Aerial Photograph Types and Characteristics

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Dr. SHYAMA PRASAD MUKHERJEE UNIVERSITY, RANCHI

1.1 What is Aerial Photographs?

Photographing from air is basically known as aerial photography. The word ‘aerial’ derived in early 17th century from Latin word aerius , and Greek word aerios . The term "photography" is derived from two Greek words phos meaning "light" and graphien meaning "writing" means "writing by light".

Aerial photography comes under the branch of Remote Sensing. Platforms from which remote sensing observations are made are aircraft and satellites as they are the most widespread and common platforms. Aerial photography is a part of remote sensing and has wide applications in topographical mapping, engineering, environmental science studies and exploration for oil and minerals etc. In the early stages of development, aerial photographs were obtained from balloons and kites but after the invention of aircrafts in 1903 aircrafts are being used widely for aerial photographs.

The sun provides the source of energy (electromagnetic radiation or EMR) and the photosensitive film acts as a sensor to record the images. Diversifications observed in the images of photographs shows the different amount of energy being reflected from the objects as recorded on the film. Nowdays aerial photography also become digital where values of reflected electromagnetic radiation is recorded in digital numbers.

An aerial photograph is any photograph taken from an airborne vehicle (aircraft, drones, balloons, satellites, and so forth). The aerial photograph has many uses in military operations; however, for the purpose of this manual, it will be considered primarily as a map supplement or map substitute.

Characteristics of Aerial Photographs:

1. **Synoptic view:**
   Recording or taking aerial photographs spatially over large area is like birds eye view from the top. These technologies allows discriminating and detecting small scale features and spatial relationships among them.
2. **Time freezing ability**:
   They are defined as virtually permanent records of the existing conditions on Earth’s surface at one point of time, and further can be used as past document.

3. **Capability to stop action:**

   They provides a stop action view of dynamic state and are used in studying the variable/dynamic phenomena such as flooding, moving wildlife, traffic, oil spills, forests fires, changing dynamics in natural phenomenon etc.

4. **Three-dimensional perspective:**

   Aerial photographs provide a stereoscopic view of the Earth's surface where one can make horizontal and vertical measurements.

5. **Spectral and spatial resolution:**

   Aerial films are susceptible to electromagnetic rays in wavelengths ((0.3 µm to 0.9 µm) beyond spectral sensitivity of the human eye (0.4 µm to 0.7 µm).

6. **Availability:**

   Airborne photographs can be taken on user specific time and make permanent record at a range of scales for any area.

1.2 Factors that influence Aerial Photography

Scale

Scale is define as the ratio of distances between two images on an aerial photograph and the actual distance between the same two points/objects on the ground, in other words the ratio f/H (where f is the focal length of the camera lens and H is the flying height above the mean terrain), shown in figure 1. Change in scale from photograph to another is because of the variations in flying height other factors that further affect the scale variations are tilt and relief displacements. Aerial photograph, the image should be of the highest quality. To guarantee good image quality, recent distortion-free cameras are used. Some latest versions of cameras have image motion compensation devices to eliminate or reduce the effects of forward motion. Depending upon the requirements, different lens/ focal length/film /filter combinations can be taken in use.

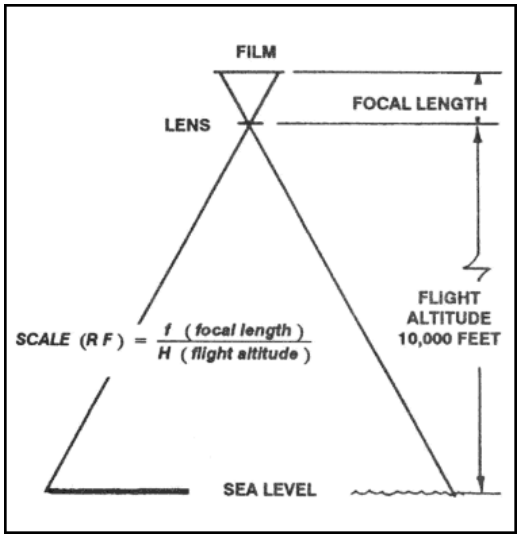

Fig: 1. Scale of photograph

Camera/Film/Filter Combinations

Aerial Cameras:

Aerial Cameras are special cameras that are built for mapping which have high geometric and radiometric accuracy. Airborne camera are built with exactness and purposely designed to expose a large number of films/photographs in speedy succession with the ultimate in geometric fidelity and quality. Aerial cameras generally have a medium to large format, with good quality lens, a large film magazine, a mount to hold the lens, the camera in a vertical position and a motor drive.

