Image Resolution

Chapter 10

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RESOLUTION

- Ability of imaging system to record fine detail in a distinguishable manner
  - Emphasis upon imaging system
  - Fine detail a relative concept
- Practical limit to level of detail possible from aerial/satellite image
  - Limit defined as “resolution”
  - Image detail also affected by character of scene, atmospheric conditions, illumination, experience and ability of interpreter

RESOLUTION

- Spatial
  - Fineness of spatial detail visible in image
  - Fine detail – small objects can be identified
- Radiometric
  - Ability of sensor to record many levels of brightness
  - Coarse radiometric resolution – record scene using only a few brightness levels or a few bits

RESOLUTION

- Spectral
  - Ability of sensor to define fine wavelength interval
- Temporal
  - Ability to record sequence of images over time

- Often a tradeoff between the different types of resolution

TARGET VARIABLES

- Contrast
  - Difference in brightness between an object and its background
  - One of most important influences on spatial and radiometric resolution
  - High contrast – favors recording fine spatial detail
  - Dynamic quality – for given landscape varies greatly from season to season and within a single day (angle and intensity of illumination varies)

TARGET VARIABLES

- Shape of object/feature important
  - Aspect ratio – length of feature relative to width
  - Regularity of shape – favors recording of fine detail
    - Features with regular shapes like cropped agricultural fields tend to recorded in fine detail while complex shapes will be imaged in coarser detail

TARGET VARIABLES

- Number of objects
  - Example, pattern formed by number and regular arrangement of tree crowns in orchad favors imaging entire pattern in fine detail while the crown of single isolated tree might not be visible
- Extent and uniformity of background
  - Single auto in large, uniform parking area or single tree in large cropped field will be imaged in detail not achieved under other conditions

SYSTEM VARIABLES

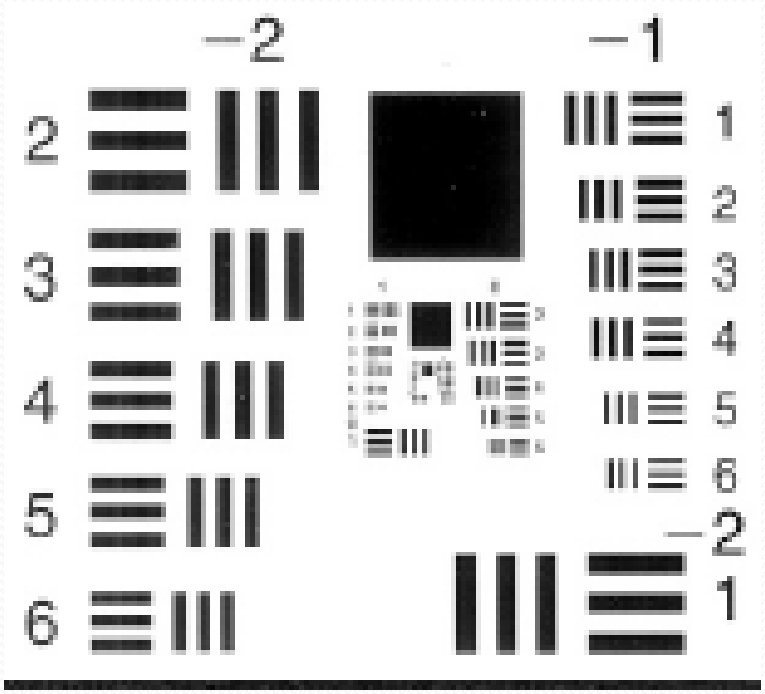
- Resolution of individual sensors depends on design and part on its operation
- Aerial photograph controlled by quality of camera lens, choice of film, flying altitude, scale and design of aerial camera
- Scanning systems (MSS/TM or therma scanners) depend on IFOV which depends on angular field of view, operating altitude and speed of scanning motion and movement of vehicle
- Active microwave – depends on bandwidth (antenna gain), wavelength, etc.

GROUND RESOLVED DISTANCE (GRD)

- Dimension of smallest objects recorded on an image
- Rough suggestion of usable detail and has very subjective meaning
- Object vary in size, shape, contrast with background and pattern

