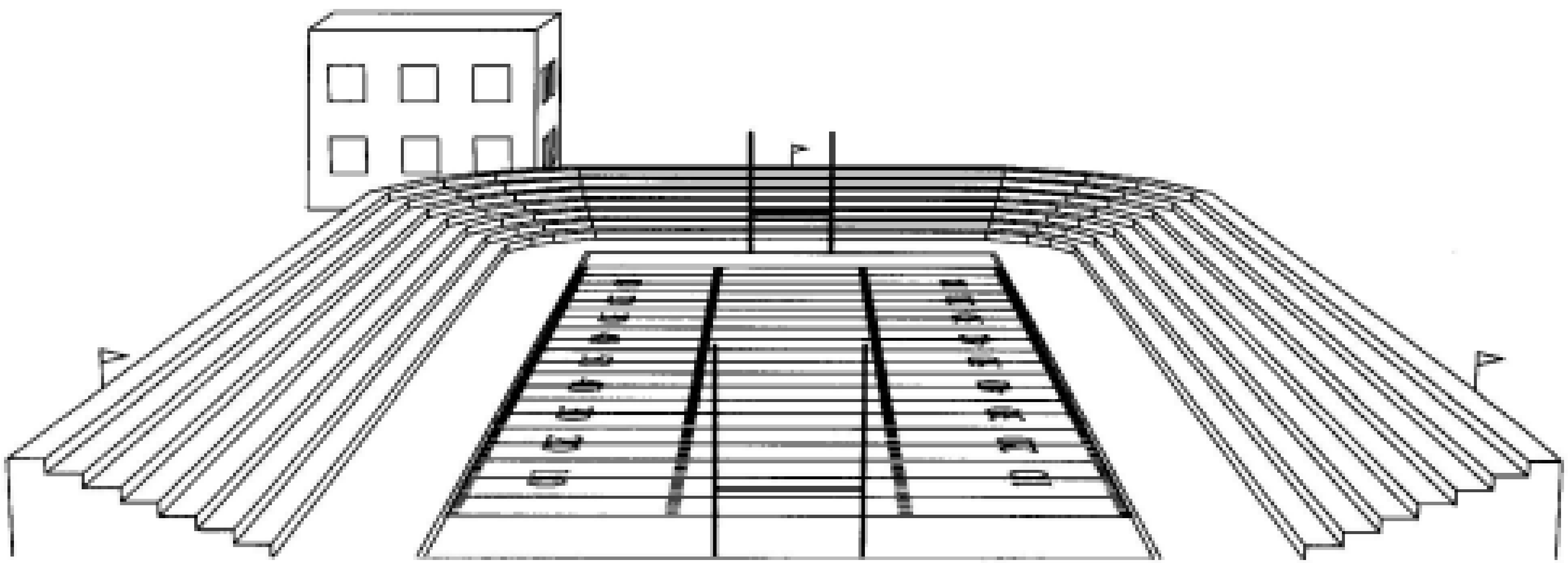
STEREOSCOPIC VIEWING

DEPTH PERCEPTION

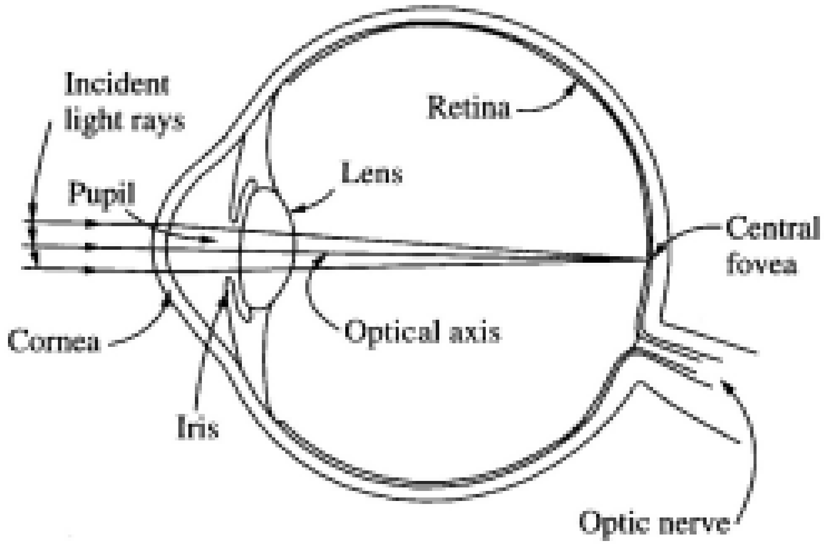
- Binocular vision – capable of viewing with both eyes simultaneously
  - Stereoscopic viewing – perception of depth when viewing through binocular vision
- Monocular vision – viewing with only one eye
  - Monoscopic viewing – judging depth with one eye

