CHAPTER 5

Image Interpretation
Introduction

- To translate images into information, we must apply a specialized knowledge, *image interpretation*, which we can apply to derive useful information from the raw uninterpreted images we receive from remote sensing systems.
• SUBJECT
Knowledge of the subject of our interpretation the kind of information that motivates to examine the image is the heart of interpretation. Accurate interpretation requires familiarity with the subject of the interpretation.

• GEOGRAPHIC REGION
Knowledge of the specific geographic region depicted on an image can be equally significant. Every locality has unique characteristics that influence the patterns recorded on an image.

• REMOTE SENSING SYSTEM
Knowledge of the remote sensing system is obviously essential.
The Context for Image Interpretation

- Three issues distinguish interpretation of remotely sensed imagery from interpretation conducted in everyday experience.

I. Remotely sensed images usually portray an overhead view at an unfamiliar perspective.

II. Many remote sensing images use radiation outside the visible portion of the spectrum.

III. Remote sensing images often portray the Earth’s surface at unfamiliar scales and resolutions.

Experience is the only sure preparation for skillful interpretation.
Image Interpretation Tasks

- **Classification** is the assignment of object, features, or areas classes based on their appearance on the imagery.

  *Detection* is determination of presence or absence of a feature.

  *Recognition* implies a higher level of knowledge about feature or object.

  *Identification* means that the identity of an object feature can be specified with enough confidence and detail to place it in very specific class.

- **Enumeration** is the task of listing or counting discrete items visible on an image.

- **Measurement** is an important function of many image interpretation problems.

- **Delineation**, the interpreter must often delineate, regions ats they are observed on remotely sensed image.
Image interpretation skills. (a) Classification. (b) Enumeration. (c) Mensuration. (d) Delineation.
Elements of Image Interpretation

- **Image Tone**

  *For black and white* denotes the lightness or darkness of a region within an image and for colour or CIR imagery image tone refers simply to **colour**, and image tone can also be influenced by the intensity and angle of illumination and by processing of the film.
**Image Texture** refers to apparent roughness or smoothness of an image region. Usually texture is caused by the pattern of highlighted and shadow areas created when an irregular surface is illuminated from an oblique angle.

Image texture depends not only upon the surface itself, but also upon the angle of illumination, so it can vary as lighting varies.
- *Shadow* is an especially important clue in the interpretation of objects. A vehicle illuminated at an angle, cast a shadow that may reveal characteristics of its size or shape that would not be obvious from the overhead view alone.

(a) Fuel storage tanks  
(b) Military aircraft on runway  
(c) Water tower
- **Pattern** refers to the arrangement of individual object into distinctive recurring forms that facilitate their recognition on aerial imagery.
Image Interpretation Strategies

- Image interpretation strategy can be defined as a disciplined procedure that enables the interpreter to relate geographic on the ground to their appearance on the image.

- Categories of image interpretation (Campbell 1978):
  - **Field observation** are required when the image and its relationship to ground conditions are so imperfectly understood that the interpreter is forced to go to the field to make identification.
  - **Direct recognition** is the application of in interpreter’s experience, skill and judgment to associate the image patterns with informational classes.
• **Association** specifies the occurrence of certain object, usually without the strict spatial arrangement implied by pattern.

• **Shape** of features are obvious clues to their identities.

![Images of various features](a), (b), (c), (d)

**FIGURE 5.7.** Significance of shape for image interpretation, as illustrated by (a) athletic fields, (b) aircraft marked on a runway, (c) automobiles in a salvage yard, and (d) a water treatment plant. From USDA.

• **Size**

• **Site** refers to topographic position
- **Interpretation by inference** is the use of a visible distribution to map one that is not itself visible on the image.

- **Probabilistic interpretation** are efforts to narrow the range of possible interpretations by formally integrating nonimage information into the classification process, often by means quantitative classification algorithms.

- **Deterministic interpretation** are based on quantitatively expressed relationship that tie image characteristics to ground conditions.
Collateral Information

- Collateral information refers to nonimage information used to assist in the interpretation of an image.
- Collateral information can consist of information from books, maps, statistical tables, field observation and other source.

Imagery Interpretability Rating Scales

The National imagery Interpretability Rating Scale (NIIRS) has been developed for single channel and panchromatic imagery and the Multispectral Imagery Interpretability Rating Scale (MS IIRS) has been developed for multispectral imagery.
Image Interpretation Keys

- Image Interpretation Keys are valuable aids for summarizing complex information portrayed as images.
- Keys designed solely for use by experts are referred to as technical keys. Nontechnical keys are those designed for use by those with a lower level of expertise.
- Essay keys consist of extensive written descriptions, usually with annotated images as illustrations.
- A file key is essentially a personal image file with notes; its completeness reflects the interest and knowledge of the compiler.
Interpretive Overlays

- Interpretive Overlays approach to image interpretation is a way of deriving information from complex interrelationship between separate distributions recorded on remotely sensed images.

