R. C. Patel College of Engineering & Polytechnic, Shirpur

Department of Civil Engineering

Name of Subject: - **ADVANCED SURVEYING (ASU)**

Course Code: - **313321**

Scheme:- **CE-3K**

Semester:- **Third**

Unit No. 05 - Aerial Surveying and Photogrammetry

CO5 - Interpret the images of given terrain using Photogrammetry Techniques.

Unit	Title	COs	Learning hours	R Level	U Level	A Level	Total Marks
V	Aerial Surveying and Photogrammetry	CO5	08	04	04	04	12

THEORY SYLLABUS CONTENT

Unit - V Aerial Surveying and Photogrammetry

5.1 Aerial surveying: Definition, principle, uses, methods

5.2 DGCA Classification of Drones, Silent features of Drone Rules, 2021 as per DGCA.

5.3 Definition of photogrammetry, Basic Principles of Photogrammetry. Types of Photogrammetry: Terrestrial and Aerial Photogrammetry

5.4 Types of Photographs, Terminology in aerial surveying.

5.5 Merits and Demerits of Photogrammetry surveying

5.6 Applications of Photogrammetry in civil engineering.

Subject In charge

Mr. D. B. Wagh

Unit - 5

Aerial surveying and photogrammetry

Aerial surveying :-

Aerial surveying is the collection of geospatial data, topographical measurement, and imagery using sensors mounted on airborne platforms.

→ These platforms includes airplanes, helicopters, drones and balloons

→ The technique involves capturing images or other forms of remote sensing data from above the Earth's surface, which can then be used in various fields such as create detailed maps, 3D models, and other representations of the surveyed area.

*Principle of Aerial surveying :-

It is based on collecting information about the earth surface from the air using aircraft, drones, or satellites equipped with cameras and sensors. The collected data is processed to prepare maps, plans, and 3D models.

Key principles of Aerial surveying :-

1) Remote sensing :- It is the process of obtaining information about an object or area without physically touching it
Techniques :- Aerial photography, LiDAR (Light Detection & Ranging), Multispectral

2) Georeferencing * :→
Georeferencing is the process of assigning real-world coordinates (latitude, longitude, and elevation) to arial photographs, maps, or survey data so that their exact position on the Earth's surface can be identified.
Tools used :- GPS, GNSS (Global Navigation Satellite system)

3) Data capture :- Collection of data from the Earth's surface using different sensors
methods :- Aerial photography, LiDAR survey, multi spectral

4) Data processing :- converting collected raw data into useful information

methods :- photogrammetry, LiDAR data processing, image processing.

5) Output Generation :- final products obtained after processing aerial survey data

output :- Maps, 3D models, Analysis Reports.

* Uses of Aerial surveying

1. Topographic Mapping :-
   a) Preparation of topographic maps showing contours, rivers, roads, and other features.
   b) Useful for engineering and construction projects.
2. Route survey :-
   a) selection of suitable routes for highways, railways, canals pipelines, and transmission lines.
3. Urban planning :-
   - planning of cities and towns,
   - monitoring urban growth and land development
4. Land use and Land Cover Mapping
   - Identification of agricultural land, forests, water bodies and built-up areas.
   - Helps in land management.
5. Agriculture
   - monitoring crop healt and crop area also estimation of crop production.
6. Forest survey
   - Mapping forest areas
   - Monitoring deforestation and forest resources.
7. Mining and Geological survey :-
   - Identification of mineral resources
   - planning and monitoring mining activities.

8. Disaster management

- Assessment of flood, earthquake, landslide and cyclone affected areas.

9. Environment studies

- Monitoring pollution, forests, rivers, and coastal areas.
- Studying environmental changes.