DEPTH PERCEPTION

- Distances perceived monoscipically by
  - Relative sizes of objects
  - Hidden objects
  - Shadows
  - Differencing in focusing

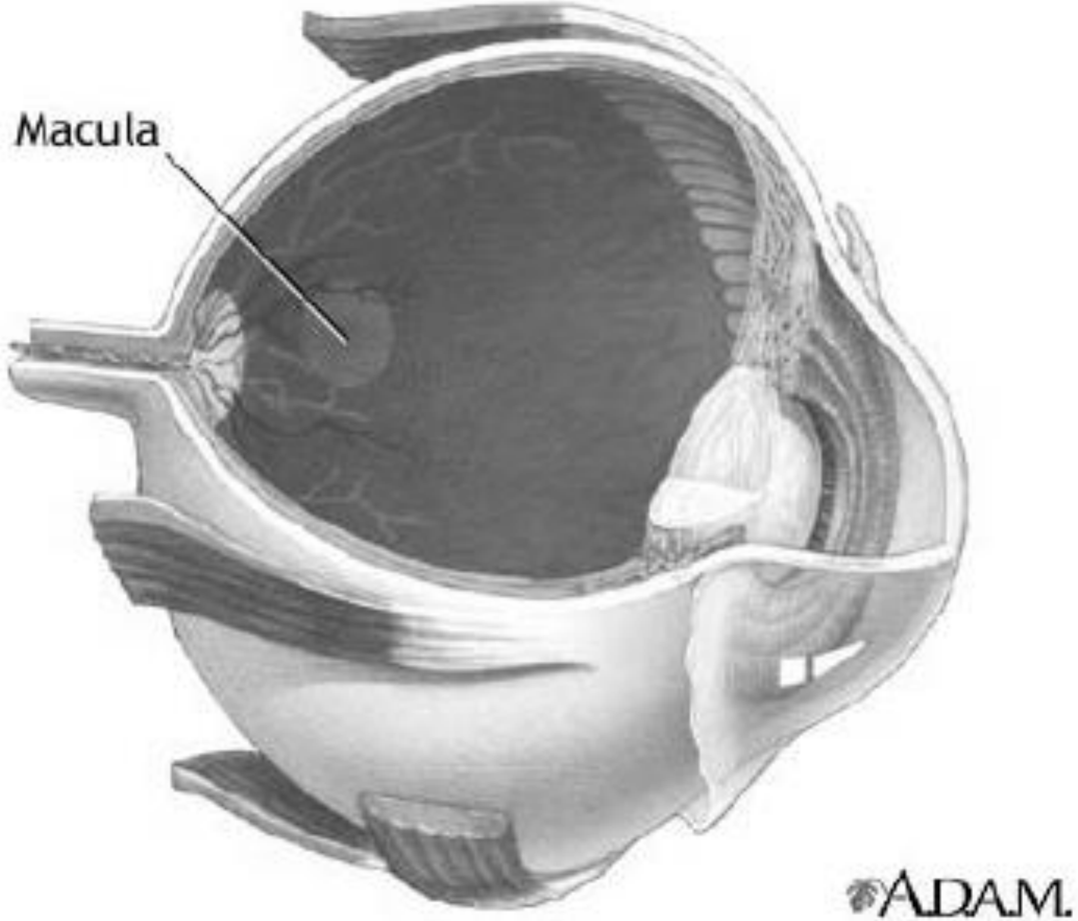


HUMAN EYE



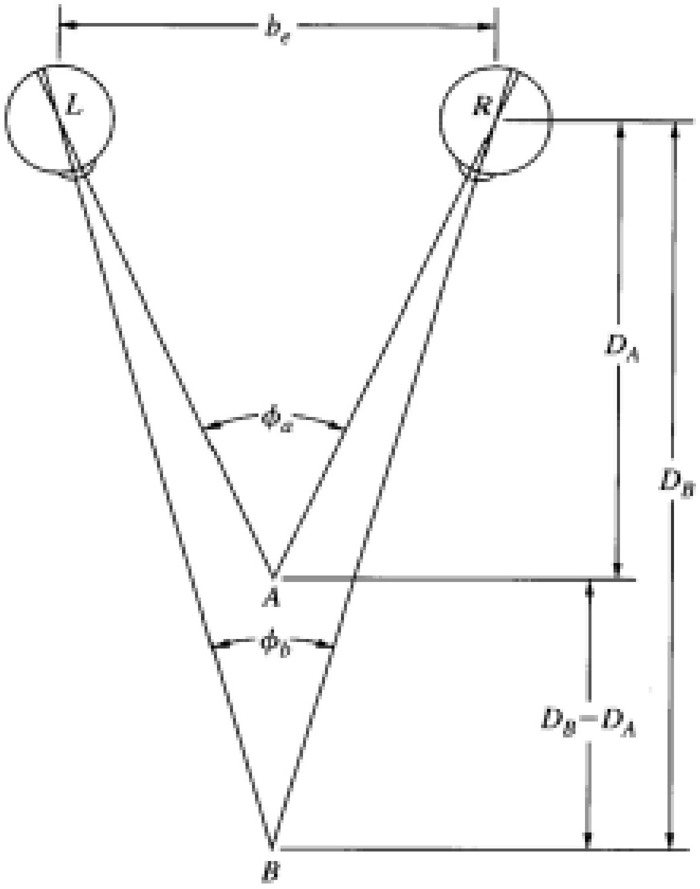
- Pupil – circular opening where light passes
  - Protected by cornea
- Light passes through lens and brought to focus at Central fovea
- Iris – diaphragm