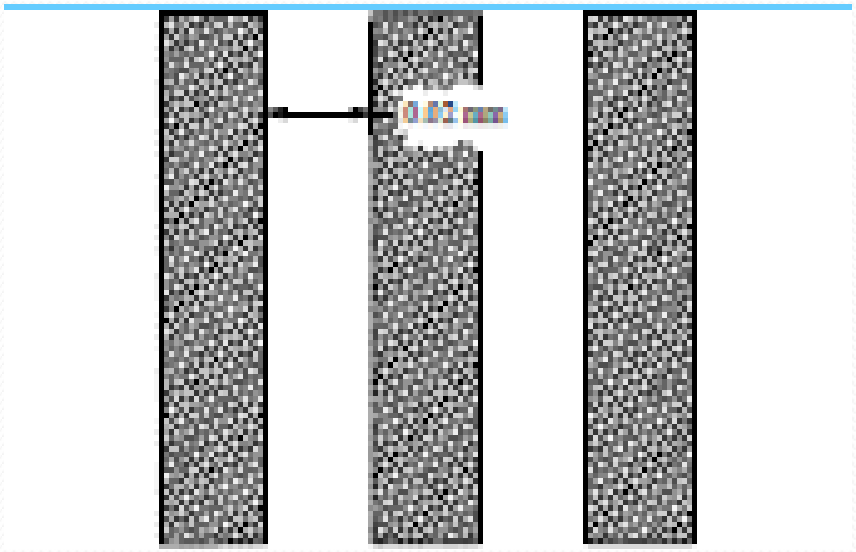
LINE PAIRS PER MILLIMETER (LPM)

- Quantifies, under controlled conditions the estimate of GRD using a standard target
- Width of spacec equal to width of lines
- Block of 3 lines and 2 white spaces form square



LINE PAIRS PER MILLIMETER (LPM)

- If images of 2 objects visually separated – said to be "visually resolved"
- Find smallest set of lines where individual line completely separated
- Analyst measures width of one "line pair"
- Example – width of line and adjacent gap = 0.04 mm
- 1 line pair/0.04 mm gives a resolution 0f 2 LPM



LINE PAIRS PER MILLIMETER (LPM)

- Resolution translated into GRD

$$GRD = \frac{H}{fR}$$

Where :

GRD – ground resolve distance

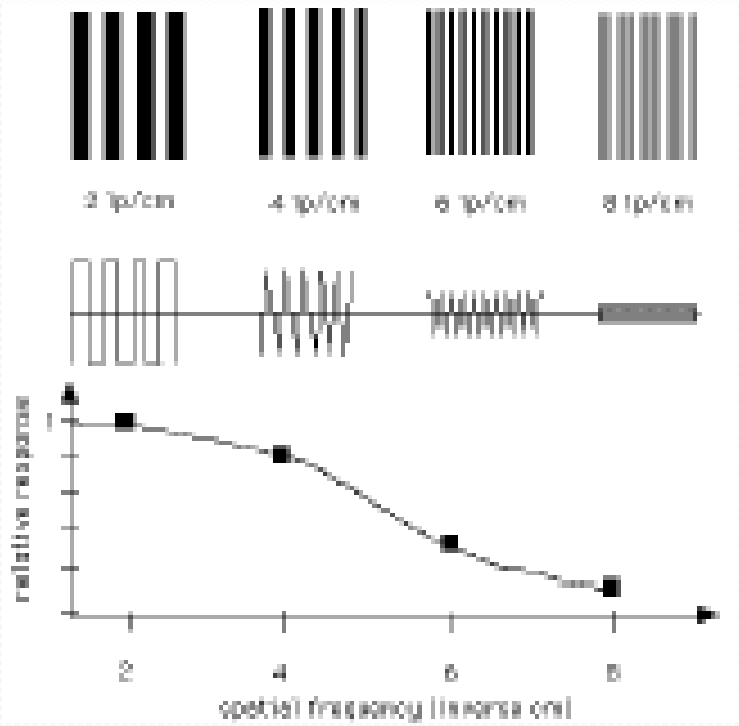
H – flying altitude above ground

f – focal length in millimeters

R – System resolution, in line pairs per millimeter

MODULATION TRANSFER FUNCTION

- Records response to target array with elements of varying spatial frequency

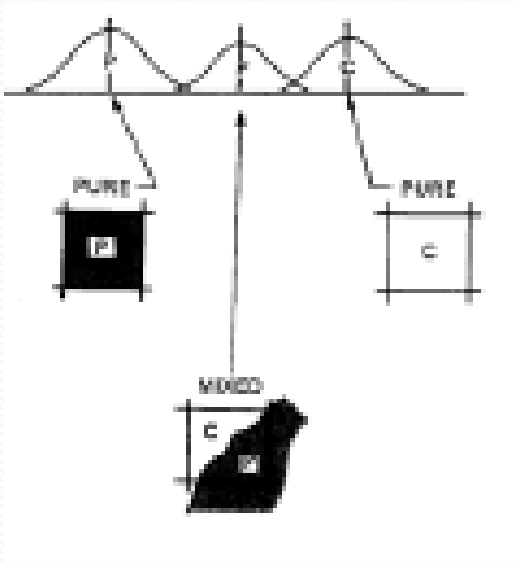


MODULATION TRANSFER FUNCTION

- Modulation – refers to changes in widths and spacing
- Transfer – denotes ability of imaging system to record changes on image

MIXED PIXELS

- Pixels not completely occupied by single, homogenous category
  - Subdividing scene into discrete pixels means that brightness values averaged within pixel