There are various types of aerial cameras such as Aerial mapping camera (single lens), Reconnaissance camera, Strip camera, Panoramic camera, Multi- lens camera, multiband aerial cameras, Digital camera.

Aerial Films:

Aerial film is multi layer emulsion laid on a stable anti-halation base. Generally aerial films are available in rolls that has cross section of about 10 inch in wide and 200 to 500 ft in length.

Types of Film:

Depending upon the suitability for different purpose and unique situations variety of films are available that are used. Panchromatic and natural color films are the two most commonly utilized films. These two films along with infrared and false colour form the basic media used in aerial photography. As shown below in fig.2.

Fig: 2. Types of film photographs

Panchromatic:

Panchromatic, more often termed black and white, is the most commonly encountered film employed for photogrammetry. The sensitive layer consists of silver salt (bromide, chloride, and halide) crystals suspended in a pure gelatine coating which sits atop a plastic base sheet. The emulsion is sensitive to the visible (0.4- to 0.7-µm) portion of the electromagnetic spectrum.

Colour:

Natural colour also known as true colour film.. The multilayer emulsion is sensitive to visible region of electromagnetic spectrum. There are three layers of gelatine containing sensitized dyes, one each for blue (0.4–0.5 µm), green (0.5–0.6 µm), and red (0.6–0.7 µm) light. Green and red layers are also sensitive to blue wavelengths. Visible light waves first pass through and react with the blue layer and then pass through a filter layer which halts further passage of the blue rays. Green and red waves pass through this barrier and sensitize their respective dyes, causing a chemical reaction and thus completing the exposure and creating a true colour image.

Infrared:

Current aerial infrared film is offered as two types: black and white infrared and colour infrared. Black and White Infrared have the emulsion sensitive to green (0.54–0.6 µm), red (0.6–0.7 µm), and part of the near infrared (0.7–1.0 µm) portions of the spectrum and renders a gray-scale image. (Fig.3)

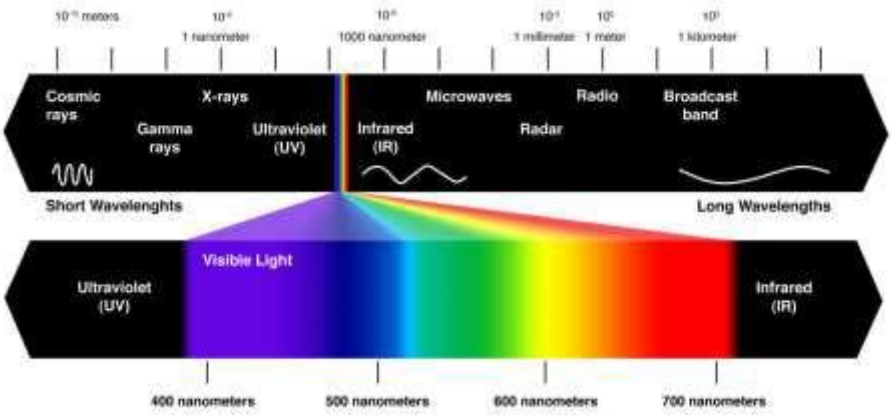

Fig No: 3. Visible Spectrum

Colour Infrared:

Colour Infrared film is commonly termed as false colour. The multilayer emulsion is sensitive to green (0.5–0.6 μm), red (0.6–0.7 μm), and part of the near infrared (0.7–1.0 μm) portions of the spectrum. A false colour image contains red/pink hues in vegetative areas, with the colour depending upon the degree to which the photosynthetic process is active (Fig:4).

Fig No: 4. Vegetative areas

Flight Direction:

It is advisable that aerial photography is flown in tiles to cover the chosen area in designated flight line(shown in fig 5). For easiness in handling, it is prudent to keep the number of tiles to minimum. The flight direction of the strips/tiles is therefore kept along the length of the area.

This direction may be any suitable direction along a natural or man-made feature and should be clearly specified. The further transmission process and data collection is shown in fig 6.