- Optic nerve sends sense of vision to brain

MACULA LUTEA

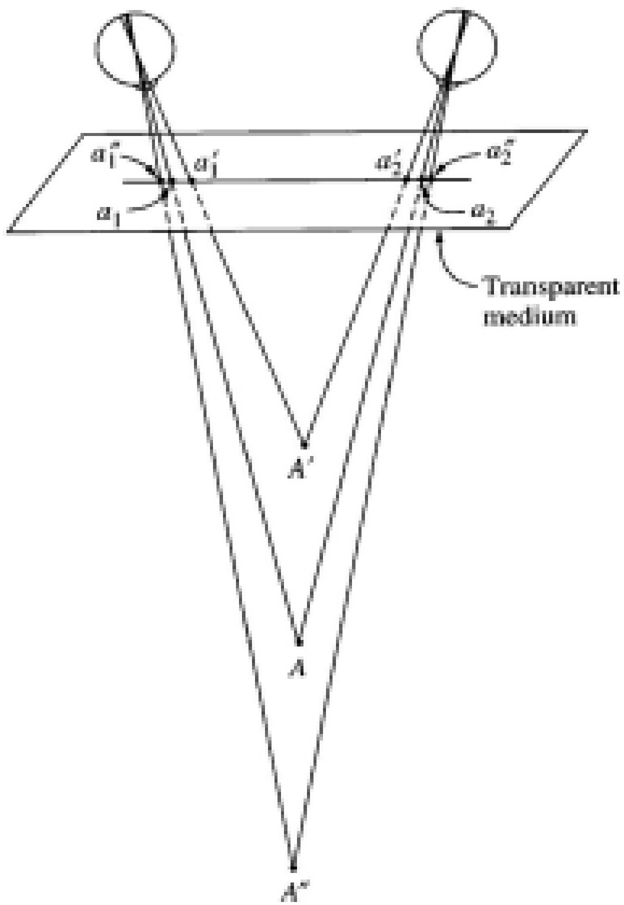


STEREOSCOPIC DEPTH PERCEPTION

- When eyes fix on point, optical axes converge on that point, intersection at an angle called parallactic angle (ϕ)
  - Nearer object, greater parallactic angle
- b_e – eye base
  - About 2.6" (63-69 mm)
- Depth between objects A and B is $D_B - D_A$



