AERIAL CAMERAS

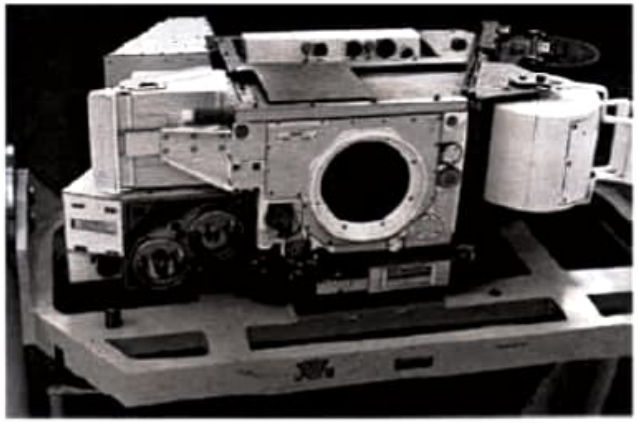
FILM-BASED CAMERAS

CAMERA

- Light-proof chamber or box in which the image of an exterior object is projected upon a sensitized plate or film, through an opening usually equipped with a lens or lenses, shutter and variable aperture
- In digital photography – use semiconductor electronics instead of film

Types of Aerial Cameras

- Frame camera (sensor)
  - Acquire image simultaneously over entire format



- The frame camera: exposes a square-shaped of ground all at the instant of time
- The continous strip:The film moves continously past a slit in the focal plane
- The panoramic camera: operates in a direction normal to the direction of flight.It takes a sweeping picture of the ground from right to left

AERIAL MAPPING CAMERA REQUIREMENTS

- Lens of high geometric quality
- Capable of exposing large no. of photos in rapid succession to exacting specifications
- Short cycle time
- Fast lenses
- Efficient shutter
- Functional under extreme weather conditions, like temperature and humidity, in spite of aircraft vibration
- Simple to use during photo mission
- Equipped with safeguards to protect against operator blunders
- Automatic as possible
- Able to preserve elements of interior orientation and preserve internal geometric relationships

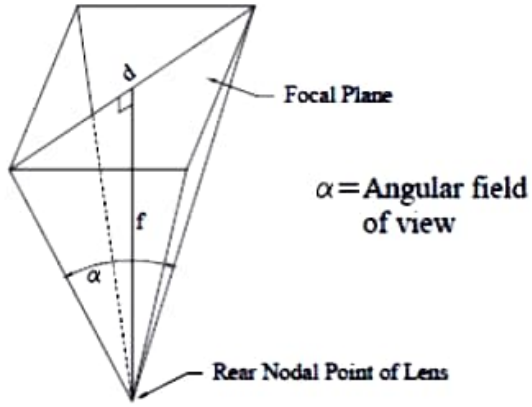
METRICAL CAMERAS

- Designed specifically for use in photogrammetry
- Precise determination of spatial positions of objects
- Traditionally use of roll film for recording images

SINGLE LENS FRAME CAMERA

- Lens held fixed relative to focal plane
- Film generally held fixed
- Classified by angular field of view
  1. Normal angle (up to 75°)
  2. Wide angle (75° – 100°)
  3. Superwide angle (> 100°)
- Angular field of view

