Six Advantages of Aerial Photography
Over Ground OR Aerial Observation

1. Improved vantage point
2. Ability to stop action; permanent recording
3. Greater radiometric sensitivity/resolution
4. Greater spectral sensitivity/resolution
5. Greater spatial sensitivity/resolution
6. Photogrammetric Techniques
Basic B/W Film Photography

A Simple Camera

Exposure

1. Exposure (E) at any point in a photograph is dependent on:
   \[ E = \frac{sd^2t}{4f^2} \]
   where:
   - \( s \) = scene brightness
   - \( d \) = diameter
   - \( t \) = time (shutter speed)
   - \( f \) = focal length

   So how do we control the range of exposure?

   2. Diameter of the lens opening (\( d \)) is adjusted by setting the aperture or f-stop \( F = \frac{f}{d} \)
   \[ E = \frac{st}{4F^2} \]

   3. Shorter exposure times prevent blurring/image motion, but require high speed films (grainier)

   4. Longer exposure times allow more light, so slower (crisper) films can be used, but may result in blurring
Extraneous Effects

Exposure falloff is the result of:

1. 
2. 
3. 

Effect of Exposure Falloff

Film Density Measurements

Film density is a measure of?

Determined using a _________________?

What are measures of film density used for?

- 
- 
- 
- 


Characteristic Curves - Contrast

- Low Slope ($\gamma$)
- Low Contrast
- High Slope ($\gamma$)
- High Contrast

Note: Wbc and # wbc per unit area are shown for clarity. Actual measurements may vary.
Characteristic Curves - Resolution

- Poorer Radiometric Resolution
- Better Radiometric Resolution

Characteristic Curves – Exp. Lat.

- Low Exposure Latitude
- High Exposure Latitude

Characteristic Curves – Film Speed

- Slow Film: More Exposure, Better Spatial Resolution
- Fast Film: Less Exposure, Poorer Spatial Resolution
What are the advantages of colour photography?

1. 
2. 
3. 

Colour Theory

- R. G. B are additive primaries

- Yellow, magenta, and cyan are subtractive primaries
Colour Theory
Complimentary colours are those that produce white light when combined.

How Colour Film Works
- Colour film is based on the principles of subtractive primary colours.
- Yellow, magenta, and cyan dyes are used to filter differing proportions of blue, green, and red light.
- The dyes are introduced into different layers of colour film each containing silver halide crystals modified by organic molecules known as spectral sensitizers.
- The subtractive primaries are used to control the relative proportions of additive primaries reflected back to our eye.
How Colour Film Works

When developed, yellow, magenta, and cyan dyes are introduced inversely proportional to the amount of blue, green, and red light reflected.
How Colour IR Film Works

- Assignment of dyes to emulsion layers is arbitrary AND spectral sensitivity of emulsion layers can be controlled.
- Y, M, and C dye layers still control B, G, and R light BUT are assigned to emulsion layers that now contain organic molecules sensitive to G, R and NIR light.
- Also called “false colour” IR film.

Spectral Sensitivity

Blue wavelengths are filtered out of incoming light using a filter placed in front of the camera lens.

Near infrared → cyan dye - controls red reflectance to our eye.

Red → magenta dye - controls green reflectance to our eye.

Green → yellow dye - controls blue reflectance to our eye.
Filters

- Made of glass or gelatin

- Wavelength selectors
  - Example
    - Yellow filter absorbs blue wavelengths
    - Allows green and red to pass through
    - Commonly used to reduce haze

- High vs. low pass

- Reduce exposure, so adjustments necessary
Aerial Cameras

- Wide variety can be used
  - Hand-held 35 mm (D)SLR cameras
  - Hand-held digital cameras
  - Single lens frame cameras
  - Multi-lens frame camera
  - Strip Camera
  - Panoramic Camera
  - Analog and digital video recorders

Single Lens Frame Camera

![Diagram of Single Lens Frame Camera](image)

Single Lens Frame Camera

![Image of Single Lens Frame Camera](image)
Panoramic Camera

Digital Imaging
- Utilize an rectangular array of solid-state detectors, either CCDs or CMOS
- Size of array (# photosites or pixels) determines image resolution

Advantages:
- Increased spectral and radiometric resolution
- Ability to digitally process/analyze imagery
- Linear response to incident energy
- Can record GPS position
- Greater storage capacity

Digital Imaging
- Photo-sites are actually “colour blind”
- Filter is used to control \( \lambda \), detected at each photo-site
- Called a Bayer mask
  - in each 4x4 pixel area: 2 green, one red, one blue
- Interpolation algorithm is used to fill in the resulting checker board pattern with missing colours
Large Format Digital Aerial Cameras
- Gyro-stabilized, w/ computer controlled IMC
- Eight-camera system, 12 bit radiometric res.
- Four panchromatic bands mosaicked into 14,000 x 8000 (112 Mega pixel) image
- Other 4 bands are B, G, R, and NIR at 3000 x 2000 (6 M pixel)

Hand-held Digital Cameras