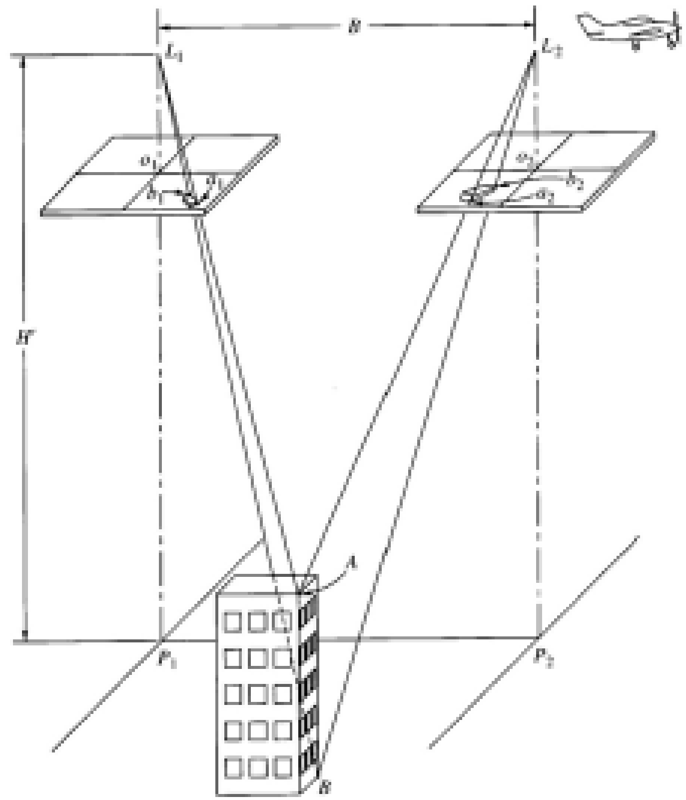
VIEWING PHOTOS STEREOSCOPICALLY



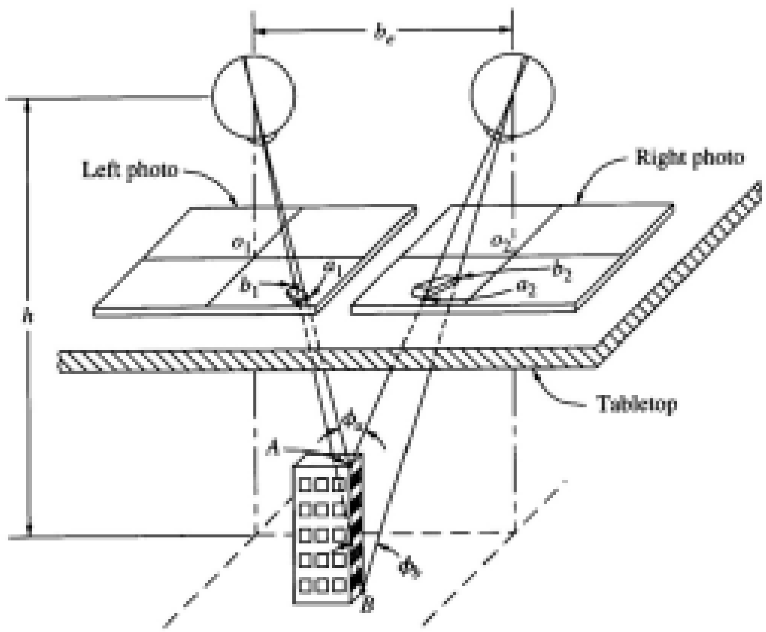
- As A moves to A′, image marks (a'_1 and a'_2) on transparent medium move closer together
  - Parallactic angle increases and object perceived nearer
- At A″, marks (a''_1 and a''_2) move apart
  - Parallactic angle decreases and object perceived farther away