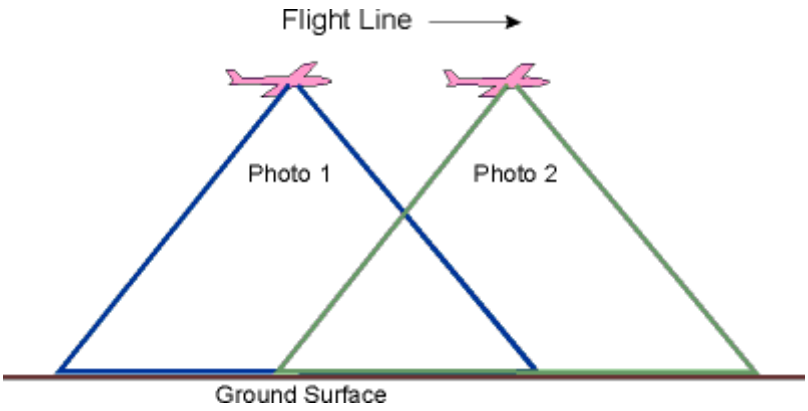

Fig No: 5. Flight Line

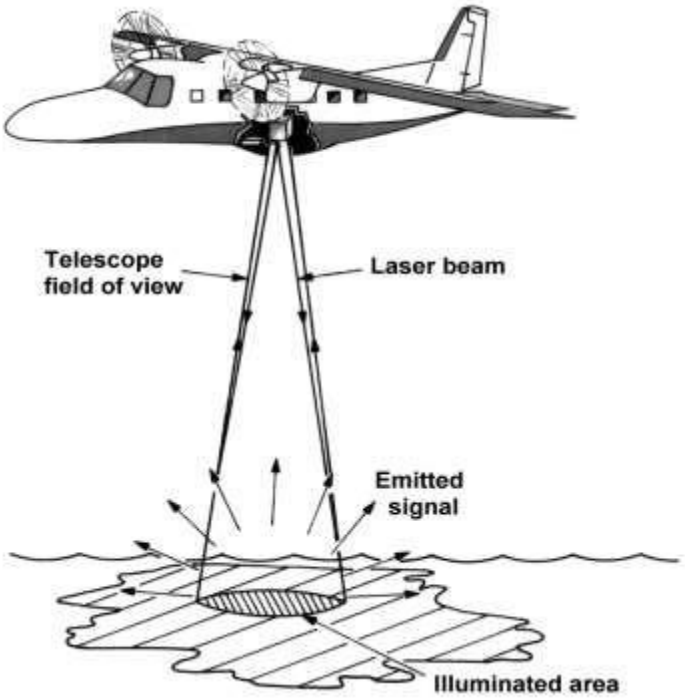

Fig No: 6. Flight direction and signal receiving process

Time:

The time at which aerial photograph taken is very important, as long, deep shadows tend to doubtful details, where as undersized/small shadows tend to

mark out some details effectively and are generally fruitful in improving the interpretational values of a photograph. Based on experience, aerial photography should be flown when the sun's elevation is 30 degrees above the horizon or three hours before and after the local noontime.

Season:

Factors such as seasonal variations in light reflectance, seasonal changes in the vegetation cover and seasonal changes in climatological factors are the tip points for choosing the suitability of season.. The purpose for which aerial photography is flown also dictates the season. For example, for photogrammetric mapping, geological or soil survey purposes, the ground should be as clearly visible as possible.

Atmospheric Conditions:

As mentioned before, the presence of particles (smoke or dust) and molecules of gases in the atmosphere tends to reduce contrast because of scattering, especially by the heavier particles; therefore the best time for photography is when the sky is clear, which normally in India is from November to February. The presence of dust and smoke during the pre monsoon summer months and of clouds during the monsoon months forbids aerial photography during these periods.

Stereoscopic Coverage:

To examine the Earth's surface in three dimensions, aerial photography is normally flown with a 60 % forward overlap and a 25 % side lap, to provide full coverage of the area (Fig.7a and b). This is an essential requirement from the photogrammetric mapping point of view to obtain data both on planimetry and heights using the stereoscopic principle of observation in 3-D and measurement techniques with stereo plotting instruments. Stereoscopic viewing also helps in interpretation, as the model is viewed in three dimensions.