* Methods of Aerial surveying →

1) Aerial photography
2) Lidar (light detection and Ranging)
3) Multispectral and Hyperspectral Imaging
4) Thermal Imaging
5) Synthetic Aperture Redar (SAR)
6) photogrammetry
7) Doone (UAV) surveying)
8) GNSS (Global Navigation satelite system)
9) SLAM (Simultaneous Localization and Mapping)

1) Aerial photography

Methods :- a) Vertical photography.
b) Oblique Photography.

a) Vertical photography :-

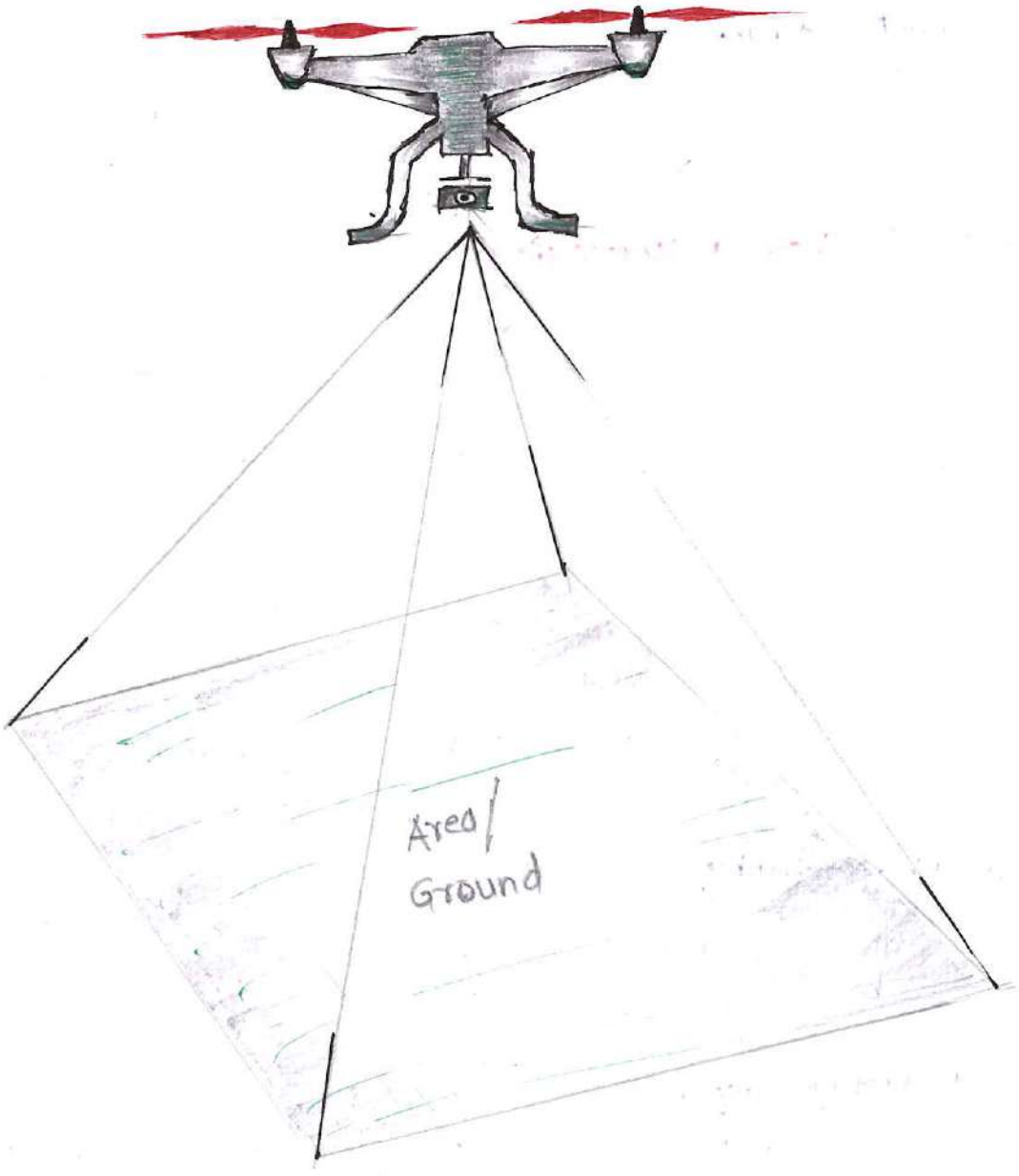
In this method, the camera axis is kept nearly vertical (perpendicular) to the ground while taking photographs.

b) Oblique Photography :-

In this method, the camera axis is intentionally inclined (tilted) from the vertical position.