VIEWING PHOTOS STEREOSCOPICALLY

- 2 exposures made at L_1 and L_2
  - Building on both photos
- B is air base – distance between exposures
- H′ is flying height above ground
- Top and bottom imaged on left photo at a_1 and b_1 and on right photo at a_2 and b_2



VIEWING PHOTOS STEREOSCOPICALLY

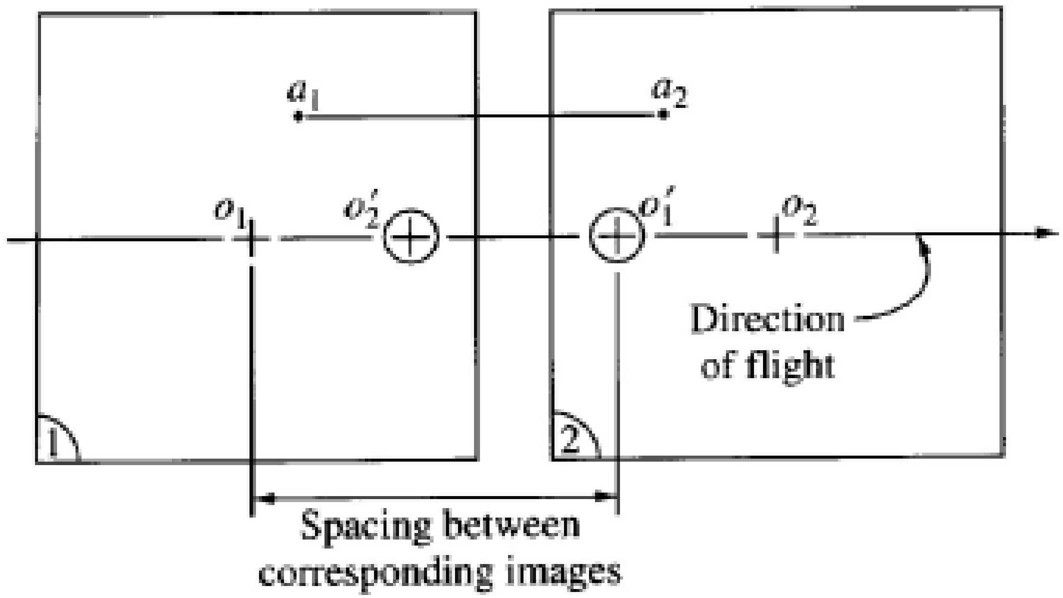


- Placing photos laid on table so left eye sees left image and right eye the right image
- Stereoscopic model (called stereomodel) appears below table top
- Brain judges height of building from differences in parallactic angle

STEREOSCOPES

- Pocket stereoscope
- Mirror stereoscope

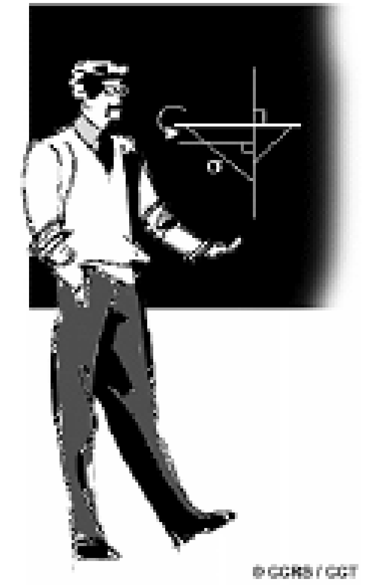
USE OF STEREOSCOPES



- Accurate & comfortable stereoscopic viewing requires eye base, line between centers of stereoscope lenses, and flight line be parallel
- Conjugate principal point (corresponding principal point

Y-PARALLAX

- Slight amounts causes eye strain & excessive amounts prevent stereoscopic viewing
- Causes of y-parallax
  - Photos improperly oriented
  - Unequal flying height between photos
  - Tilt in photography