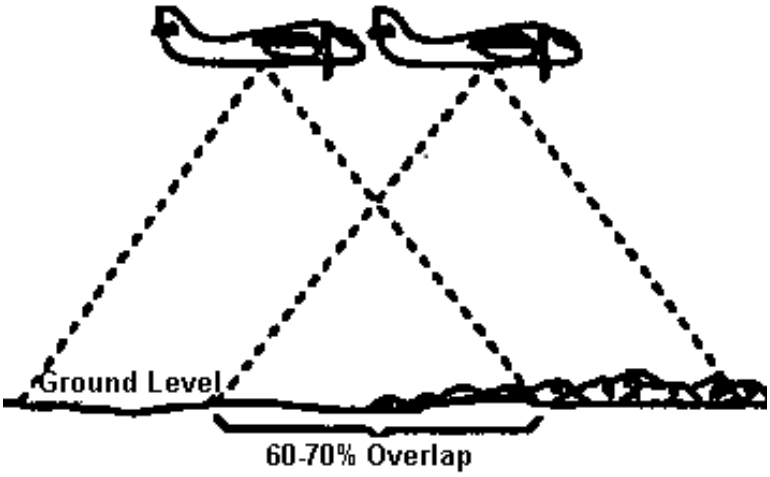

Fig 7(a) Overlap required to get the full coverage of area

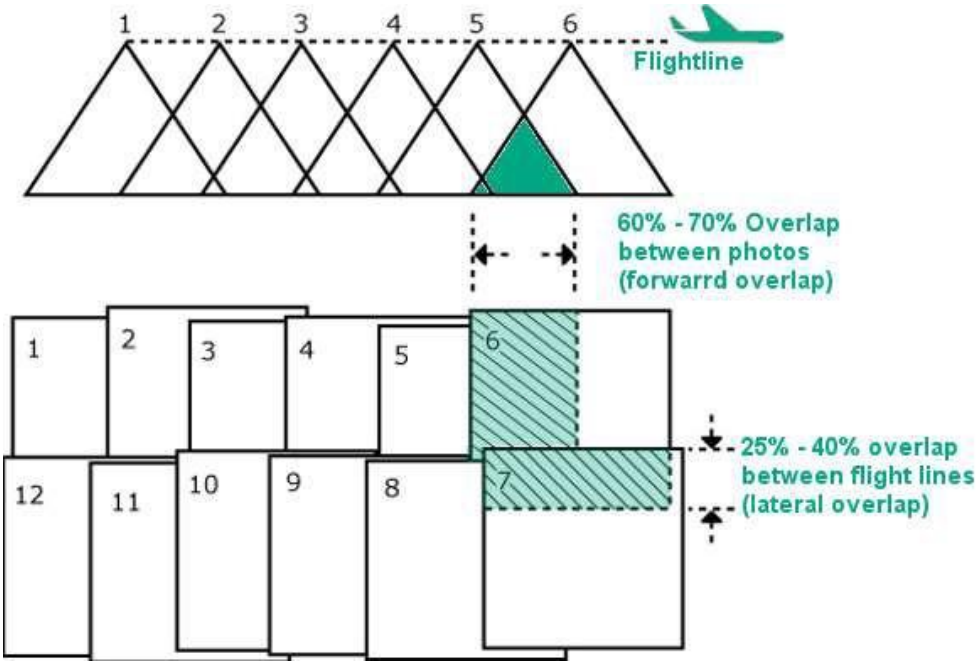

Fig 7(b) Overlap required to get the full coverage of area

1.3 Classification of Aerial Photograph:

There are different criteria to classify aerial photographs. Different criteria are scale, tilt angle, angular coverage, type of film and spectral bands. Depending upon these criteria aerial photographs can be classified as follows (fig 8a, 8b):

A. Scale:

- ✓ Large scale: between 1:5,000 and 1:20,000
- ✓ Medium scale: between 1:20,000 and 1:50,000
- ✓ Small scale: smaller than 1:50,000

Fig 8(a) Small scale and large-scale difference

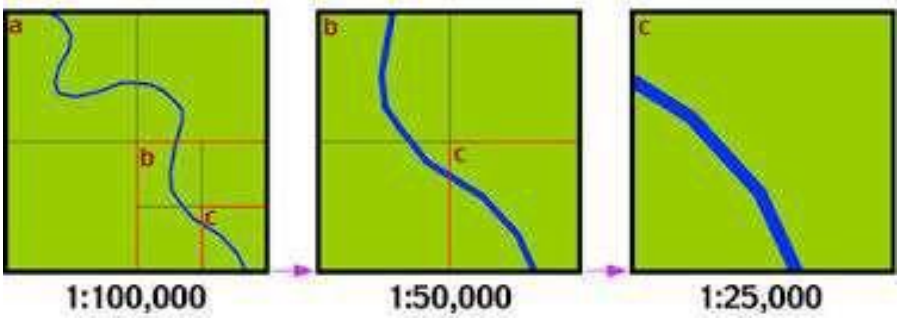

Fig 8(b) Difference in levels of scale

B. **Camera Orientation:**

Vertical:

A vertical photograph is taken with the camera pointed as straight down as possible. Allowable tolerance is usually + 3° from the perpendicular (plumb) line to the camera axis. (Fig 9a)

The result is coincident with the camera axis. A vertical photograph has the following characteristics:

(1) The lens axis is perpendicular to the surface of the earth.