* DGCA classification of drones

DGCA ⇒ Directorate General of Civil Aviation



- DGCA has established specific classifications for drones based on their maximum take-off weight (MTOW).
- It helps in regulating and managing drone operations within the country.

1) Nano drones (≤250g)
2) Micro drones (250g to 2kg)
3) Small drones (2kg to 25kg)
4) Medium drones (25kg to 150kg)
5) Large drones (>150kg)

1) Nano Drones - Weight :- Upto 250grams (0.25kg)
- Usege : Recreational and hobby purpose
- Regulations : require minimal permission for certain areas

2) Micro Drones :- Weight :- More than 250grams and up to 2 kg.
Usege :- Recreational & professional applications.
- Regulations :- Require registration & permission for certain operations, especially in controlled airspace or for commercial area

3) Small Drones : Weights :- More than 2kg & up to 25 kg
Usege :- commercial / Industrial → surveying, agriculture, Inspection.
- Regulations :- Required registration, operation training, permission for sp. operation.

4) Medium Drones :- Weight :- More than 25kg upto 150 kg.
Usage :- special commercial & Industrial task, large scale surveying, delivery service.
- Regulations :- Requires detailed registration, operator certification & permission.

5) Large Drones :- Weight :- More than 150 kg.
Usage : Used for heavy duty Industrial applications, cargo transport, & large scale surveillance
Regulations : Requires comprehensive registration, operator certification and adherence to stringent operational and safety guidlines.

* Silent Features of Droone Rules, 2021 as per DGCA

1) Digital sky online platform
- Single window online system for registration and licensing permission

2) Classification of drones based on weight
i) Nano Drones (≤ 250 gm)
ii) Micro Drones (250 gm to 2 kg)
iii) Small Drones (2kg to 25 kg)
iv) Medium Drones (25 kg to 150 kg)
v) Large Drones (> 150 kg)

3) Unique Identification Number (UIN)

Every drones must obtain a unique Identification Number (UIN), except where exempted under the rules.

4) Remote pilot certification :-

- Remote pilot must obtain a remote pilot certificate from an authorized training organization for specified categories of drones.

5) No permission, No Take off (NPNT) :-

- Drones must comply with the NPNT system before operation where applicable

6) Airspace Map :-

Three - zone classification

i) Red Zone :- No drone operations without permission

ii) Yellow zone :- controlled airspace requiring permission for operations.

iii) Green Zone :- Free to fly up to 400 feet without prior permission.

iv) Interactive Maps :- Regularly updated maps to inform operators about permissible areas for flying.

7) Safety and Security :-

must follow safety guidlines provided by DGCA, Operations near airports, military areas, and sensitive locations are restricted.