VERTICAL EXAGGERATION

- Apparent scale disparity between horizontal and vertical scales
- Primary cause: lack of equivalence between photographic base-height ratio, B/H', and stereoviewing base-height ratio, b_e/h

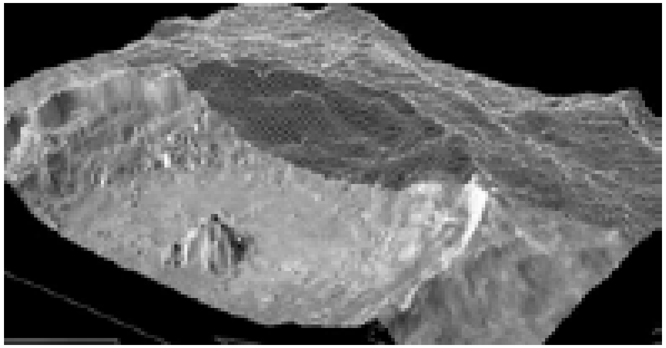
Vertical Exaggeration - Causes

Stereoscopic Causes

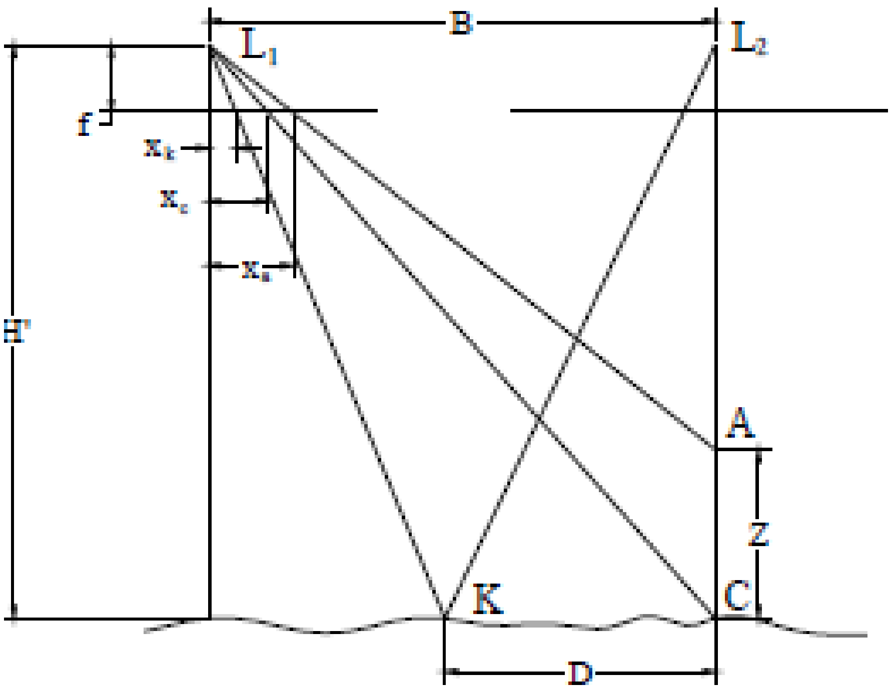
- Viewing distance
- Separation of photographs
- Eye base
- magnification