(2) It covers a relatively small area.

(3) The shape of the ground area covered on a single vertical photo closely approximates a square or rectangle.

(4) Being a view from above, it gives an unfamiliar view of the ground.

(5) Distance and directions may approach the accuracy of maps if taken over flat terrain.

(6) Relief is not readily apparent.

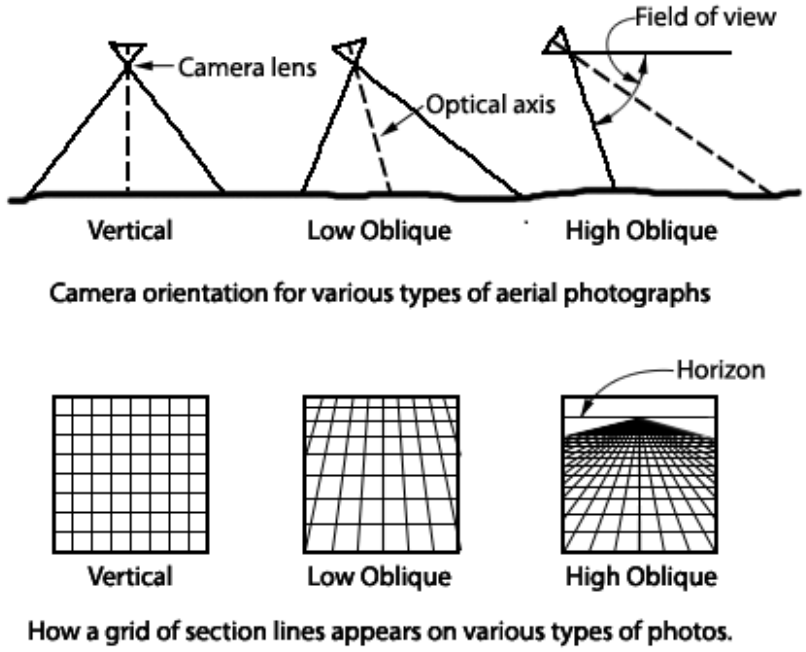

Fig 9(a) Camera orientation for various types of photograph

Oblique:

a. Low oblique:

This is a photograph taken with the camera inclined about 30° from the vertical. It is used to study an area before an attack, to substitute for a reconnaissance, to substitute for a map, or to supplement a map (Fig 9b). A low oblique has the following characteristics:

(1) It covers a relatively small area.

(2) The ground area covered is a trapezoid, although the photo is square or rectangular.

(3) The objects have a more familiar view, comparable to viewing from the top of a high hill or tall building.

(4) No scale is applicable to the entire photograph, and distance cannot be measured. Parallel lines on the ground are not parallel on this photograph; therefore, direction (azimuth) cannot be measured.

(5) Relief is discernible but distorted.

(6) It does not show the horizon.

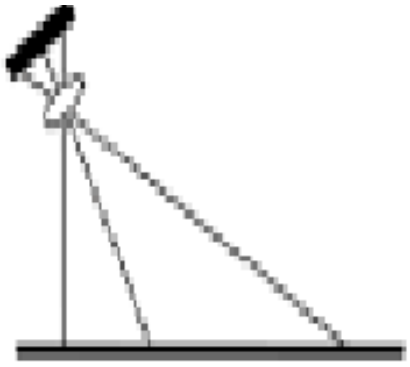

Fig. 9(b)Low oblique

b. High oblique:

The high oblique is a photograph taken with the camera inclined about 60° from the vertical. It has a limited military application; it is used primarily in the making of aeronautical charts. However, it may be the only photography available. A high oblique has the following characteristics:

(1) It covers a very large area (not all usable).

(2) The ground area covered is a trapezoid, but the photograph is square or rectangular.

(3) The view varies from the very familiar to unfamiliar, depending on the height at which the photograph is taken.

(4) Distances and directions are not measured on this photograph for the same reasons that they are not measured on the low oblique.

(5) Relief may be quite discernible but distorted as in any oblique view. The relief is not apparent in a high altitude, high oblique.