8) Reduced Approvals

9) promotion of Drone Industry

10) Penalties for violations

* Photogrammetry :→

Definition :-

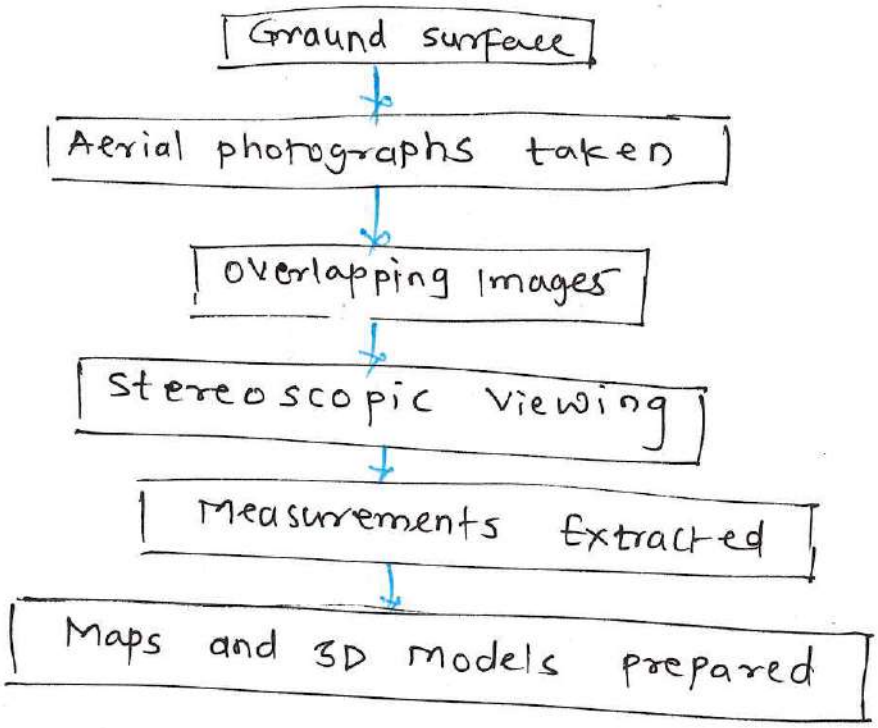
It is Art, Science and technology of obtaining reliable Information about physical objects and the environment through processes of recording, measuring and interpreting photographic Images.

(OR)

- Process of making surveys and maps using photographs.

* Basic Principles of photogrammetry.

The basic principle of photogrammetry is based on stereoscopic vision, which means observing the same object from two different positions to determine its shape, size, and location.



Types of Photogrammetry :-

1) Aerial photogrammetry
(photos from Air)

2) Terrestrial photogrammetry
(Photos from ground)

(1) Aerial photogrammetry :-

Aerial photogrammetry is the process of obtaining measurements and information from photographs taken from the air using aircraft, drones or satellites.

Features :- (1) covers large areas
(2) Uses aerial photographs.
(3) suitable for mapping and surveying.

Applications :-
i) Topographic mapping
ii) Route surveys
iii) Land use mapping
iv) Urban mapping.
v) Geology & mining
vi) Agriculture

(2) Terrestrial photogrammetry :-

Terrestrial photogrammetry is the process of obtaining measurements from photographs taken from the ground.

features:- i) camera is placed on the ground
ii) Suitable for small areas and structures.
iii) Used for detailed measurements.

Applications :-
i) Building survey
ii) Bridge survey
iii) monument documentation
iv) Engineering projects.
v) Archaeology

Trick -
Air → Aerial
Terrain → Terrestrial (Ground)

* Types photographs :-

1) Terrestrial photographs :-

Taken from ground-based cameras (e.g., tripods or handled) to map smaller objects, architectural structures or vertical faces.

2) Aerial photographs :-

Taken from aircroft or drones (UAVs), these are the industry standard for mapping large land areas. They are classified by the tilt of cameras lens relative to earth's surface

i) Vertical Photographs :- camera axis is pointed ⊥er to ground

ii) Oblique photographs :- i) low oblique - tilted @ roughly 30°
ii) High oblique - Tilted @ larger angle around 60°

3) Satellite photographs :-

Captured by satellites in orbit, these are used for massive regional mapping, geographical information systems (GIS), & Global terrain modeling.

4) Categorization by sensor Type :-

i) RGB :- Standard true colour photos

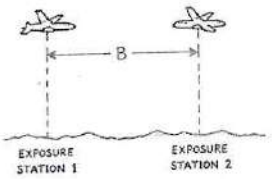
ii) Multispectral :- Infrared bands, used for agriculture.

iii) Thermal :- Heat Signatures, Used for Infrastructure Inspection

TERMINOLOGY IN AERIAL SURVEYING

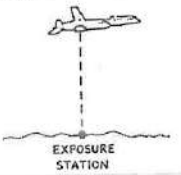
1. Air Base (B)

Distance between two successive exposure stations. (Distance between two positions of aircraft)



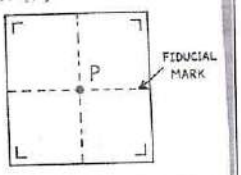
2. Exposure Station

Position of the aircraft when a photograph is taken.



