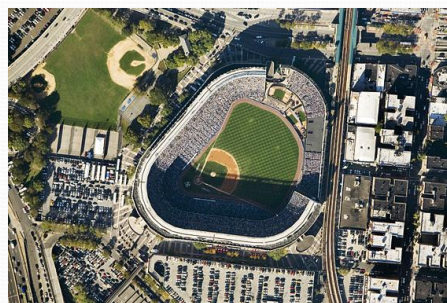


Geometric Distortion of Aerial Photo



Three photo centers

- Except on a perfectly vertical aerial photo, there are three different photo centers:
- **Principal point:** It is the point where a perpendicular projected through the center of the lens intersects the photo image. It is the geometric center of the photo and is assumed to coincide with the intersection of the x and y axes. Lens distortion is radial from the principal point.
- **Nadir:** it is a point vertically beneath the camera center at the time of exposure.
- **Isocenter:** Is the point on the photo that falls on a line approximately halfway between the principal point and the nadir. It is the point from which tilt displacement radiates.

On a true vertical photograph the principal point, isocenter and nadir all coincide at the geometric center of the photo.

Scale

- The scale of an aerial photo will vary depending upon the height at which the photograph is taken.
- Scale = Focal length of camera (f) / Flying height about terrain (H)
- The scale given for an aerial photo is often an average scale;
- An aerial photo will have different scale at different elevation.

Distortion

- Distortion is any shift in the position of an image on a photograph that alters the perspective characteristics of the image.
- Displacement is any shift in the position of an image on a photograph that does not alter the perspective characteristics of the photo
- Because all the points on an image are represented as if they are being viewed from the center of the image, distortion increases the farther the point is from the center of an image.

Types of Distortion

- Film and print Shrinkage
- Atmospheric Reaction of light rays (refraction)
- Image motion
- Lens Distortion

The effects of film shrinkage, atmospheric refraction are usually negligible in most cases.

Lens Distortion

- This distortion radiates from the principal point and causes an image to appear either closer to or farther from the principal point than it actually is.
- It is more serious near the edges of the photograph.
- By calibration of the lens, we can obtain a distortion curve that shows us how the distortion varies with the radial distance from the principal point.
- High-quality aerial camera lenses are almost without distortion.

Lens Distortion



Image Motion

- With slow-flying aircraft, fast film, and fast shutter speeds, image motion is frequently not a problem.
- For a very-large photography flown close to the ground, and image motion calculation should be made prior to the photo mission so that adjustments can be made if necessary.
- We can calculate the amount of this movement using this equation: $M = (17.6)(v)(t)(f) / H$

Where:

17.6 = a constant, with units: inch hours per mile second, v = ground speed of the plane in miles per hour, t = shutter speed in seconds, f = focal length of the camera length in feet, and H = flying height of the plane above the ground in feet

Image Motion

- As an example, let's consider a plane flying 5000 feet above the ground at 400 miles per hour, taking photos with a 12-in, focal length camera lens and a shutter speed of $1/50^{\text{th}}$ of a second.
- $M = (17.6)(400)(0.02 \text{ s})(1 \text{ foot}) / 5000 \text{ ft} = 0.028 \text{ in}$
- This much image motion would result in a definite blur.
- The acceptable limit for image motion for good interpretation is about 0.002 in.
- Solution: Faster shutter speed, a faster film or a slower-flying craft

Discussion/Quiz Questions

Q1: True or False. Distortion is any shift in the position of an image on a photograph that alters the perspective characteristic of the image; and displacement is any shift in the position of an image on a photograph, but does not alter the perspective characteristics of the photo?

Q2: True or False. Aerial photo distortion is more serious at the center of the photo?

Q3: True or False. Image motion distortion is frequently a problem when using a slow-flying aircraft, fast film, and fast shutter speeds?

Q4: Which of the following types of distortion is the most critical when working with aerial photos? a) Film and print shrinkage, b) Atmospheric refraction of the light rays, c) Image motion, and d) Lens distortion

