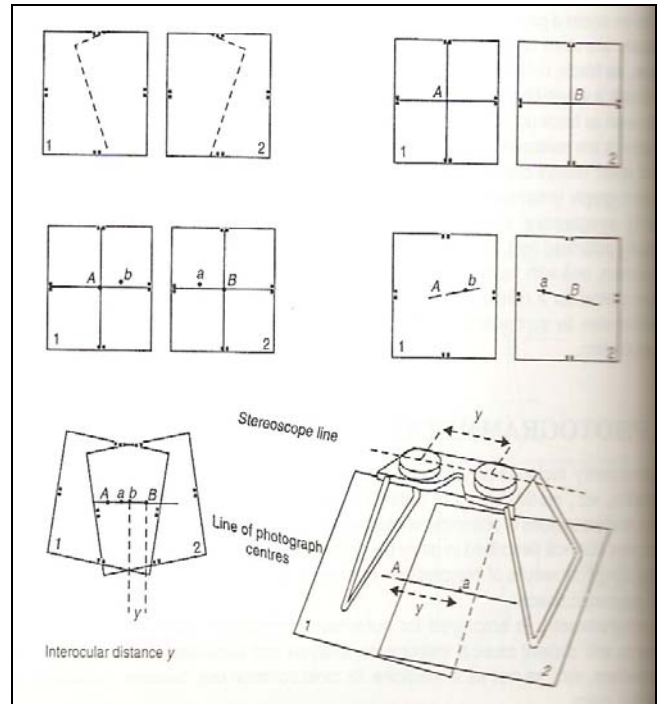


Figure 15

8. Conclusion

Stereoscopic vision is the basic prerequisite for photogrammetry and photo interpretation. Stereoscopy is defined as the science or art which deals with stereoscopic or other three dimensional effects and methods by which these effects are produced. The close objects are larger, brighter, and more detailed than distant object, and that the close object obstructs the view of distant object. Stereoscopy is a technique for creating or enhancing the illusion of depth in an image by means of stereopsis for binocular vision. Any stereoscopic image is called stereogram. Stereoscopy creates the illusion of three-dimensional depth from given two-dimensional images. Human vision, including the perception of depth, is a complex process which only begins with the acquisition of visual information taken in through the eyes; much processing ensues within the brain, as it strives to make intelligent and meaningful sense of the raw information provided. One of the very important visual functions that occur within the brain as it interprets what the eyes see is that of assessing the relative distances of various objects from the viewer, and the depth dimension of those same perceived objects. The brain makes use of a number of cues to determine relative distances and depth in a perceived scene, including stereopsis, accommodation of the eye, overlapping of one object by another, linear perspective, vertical position, change in size of textured pattern.

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