Geography 403
Lecture 2
Cameras, Films and Filters

Needs: Lect_403_2.ppt, Milwaukee CIR photos, example teaching image sets

Key Terms and Concepts
Camera System Components
Film Speed (grain size)
Filters
Additive and Subtractive Color Processes
Color InfraRed (false color) process and photography
Quantitative Interpretation Criteria (10)
Parallax

A. Components of a Camera System
PP1-2 1. Light-proof box, lens to focus, photo-sensitive emulsion

B. Framing Camera--shutter opens briefly to record image on film emulsion or digital sensor
PP3 1. Different size films and lens, designated by frame size (35 mm)
2. Usually the larger the film the better the resolution
3. Lens focal length (f) distance between lens and film plane
a. determines kind of lens (normal, wide angle, telephoto)
4. Aperture--size of opening--part of controlling exposure, given as a ratio to focal length, so can apply to all lens (f/8, f/5.6, etc.)
5. Shutter speed--controls timing shutter is open
6. Film speed--"slow" need more light to expose, i.e. keep shutter open longer, "fast" need less light, can capture fast moving objects or objects in low light
7. Resolving power of film--the smallest object visible on the film is determined by the "grain size"
a. Film is made up of a discrete number of chemical grains that respond separately to light, and a picture is formed by their composite response
b. Smaller grain size means greater resolution
c. Trade off--faster films have lower resolution
PP4 8. Filters--allow a selective reduction of the wavelengths that reach the emulsion
a. Haze filter--cuts out UV "haze", as films may be sensitive to UV even through designed for other wavelengths
b. Color or band filters-used to allow only certain bands of EMR to pass. This allows production of color images.
9. Digital Cameras–recording sensor is a charge-coupled device (CCD) or Complementary Metal Oxide Semiconductor (CMOS) computer chip. These devices convert EMR into electrons that can be measured and converted to a radiometric intensity value by way of linear or area arrays of detectors. Hand-

held cameras use filters and three separate sensors and then an additive process (see below) to produce natural-looking color images.

C. Basic negative to positive sequence for B&W
1. Emulsion produces a "negative", pass light through to print
2. Different EMR regions referred to as bands (classed by wavelength)--more later
3. Most B&W emulsions cover only visible spectrum (.4 to .7μm), but B&W IR goes to about .9μm
a. Filters are used to select portions of this range

D. Basic negative to positive sequence for Color Film
PP5-6 1. For color three separate B&W emulsions and dyes are used
a. Based on the color spectrum from 3 primary colors (blue, green, red) all three combine into white light
b. Additive processes (light beams) draw intersecting circles
i. red+green = yellow
ii. green+blue = cyan
iii. blue+red = magenta
c. Subtractive processes (filter or paints)
i. yellow (-blue) + cyan (-red) = green
ii. magenta (-green) + cyan (-red) = blue
iii. magenta (-green) + yellow (-blue) = red
d. Eye averages wavelengths, so .5 to .7μm is seen as .6μm
PP7 e. Color films use subtractive process combinations
PP8 f. Color films have emulsions for three spectral bands, which when exposed produce images of different intensity in different layers, and when processed generate dyes of a particular "complementary" color (yellow, cyan, or magenta)
g. When light is passed through the developed negative, each dye subtracts the proper amount of a primary color to produce the correct shade on the print

E. Color IR (false color) process--produce color for objects different than those seen by the human eye
PP9 1. Sensitive to the near-IR, green and red bands, excludes blue
PP10 2. "Shifts" incoming wavelengths to shorter wavelengths on image
3. Eliminates most blue sensitivity, and adds NIR sensitivity
4. Blue is highly scattered by the atmosphere, generally produces sharper images than regular color
PP11 5. Object appearances change
a. Turbid water--green or blue clear--dark blue or black
b. Brilliant red color for vegetation due to high IR reflection
c. Deciduous vegetation can be viewed as seasons change
d. Different plant types have different shades of red (conifer, deciduous, lawns)

F. Qualitative Interpretation Criteria (eye and brain as only tools)

PP12-21 1. Shape--natural features (geologic structures), human-made features like stadiums and golf courses, etc.

2. Size--relative size of object on image compared to other known features (roads, autos)
3. Tone (or density of color)--various shades of gray or color levels
4. Shadow--can help or hinder
    a. Can reveal vertical characteristics of features in profile, such as the size and shape of a building
    b. Can reveal subtle features of topography
    c. Can also obscure, most imaging done between 10a-2p LST
    d. Low sun (early morning or late afternoon for topographic analysis)
5. Pattern--regular geometric arrangement of features
    a. Lines--roads, faults, curved lines of contour farming
    b. Street and building relationships
    c. Field versus Orchard crops depending on scale
6. Texture--visual inspection of roughness or smoothness, often produced by tonal differences in objects too small to be viewed directly
    a. Example--young trees can be smooth and velvet-like, while mature trees have a pebbled-cobbled texture
    b. Highly dependent on scale
7. Site--location with respect to terrain or other objects
    a. Some vegetation types likely to be found on steep slopes, others on gentle slopes, still others in poorly drained areas
    b. Identifying the site features narrows down the number of land cover types in many cases
8. Association--certain objects always associated with others
    a. Industrial--coal, smokestack, conveyor belts, cooling towers, power lines/plant
    b. Farms--barns and silos
    c. Schools-gyms and sports fields
9. Resolution--influences what can be viewed individually, large objects can be used to help identify others, small objects must have a regular pattern to be detected
    a. Low altitude photography--can see individual trees
    b. LANDSAT satellite--each pixel an integration of trees and soil surfaces mixed together (30-80 m resolution)
10. Parallax (Stereo) permits gathering of 3-D information to contribute to the analysis (height of objects, locations of hills, and buildings, etc.)

G. How Parallax allows 3-D viewing

1. The human eye normally uses this effect to produce depth perception
    a. See same image from two different perspectives, several inches apart
    b. Camera takes images of the same object from different perspectives (successive frames)
    c. Effect is exaggerated compared to normal viewing, since change in perspective in images is usually many meters