MIXED PIXELS

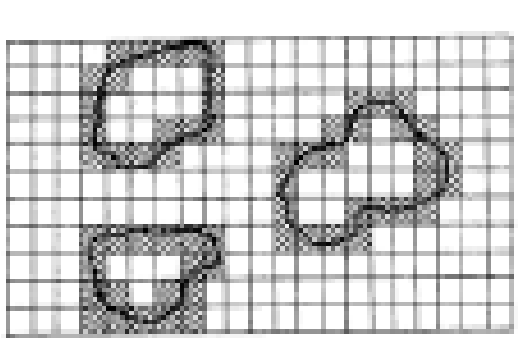
- Pure signatures
  - Pixel contains only digital number of one feature
- Composite signature
  - Mixed pixels containing energy from more than one feature
  - Sometimes useful when mapping features too complex to resolve individually

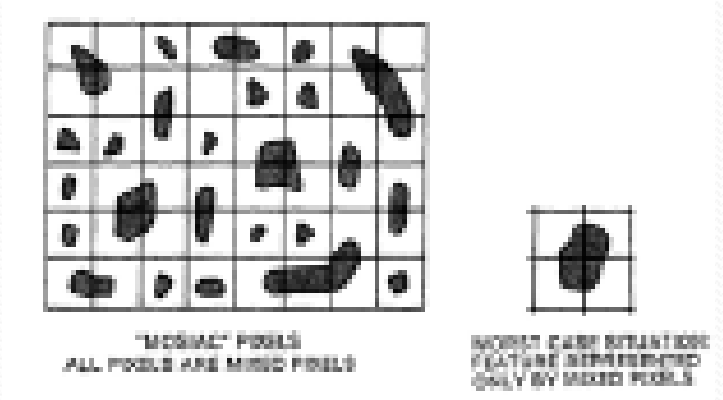
MIXED PIXELS

- Source of error/confusion
  - Mixed pixels' digital value maynot resemble any of features in scene
  - The values may form to resemble values from other categories in scene but not within pixel

MIXED PIXELS

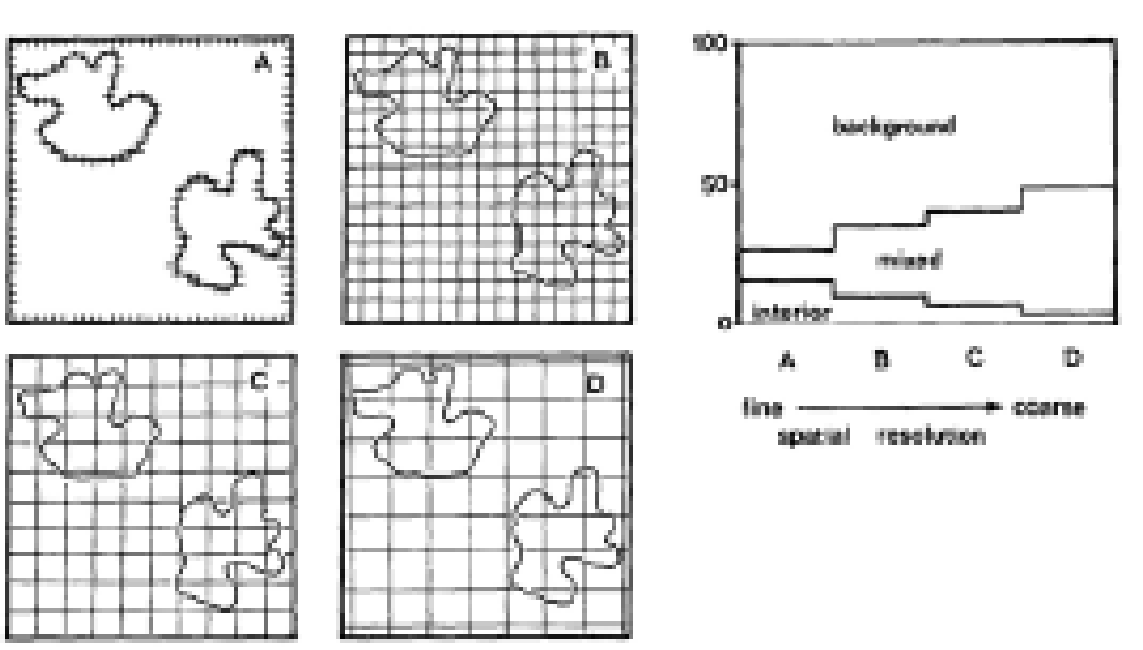
- Often at edges of large parcels or along long linear features
- Scattered occurances of small parcels may produce pixels represented only by mixed pixels





MIXED PIXELS

- Example : 2 contrasting categories examined at different resolutions
- Pixels categorized as background, interior or border



MIXED PIXELS EXAMPLE

- Coarser resolution – number of mixed pixels increase with pure background and pure interior pixels
- Fine spatial resolution may help in capturing fine detail but at cost
  - More expensive – cost of processing
  - May resolve features not captured at coarser detail thereby increasing proportion of mixed pixels