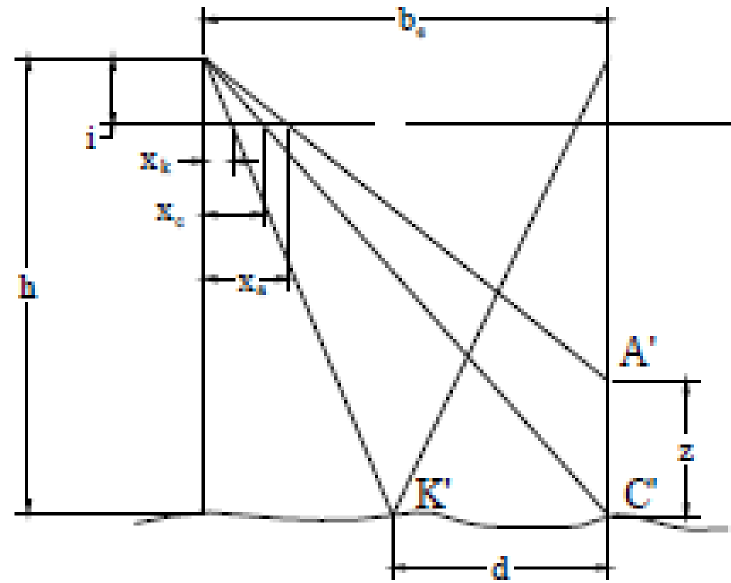
Photographic Causes

- Photographic scale
- Altitude above terrain
- Air base
- Terrain relief



VERTICAL EXAGGERATION





VERTICAL EXAGGERATION

- From aerial geometry

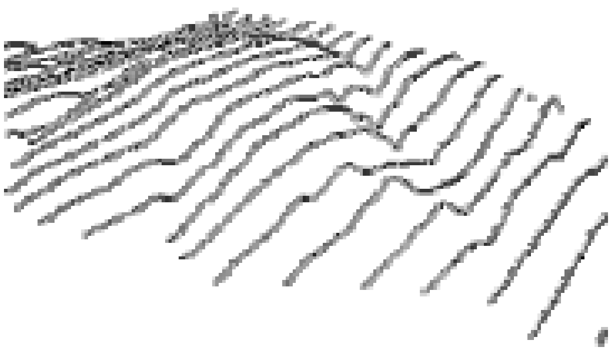
$$\frac{x_a}{B} = \frac{f}{H'-Z} \Rightarrow x_a = \frac{Bf}{H'-Z}$$

- From stereoscopic geometry

$$\frac{x_c}{B} = \frac{f}{H'} \Rightarrow x_c = \frac{Bf}{H'}$$

- Subtracting

$$x_a - x_c = Bf \frac{Z}{(H')^2 - H'Z}$$



VERTICAL EXAGGERATION

- From similar triangles

$$\frac{x_a}{b_e} = \frac{i}{h-z} \quad \Rightarrow \quad x_a = \frac{b_e i}{h-z}$$

$$\frac{x_c}{b_e} = \frac{i}{h} \quad \Rightarrow \quad x_c = \frac{b_e i}{h}$$

- Subtracting yields

$$x_a - x_c = b_e i \, \frac{z}{h^2 - hz}$$

VERTICAL EXAGGERATION

- Equating the 2 equations for $x_a - x_c$

$$Bf\frac{Z}{(H')^2 - H'Z} = b_e i \frac{z}{h^2 - hz}$$

- But Z and z are considerably smaller than H' and h, thus

$$\frac{BfZ}{(H')^2} \approx \frac{b_e iz}{h^2} \quad \Rightarrow \quad \frac{z}{Z} = \frac{fh}{H'i}\frac{Bh}{H'b_e}$$

VERTICAL EXAGGERATION

- From similar triangles in 2 diagrams

$$\frac{x_c - x_k}{D} = \frac{f}{H'} \quad \Rightarrow \quad D = \left(x_c - x_k\right)\frac{H'}{f}$$

$$\frac{x_c - x_k}{d} = \frac{i}{h} \quad \Rightarrow \quad d = \left(x_c - x_k\right)\frac{h}{i}$$