(6) The horizon is always visible.

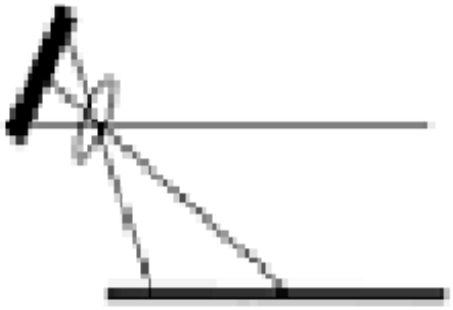

Fig. 9(c) High oblique

c. Trimetrogon: This is an assemblage of three photographs taken at the same time, one vertical and two high obliques, in a direction at right angel to the line of flight. The obliques taken at an angel of 60^0 from the vertical, sidelap the vertical photography producing composites from horizon to horizon.

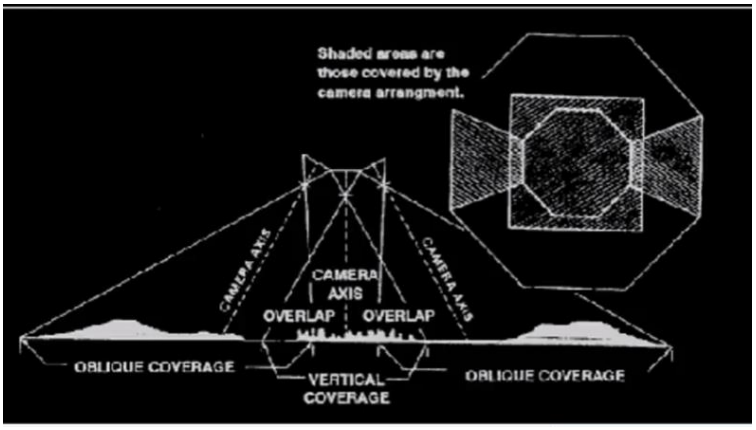

Fig. 9(d) Trimetrogon

d. Convergent Photography:

It is a sequential pair of low oblique in which the optical axes converse towards one another. in this kind of photography both the photographs cover the same area but from different locations (Fig. 9(d).

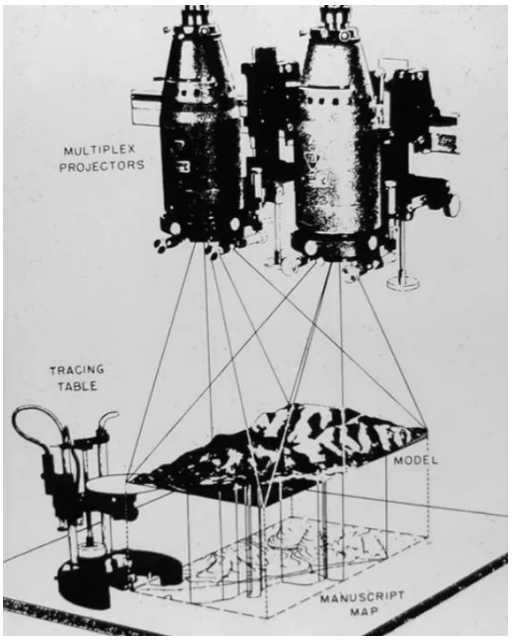

Fig. 9(d) Convergent Photography

C. Angular Coverage:

Angular coverage is a function of focal length and format size.

- ✓ **Narrow Angle**: Angle of Coverage Less than 200 (Large Focal length) Used for General interpretation, intelligence and mosaics.
- ✓ **Normal angle:** Angle of coverage between 500 - 750 used for general interpretation, mapping, ortho-photography, and mosaics.
- ✓ **Wide angle:** angle of coverage 850 - 950 used for general interpretation, general purpose photography for normal terrain, resource mapping and mosaics.
- ✓ **Super-wide angle:** angle of coverage more than 1100 Used for General purpose mapping of flat areas

D. Film

- ✓ **Black and white panchromatic:** This is most broadly used type of film for photogrammetric, mapping and interpretation.
- ✓ **Black and white infrared:** This is used interpretation and intelligence and in hazy environment as IR can penetrate through haze.
- ✓ **Colour:** This is used for interpretation and mapping.
- ✓ **Colour infrared/ false colour:** This is used for vegetation studies, water pollution, and crop studies.

E. Spectral Coverage/Response:

Multispectral: Depending upon the number of spectral bands.