$$\alpha = 2\tan^{-1}\left(\frac{d}{2f}\right)$$



Data of different lens assemblies

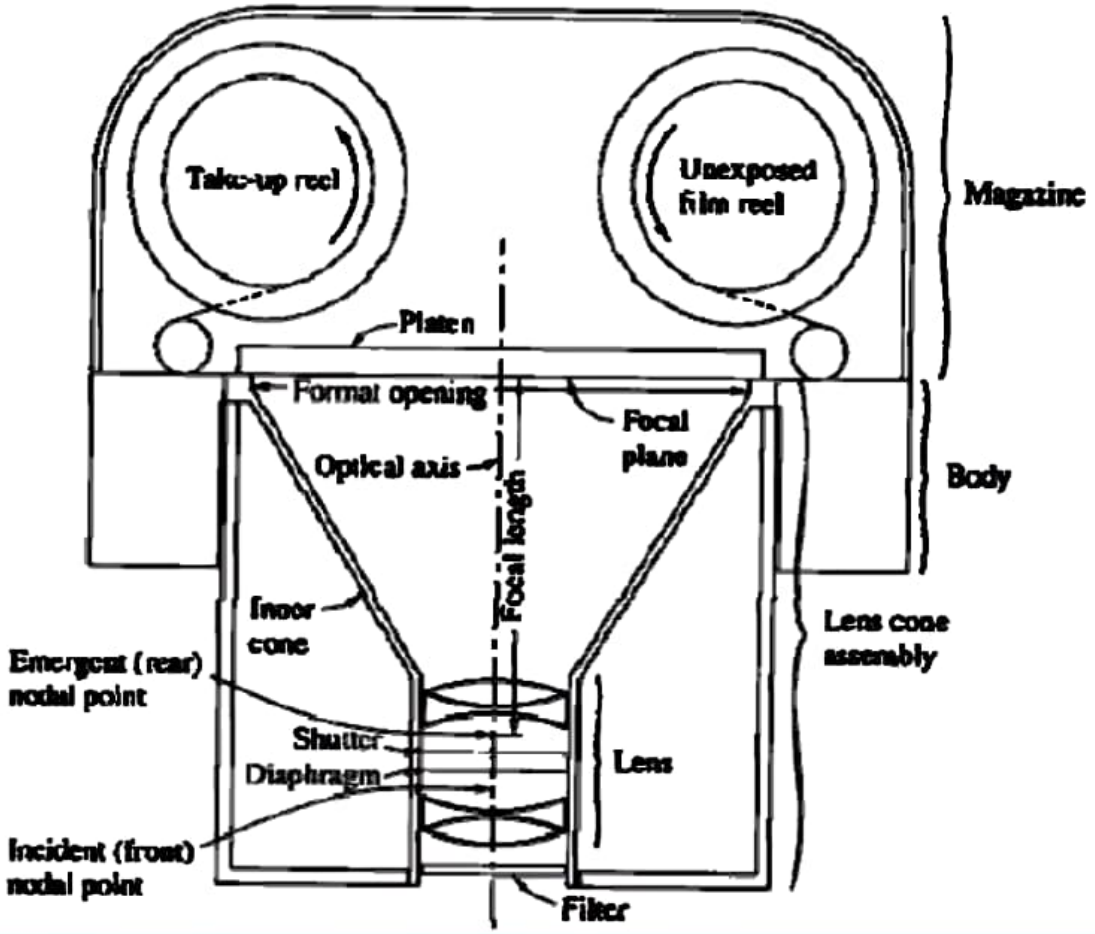
	super-wide	wide-angle	inter-mediate	normal-angle	narrow-angle
focal length [mm]	88.	153.	210.	305.	610.
field [o]	119.	82.	64.	46.	24.
photo scale	7.2	4.0	2.9	2.0	1.0
ground coverage	50.4	15.5	8.3	3.9	1.0

FRAME CAMERAS

- Used for most photogrammetric operations
- Principle parts are:

1. The lens assembly
2. The Inner cone
3. The focal plane
4. The Outer cone and body
5. The Drive Mechanism
6. The Magazine