Diagram: Interpretive overlays permit the analyst to extract and then combine information from several sources.
Photomorphic Regions

Photomorphic region outline broad scale regions of uniform appearance on aerial photographs
Significance of Context

The success of illusion depends upon its ability to confuse the viewer’s capacity to assess the figure ground relationship. Relief inversion occurs when aerial images of shadowed terrain are oriented in a manner that confuse our intuitive expectations.
Figure 5.11. Photographs of landscapes with pronounced shadowing are usually perceived in correct relief when shadows fall toward the observer. Left: When shadows fall toward the observer, relief is correctly perceived. Right: When the image is rotated so that shadows fall in the opposite direction, away from the observer, apparent relief appears to be reversed. From USGS.
FIGURE 5.12. Mars face illusion. Left: This 1976 Viking Orbiter image of the Cydonia region of Mars is considered by some to present a strong resemblance to a human face, causing speculation that the features might have been created by intelligent beings. From NASA. Right: In 1998 the Mars Global Surveyor re-imaged the Cydonia region at much higher spatial resolution. With greater spatial detail available to the eye, the previous features appeared to be due to natural processes rather than artificial structure. From NASA.
Image Interpretation Equipment

- Light table is a translucent surface illuminated from behind to permit convenient viewing of film transparencies.

- Measurement of length
  SI units (1 mm) and English units (1/20 in)
Measurement of area, areas on remote sensing imagery can be measured using any of several techniques.

- Dot grid was the standard technique for measuring areas.
- Polar planimeter is a compact instrument with a moveable arm that can be used to trace the outline of an area.
- Electronic planimeter (version of the electronic digitizer)
• Stereoscopes are devices that facilitate stereoscopic viewing of aerial photographs
• Magnification

![Image: Magnification equipment]

Densiometry is the science of making accurate measurements of film density.

![Image: Densitometer]

**FIGURE 5.16.** Image interpretation equipment. U.S. Air Force image interpreter uses a tube magnifier to examine an aerial photograph in detail. A mirror stereoscope is visible in the foreground. From U.S. Air Force U.S. National Archives and Records Administration, ARC 542277.

**FIGURE 5.19.** Densitometer, an instrument used to acquire measurements of image density at a specific point.
Image Scanning

FIGURE 5.20. Scanning densitometers, instruments used to systematically measure density for an entire sheet. Left: Rotating drum densitometer. Right: Flat-bed scanning densitometer.
- Parallax bar (stereometer bar or heigh finder) is an instrument designed for use with stereoscope, it permits estimation of topographic elevation or of heights of features from stereo aerial photographs.

**FIGURE 5.21.** A parallax bar attaches to the legs of the pocket stereoscope; it can be used to estimate heights from stereoscopic photographs.
Use of the Pocket Stereoscope

- Data transfer
- Digital Photointerpretation

FIGURE 5.23. A digital record of image interpretation, showing the outlines as traced by the analyst using screen digitization (left), the outlines without the image backdrop (center), and a detail of the raster structure of the digitized outlines (right).
• Stereoscope is the ability to derive height information from two images of the same scene.
Positioning aerial photographs for stereoscopic viewing
Image Scale Calculations

Scale is an expression of the relationship between the image distance between two points and the actual distance between the two corresponding points on the ground.

- **Word statement** → “one inch equals one mile”
- **Bar scale**
- **Representative fraction (RF)** → 1 : 500,000

\[
\text{RF} = \frac{\text{Focal length}}{\text{Altitude}} = \frac{\text{Image distance}}{\text{Ground distance}}
\]
Estimating image scale by focal length and altitude

\[ RF = \frac{\text{FOCAL LENGTH}}{\text{FLYING ALTITUDE}} \]
Measurement of image scale using a map to derive ground distance
Interpretation of Digital Imagery

- Image enhancement is the process of improving the visual appearance of digital images.
- Contrast enhancement, contrast refers to the range of brightness value present on an image.
• Linear stretch converts the original values into a new distribution, using new minimum and maximum values specified.
• Histogram equalization reassigns digital values in the original image such that brightnesses in the output image are equally distributed among the range of output values.
Density slicing is accomplished by arbitrarily dividing the range of brightnesses in a single band into intervals, then assigning each interval to a color.
• Edge enhancement is an effort to reinforce the visual boundaries between regions of contrasting brightness.