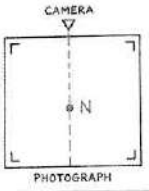
3. Principal Point (P)

The point on the photograph where the camera axis intersects the photograph.



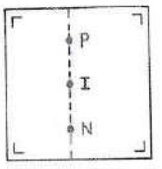
4. Nadir Point (N)

The point on the photograph vertically below the camera lens at the moment of exposure.



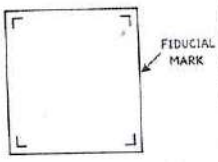
5. Isocentre (I)

The point lying midway between the Principal Point and Nadir Point.



6. Fiducial Marks

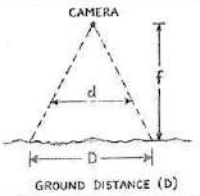
Reference marks fixed on the edges of a photograph by the camera.



7. Photo Scale

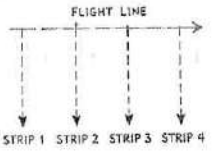
The ratio of a distance measured on a photograph to the corresponding distance on the ground.

$$\text{Scale} = \frac{\text{Photo Distance}}{\text{Ground Distance}}$$



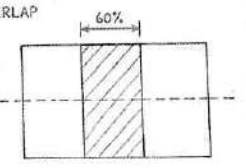
8. Flight Line

The path followed by the aircraft during aerial photography.



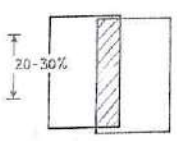
9. Forward Overlap (End Lap)

The common area covered by two consecutive photographs in the same flight line.



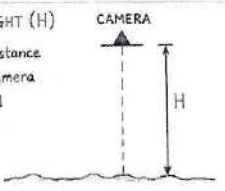
10. Side Overlap (Side Lap)

The common area covered by photographs of adjacent flight lines.



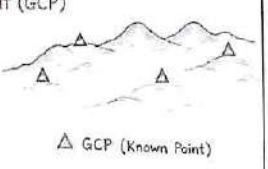
11. Flying Height (H)

The vertical distance between the camera and the ground surface.



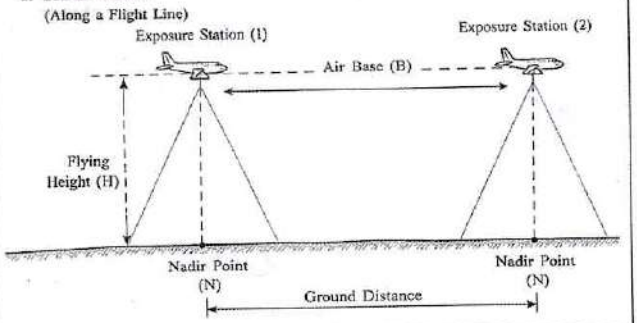
12. Ground Control Point (GCP)

Known points on the ground used for accurate positioning and georeferencing of aerial photographs.

