REMOTE SENSING

Photogrammetry and Remote Sensing is officially defined as "the art, science, and technology of obtaining reliable information from noncontact imaging and other sensor systems about the Earth and its environment, and other physical objects and processes through recording, measuring, analyzing and representation".

Simply speaking, photogrammetry and remote sensing are sciences concerned with the acquisition of information from images. In photogrammetry the emphasis is acquisition of geometric information through measurement, while in remote sensing the emphasis is on the acquisition of thematic information through interpretation. Both measurement and interpretation could be achieved either manually or automatically.

Foundations of Remote Sensing

The Electromagnetic Spectrum

Electromagnetic spectrum is defined as "electromagnetic radiation is energy propagated through space between electric and magnetic fields. The electromagnetic spectrum is the extent of that energy ranging from cosmic rays, gamma rays, X-rays to ultraviolet, visible, and infrared radiation including microwave energy."

Electromagnetic Waves

Electromagnetic waves may be classified by

http://www.colorado.edu/geography/gcraft/notes/remote/gif/em2.gifFrequency or wavelength the velocity of ALL electromagnetic waves is equal to the speed of light, which we (along with Einstein) will refer to as c.

Wave Phenomena Concepts

Electromagnetic waves are *radiated* through space. When the energy encounters an object, even a very tiny one like a molecule of air, one of three reactions occurs. The radiation will either be reflected off the object, absorbed by the object, of transmitted through the object. The total amount of radiation that strikes an object is referred to as the *incident radiation*, and is equal to:

reflected radiation + absorbed radiation + transmitted radiation

In remote sensing, we are largely concerned with REFLECTED RADIATION. This is the radiation that causes our eyes to see colors, causes infrared film to record vegetation, and allows radar images of the earth to be created.

The electric field and the magnetic field are important concepts that can be used to mathematically describe the physical effects of electromagnetic waves.

The electric field vibrates in a direction transverse (i.e. perpendicular) to the direction of travel of the electromagnetic wave.

The magnetic field vibrates in a direction transverse to the direction of the wave AND transverse to the electric field.

POLARIZATION: Polarization is defined by the orientation of the electrical field E. It is usually described in terms of HORIZONTAL POLARIZATION and VERTICAL POLARIZATION. Polarization is most important when discussing RADAR applications of remote sensing.

Aerial Photography

Introduction

Aerial photography has two uses that are of interest within the context of this course:

(1) Cartographers and planners take detailed measurements from aerial photos in the preparation of maps.

(2) Trained interpreters utilize aerial photos to determine land-use and environmental conditions, among other things.

Although both maps and aerial photos present a "bird's-eye" view of the earth, aerial photographs are NOT maps. Maps are orthogonal representations of the earth's surface, meaning that they are directionally and geometrically accurate (at least within the limitations imposed by projecting a 3-dimensional object onto 2 dimensions). Aerial photos, on the other hand, display a high degree of radial distortion. That is, the topography is distorted, and until corrections are made for the distortion, measurements made from a photograph are not accurate. Nevertheless, aerial photographs are a powerful tool for studying the earth's environment.

Because most GISs can correct for radial distortion, aerial photographs are an excellent data source for many types of projects, especially those that require spatial data from the same location at periodic intervals over a length of time. Typical applications include land-use surveys and habitat analysis.

This unit discusses benefits of aerial photography, applications, the different types of photography, and the integration of aerial photographs into GISs.

Basic Elements of Air Photo Interpretation

Novice photo interpreters often encounter difficulties when presented with their first aerial photograph. Aerial photographs are different from "regular" photos in at least three important ways:

- objects are portrayed from an overhead (and unfamiliar) position.
- very often, infrared wavelengths are recorded, and
- photos are taken at scales most people are unaccustomed to seeing

These "basic elements" can aid in identifying objects on aerial photographs.

Tone (also called Hue or Color) -- Tone refers to the relative brightness or color of elements on a photograph. It is, perhaps, the most basic of the interpretive elements because without tonal differences none of the other elements could be discerned.

Size: The size of objects must be considered in the context of the scale of a photograph. The scale will help you determine if an object is a stock pond or Lake Minnetonka.

Shape: refers to the general outline of objects. Regular geometric shapes are usually indicators of human presence and use. Some objects can be identified almost solely on the basis of their shapes.

Texture: The impression of "smoothness" or "roughness" of image features is caused by the frequency of change of tone in photographs. It is produced by a set of features too small to identify individually. Grass, cement, and water generally appear "smooth", while a forest canopy may appear "rough".

Pattern *(spatial arrangement):-* The patterns formed by objects in a photo can be diagnostic. Consider the difference between (1) the random pattern formed by an unmanaged area of trees and (2) the evenly spaced rows formed by an orchard.

Shadow: Shadows aid interpreters in determining the height of objects in aerial photographs. However, they also obscure objects lying within them.

Site: refers to topographic or geographic location. This characteristic of photographs is especially important in identifying vegetation types and landforms. For example, large circular depressions in the ground are readily identified as sinkholes in central Florida, where the bedrock consists of limestone. This identification would make little sense, however, if the site were underlain by granite.

Association: Some objects are always found *in association with* other objects. The context of an object can provide insight into what it is. For instance, a nuclear power plant is not (generally) going to be found in the midst of single-family housing.

Advantages of Aerial Photography over Ground-Based Observation

Aerial photography offers an improved vantage point.

Aerial photography has the capability to stop action.

It provides a permanent recording.

It has broader spectral sensitivity than the human eye.

It has better spatial resolution and geometric fidelity than many ground-based sensing methods.

Types of Aerial Photography

- Black and White
- Color (True color or false color)
- Color Infrared