AERIAL CAMERA PARTS



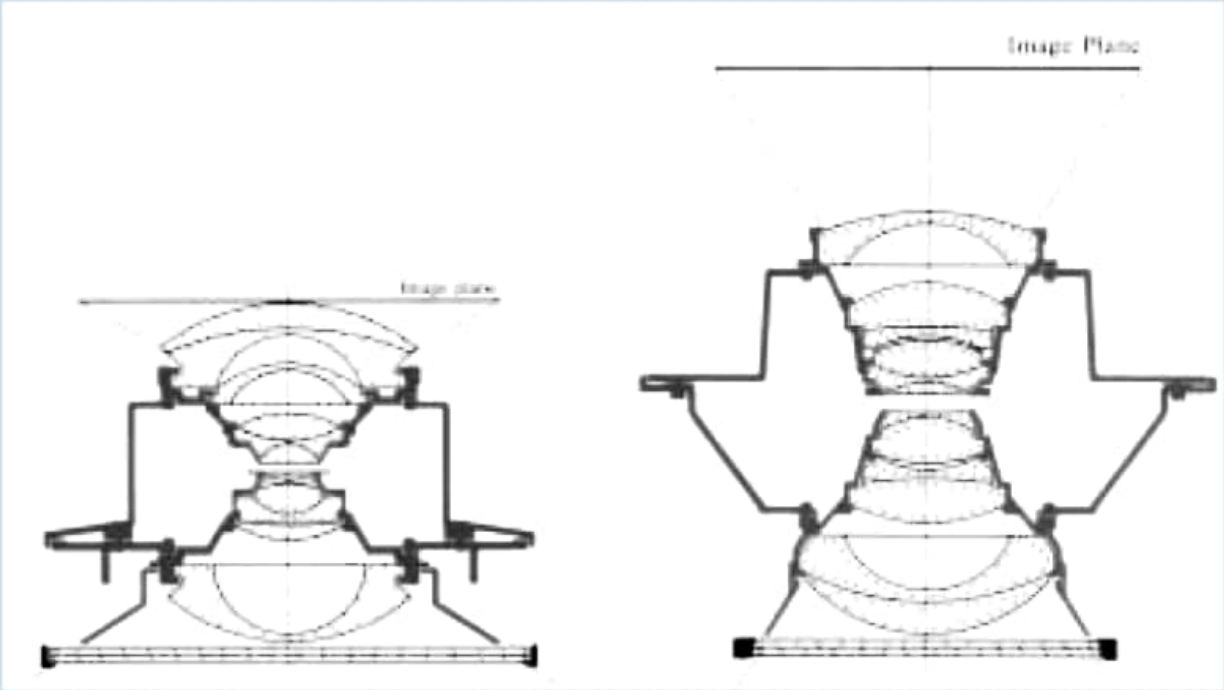
The lens assembly

- Forms the image of the ground being photographed in the focal plane
- The diaphragm and shutter control the exposure according to the amount of available light and film speed
- The Filter helps to penetrate the atmospheric haze

LENS

- Gathers light rays from object space and brings them into focus in the focal plane behind the lens
- Array of lenses aligned in lens cone

Cross-sectional view of aerial camera lenses



The Inner cone

- Holds the lens assembly fixed with respect to the upper surface (the focal plane) of the cone.
- The upper surface contains reference marks called fiducial marks which define the coordinate axes of the resulting photograph
- The relative positions of the lens axis, the focal plane and the fiducial marks fix the elements of interior orientation of the camera

FOCAL PLANE

- Plane where all incident light rays brought to focus
  - Aerial cameras have focus fixed for infinite object distance – set focal plane equal to focal length behind rear nodal point
- Defined by upper surface of focal-plane frame
  - Surface where film emulsion rests

Fiducial marks
Index marks imaged on film
Serve as reference photo coordinate system

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Outer cone and body

- To support the inner cone
- To hold the drive mechanism
- Furnish a support for the magazine

The Drive Mechanism

- Provides the motion necessary to wind and trip the shutter,flattenning the film in the focal plane and wind the film or change the plates between exposures

The Magazine

- Holds the exposed and unexposed film (or plates)
- Advances the necessary amount of film between exposures
- Houses the film flattening device
- For a 23 by 23 cm picture size, the magazine can hold up to 120m of film that is 24cm wide. This will yield as many as 475 exposures

Image Motion

- During the instance of exposure, the aircraft moves and with it the camera, including the image plane.
- Thus, a stationary object is imaged at different image locations, and the image appears to move.
- Image motion results not only from the forward movement of the aircraft but also from vibrations

