Geography 403
Lecture 3
Quantitative Air Photo Interpretation

Needs: Lect_403_3.ppt, Large Milwaukee Photos and Meter stick, Milwaukee Quad map

Key Terms and Concepts:
Air Photo Basic Characteristics (Orientation, Principal Point, Conjugate Principal Point)
Scale Determination and Relationships to Height and Focal Length
Radial and Terrain Scale Distortion
Overlap Characteristics (plus Drift and Crab)
Object Displacement (formula to Determine Height)
Area Measurement

Milwaukee CIR (6/86): 9" = 1:58,000 RF, 36" = 1:14,500 RF
altitude = 40,000 feet
effective f = .69 feet
(9" film = 36" enlarged contact print, 4X enlargement)

A. Characteristics, Terms, and Methods

PP1 1. Orientation of Photos
- a. Low oblique--no horizon, nadir usually in photo
- b. High oblique--horizon shown, usually no nadir
- c. Vertical--best for mapping as it has least scale distortion, while high oblique has greatest coverage and greatest distortion

PP2 2. Principal point(PP)--the optical center of the photo, coincides with the nadir (point directly below camera on ground) for vertical photos
- a. Found from fiducial marks or image corners if no other reference

3. Conjugate principal point(CPP)--location of the P.P. from the next photo in the flight line appearing on the present image
4. Photo base length--distance from the PP to a CPP, also a measure of absolute parallax or the total displacement in the image
5. Flight line--the line along which the plane flies as it takes images

PP3-5 6. Scale of the photo (depends on focal length and object distance)
Scale = focal length (f) / aircraft height (H)
(page 158 in Jensen)
Scale(RF denominator) = (H (related to height of aircraft) / f) / enlargement factor
Note: H and f must be in the same units
*(**reverse** equation on page 158 in Jensen)*

PP6-7 a. Radial distortion-"displacement" of objects changes as you move away from the center (no change in scale, which is constant for a vertical air photo over flat terrain). Objects appear to lean away from PP.

PP8 b. Terrain scale distortion--distance H depends on height of object above reference plane (high mountains or buildings)

PP9 7. A map of known scale can be used as a reference (with known features) to determine Image scale (areas and distances can be computed on the image like on a map)
- a. Map scale as RF shown at bottom of Topographic Quad or other map
- b. Find features on image that are also identified and measurable on the map
- c. Methodology (use same units for all measurements)
  - i. Measure image distance (a)
  - ii. Measure map distance (b)
  - iii. RF (image) = b * RF (map) / a

(related to formula on page 157 in Jensen)

8. Triangulation to determine image resolution with a know distance
- a. Determine ground length (g) of a distance on the image (use as hypotenuse)
- b. Determine length of the other two sides of the triangle in "pixel units"
- c. Use $c^2 = a^2 + b^2$ to determine hypotenuse length in pixel units (c)
- d. Divide know distance (g) by pixel distance (c) to obtain image resolution

PP10-12 9. Air photo Mission Features and Errors

Overlap--framing camera takes photos that cover the same ground area along the flight line and with adjacent flight lines, typically 60% forward and 25% side overlap
- a. Ensures that all areas get covered
- b. Produces parallax which can be used for "stereo" viewing and measurements
- c. Drift--when flight line is not straight
- d. Crab--when pilot turns plane off axis to correct for crosswind problems

PP13-14 10. Use of Object displacement to determine object heights (do several examples)
- a. From a single photo

$$h = (d / r) * H$$ *(Found on page 160 in Jensen)*

where:
h = height of the object
H = aircraft elevation from datum
r = distance from PP to object top
d = distance from object bottom to object top

- b. From stereo pairs--parallax "bars and wedges" can be used to measure differential parallax directly

(slightly different formula on page 170 in Jensen)

PP15 11. Area measurement
- a. Dot-grid planimeter (for most images)
- b. Single page "eye ball" estimator (for large format images)
  - i. Estimate coverage of land-use type in a few sample areas, and infer to larger area (using 1 cm page size grid transparencies)

12. Enhancement and applications
- a. Many uses for "plain old" B&W air photos
- b. Can actually digitize information from a photo with a scanner

c. Digital data is better suited for many kinds of analysis, because it gives you the ability to manipulate the information on the image, rather than just observe it
d. Can also find scale of photo by finding an object of know size