- From which

$$\frac{d}{D} = \frac{fh}{H'i}$$

VERTICAL EXAGGERATION

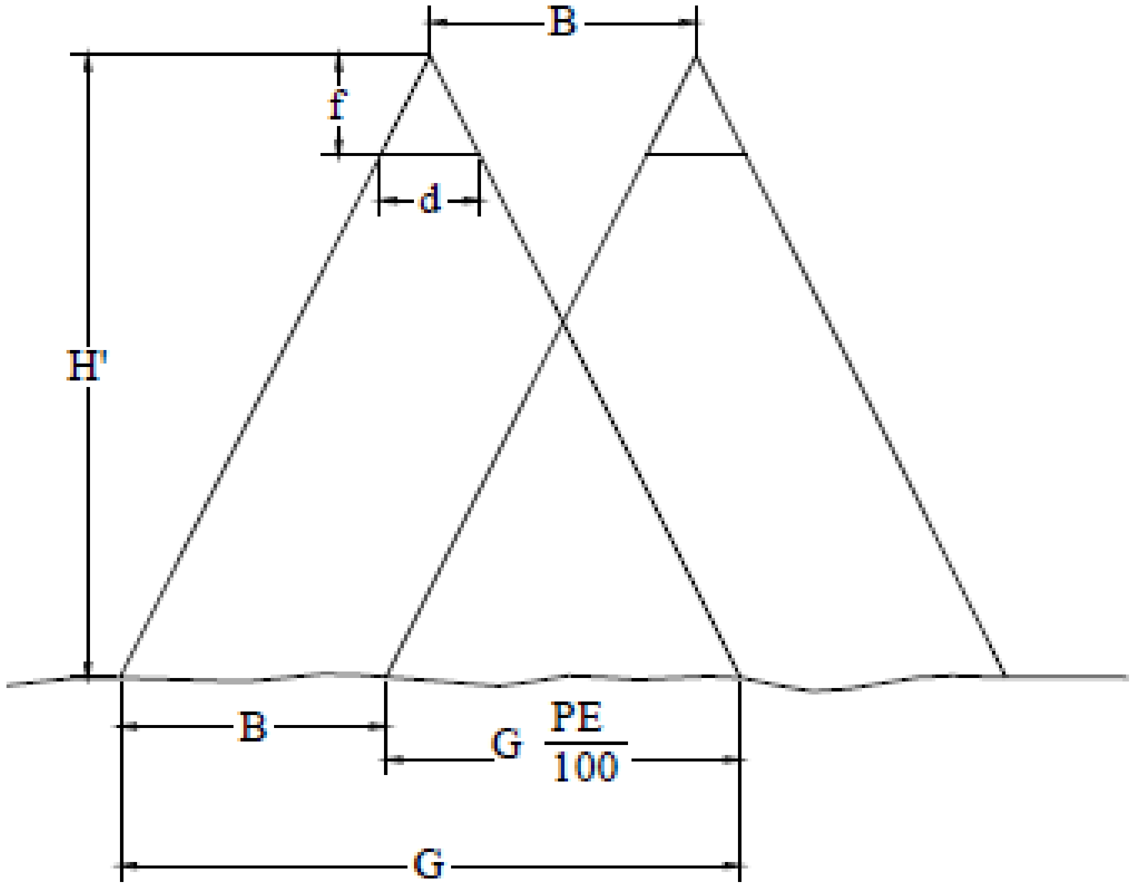
- Substitute into equation for z/Z

$$\frac{z}{Z} = \frac{d}{D}\frac{Bh}{H'b_e}$$

- If $Bh/(H'b_e)$ is 1, there is no vertical exaggeration. Thus, magnitude of vertical exaggeration, V, is given by

$$V \approx \frac{B}{H'}\frac{h}{b_e}$$

VERTICAL EXAGGERATION



VERTICAL EXAGGERATION

- From the figure

$$B = G - G\frac{PE}{100} = G\left(1 - \frac{PE}{100}\right)$$

$$\frac{H'}{G} = \frac{f}{d} \qquad \Rightarrow \qquad H' = \frac{fG}{d}$$

- From which

$$\frac{B}{H'} = \left(1 - \frac{PE}{100}\right)\frac{d}{f}$$

VERTICAL EXAGGERATION

- Example (7-1): What is the approximate vertical exaggeration for a vertical photo taken with a 152.4-mm focal length camera having a 23-cm square format if the photos were taken with 60% endlap?

VERTICAL EXAGGERATION

- Solution: $$\frac{B}{H'} = \left(1 - \frac{60}{100}\right)\frac{230}{152.4} = 0.60$$

- Assuming b_e/h is 0.15

$$V = 0.60\left(\frac{1}{0.15}\right) = 4.0 \quad \text{(approx.)}$$