Forward image motion

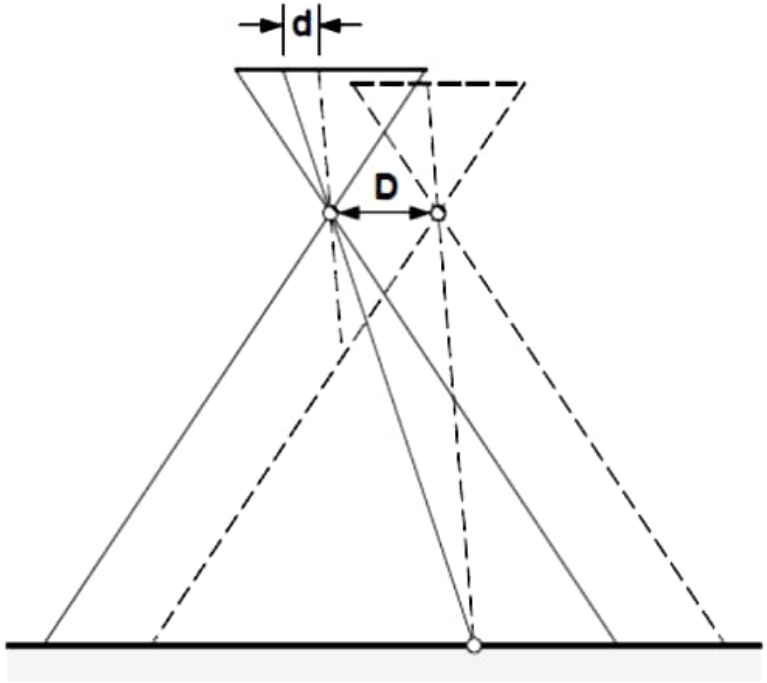


Figure 2.5: Forward image motion.

- An airplane flying with velocity v *advances by a distance* $D = v\,t$ *during the* exposure time t. *Since the object on the ground is stationary, its image moves by a* distance $d = D/m$ *where* m *is the photo scale. We have*

$$d = \frac{v\,t}{m} = \frac{v\,t\,f}{H}$$

with *f the focal length and H the flying height.*

Example: given

- exposure time t =*1/300 sec*
- velocity v= *300 km/h*
- focal length f= *150 mm*
- flying height H= *1500 m*
- **image motion d =28 μm**

FORWARD MOTION COMPENSATION

- Move film slightly across focal plane during exposure in flight direction

- Example (3.1) Camera with f = 152.4 mm, airplane velocity = 200 km/hr, flying height above terrain = 3,500m, exposure time = 1/500 sec. What distance (in mm) must film move across focal plane to obtain clear image?

FORWARD MOTION COMPENSATION

- Solution:
  - Distance plane travels during exposure

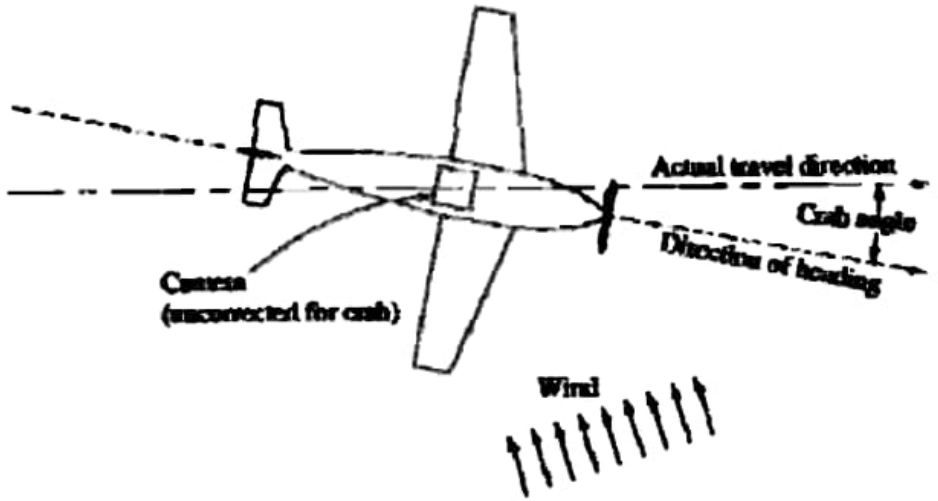
$$D = (200\ \text{km/h})\left(\frac{1}{500}\text{sec}\right)\left(\frac{1\ \text{hr}}{3600\ \text{sec}}\right)\left(\frac{1000\ \text{m}}{1\ \text{km}}\right) = 0.11\ \text{m}$$