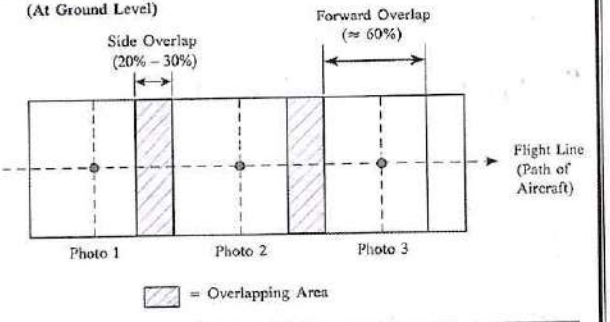


TYPICAL DIAGRAM OF AERIAL SURVEYING

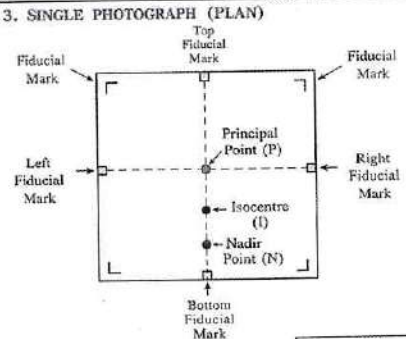
1. SIDE VIEW
(Along a Flight Line)



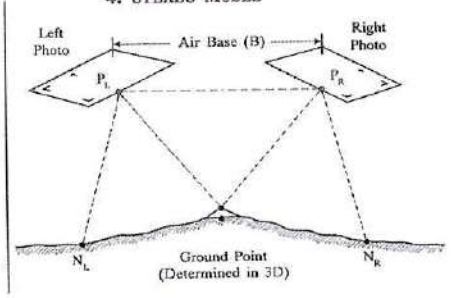
2. PLAN VIEW
(At Ground Level)



3. SINGLE PHOTOGRAPH (PLAN)



4. STEREO MODEL



LEGEND

- B – Air Base
- H – Flying Height
- P – Principal Point
- N – Nadir Point
- I – Isocentre
- P_L – Principal Point on Left Photo
- P_R – Principal Point on Right Photo
- N_L – Nadir Point on Left Photo
- N_R – Nadir Point on Right Photo

NOTE : Typically, Forward Overlap = 60% and Side Overlap = 20% – 30%

* Merits and Demerits of photogrammetry surveying

⇒ Merits (Advantages) of photogrammetry :

1) Covers large areas quickly
2) Useful for inaccessible and hazardous areas.
3) Provides permanent photographic record.
4) High accuracy for topographical mapping
5) Less field work required

⇒ :

⇒ Demirits (Disadvantages) of photogrammetry

1) Affected by weather conditions (i.e clouds, rain, fog, etc)
2) Requires skilled personnel for data processing and interpretation.
3) High intial cost (i.e camera, drones, aircraft & software are expensive)
4) Cannot survey underground features.
5) Complex data processing

* Applications of photogrammetry in civil Engineering

1) Topographic Mapping :-
- preparation of topographic maps showing contours and ground features.
- Used for planning engineering projects.

2) Rout survey :-
- selection of routes for highways, railways canals, pipelines, and transmission lines.

3) Urban planning and development :-
- Assessing potential construction sites by analyzing topography, vegetation, and existing structures.
- Aiding in the layout and design of roads, bridges, and other infrastructure elements.

4) Bridge and Tunnel Engineering :-

Capturing detailed images of bridges and tunnels for structural analysis and safety assesments.

5) Flood Risk Management :-

— Creating accurate floodplain maps to assess and manage flood risks & provide eff. drainage systems.

6) Mining and quarrying :-

— Measuring stockpile volumes and calculating the amount of extracted material.

7) Digital Terrain Model (DTM) and 3D modelling

- preparation of terrain models and three-dimensional representation of land surface.

Unit No - 5

Important Questions

1) State any two merits of photogrammetry surveying.
2) Define Aerial Surveying
3) State any four uses of aerial surveying.
4) State the classification of Drones according to DGCA.
5) State and explain any one method of aerial surveying
6) Mention any two merits and demerits of photogrammetry surveying.
7) Explain any two applications of remote sensing
8) Explain the classification of drones as per DGCA.
9) Explain any two salient features of drones.
10) ~~Explain any two salient features of drones.~~
10) Explain geo-fencing.
11) Explain any two applications of photogrammetry in civil Engineering.
12) Explain the Types of photogrammetry.
13) State the Terminology in Aerial surveying.
14) Define photogrammetry surveying.
15) Explain key components of aerial surveying.