  - Distance image moves during exposure

$$d = 0.11\ \text{m}\left(\frac{152.4\ \text{mm}}{3500\ \text{m}}\right) = 0.005\ \text{mm}$$

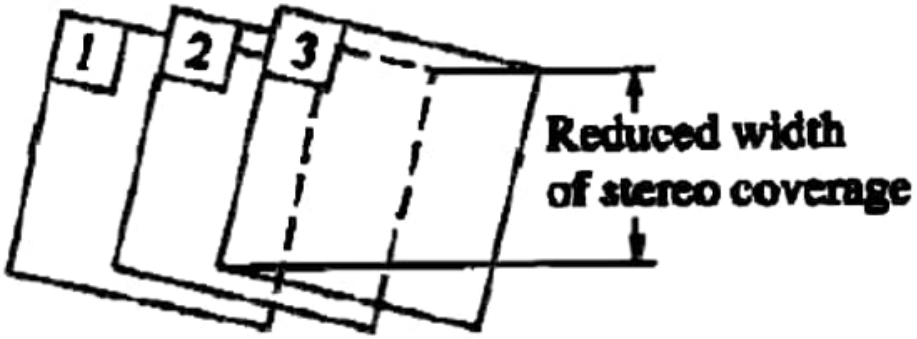
CAMERA MOUNTS

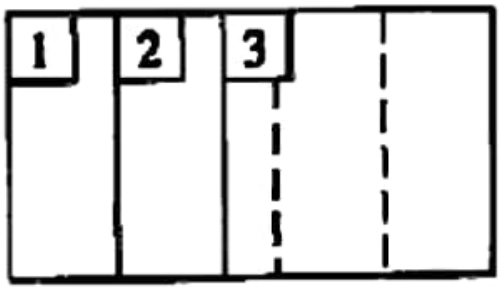
- Attaches camera to aircraft
- Constrains angular alignment of camera
- Minimum mount has dampener devices & crab correction
- Crab
  - Difference in camera orientation w.r.t. aircraft's actual travel direction



EFFECT OF CRAB

- Undesirable effect – reducing stereoscopic ground coverage of aerial photos

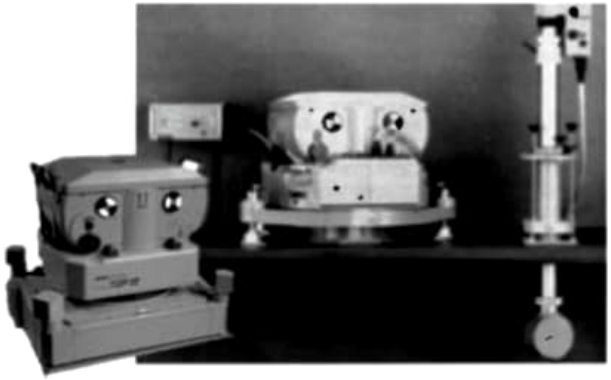




CAMERA CONTROLS

- Intervalometer
  - Device that automatically trips shutters & activates camera cycle
  - Interval depends on focal length, format size, end lap, flying height, velocity
  - Modern intervalometers – part of integrated unit incorporating GPS

CAMERA CONTROLS



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ZEISS RMK A 15/23 WIDE-ANGLE CAMERA

- With ICC/NS-1Central Interval Computer and NT-1 Navigation Telescope
- Pleogon A (153 mm) lens, 93° angular field of view, Max nominal distortion 2 µm
- Used for general work
  - Aerotriangulation, topographic and large-scale mapping