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DEPARTMENT CIVIL ENGINEERING

19CEE303 – **REMOTE SENSING**

III YEAR / V SEMESTER

Unit 1 :INTRODUCTION TO REMOTE SENSING

Introduction to remote sensing

Basic concepts

- Electromagnetic energy
- Remote sensing platforms
- Types of remote sensing

Remote Sensing

The art and science of obtaining information about an object or feature without physically coming in contact with that object or feature

- Remote sensing can be used to measure
  - Variations in acoustic wave distributions
  - Variations in force distributions (e.g., gravity meter)
  - Variations in electromagnetic energy distributions

- Remotely collected data through various sensors may be analyzed to obtain information about the objects or features under investigation

Remote Sensing of Electromagnetic Energy

- Variation in electromagnetic energy can be measured using photographic or non-photographic sensors
- Remote sensing of Electromagnetic energy is used for **earth observation**

"Remote sensing is detecting and measuring electromagnetic energy emanating or reflected from distant objects made of various materials, so that we can identify and categorize these objects by class or type, substance and spatial distribution"

[American Society of Photogrammetry, 1975]

- Surface parameters are inferred through the measurement and interpretation of the electromagnetic energy / radiation from the Earth's surface

Electromagnetic Energy

Electromagnetic energy or electromagnetic radiation (EMR)

- Energy propagated in the form of an advancing interaction between electric and magnetic fields (Sabbins, 1978)
  - Travels with the velocity of light
- Visible light, ultraviolet rays, infrared, heat, radio waves and x-rays are different forms

Expressed either in terms of frequency (f) or wave length (λ) of radiation

Shorter wavelengths have higher energy content and longer wavelengths have lower energy content

Electromagnetic Energy…

EMR spectrum : Distribution of the continuum of energy plotted as a function of wavelength (or frequency)

In remote sensing terminology, electromagnetic energy is generally expressed in terms of wavelength, λ.

Principles of Remote Sensing

Different objects reflect or emit different amount of energy in different bands of the electromagnetic spectrum differently

- Depends on the properties of
  - The target material
  - The incident energy (angle of incidence, intensity and wavelength)
- Uniqueness of the reflected or emitted electromagnetic radiation is used to detect and discriminate the objects or surface features

Sensor & Platform in remote sensing

- Sensor: A device used to detect the reflected or emitted electromagnetic radiation
  - Cameras and scanners
- Platform: A vehicle used to carry the sensor
  - Aircrafts and satellites

Stages in Remote Sensing

A. Emission of electromagnetic radiation
   - The Sun or an EMR source located on the platform

B. Transmission of energy from the source to the object
   - Absorption and scattering of the EMR while transmission

C. Interaction of EMR with the object and subsequent reflection and emission

D. Transmission of energy from the object to the sensor

E. Recording of the energy at the sensor
   - Photographic or non-photographic

E. Transmission of the recorded information to ground station

F. Processing of the data into digital or hard copy image

G. Analysis of data

Passive/ Active Remote Sensing

A simple analogy:

Passive remote sensing is similar to taking a picture with an ordinary camera

Active remote sensing is analogous to taking a picture with camera having built-in flash

Passive Remote Sensing

Passive remote sensing: Source of energy is that naturally available

- Solar energy
- Energy emitted by the Earth etc.

Most of the remote sensing systems work in passive mode using solar energy

- Solar energy reflected by the targets at specific bands are recorded using sensors
- For ample signal strength received at the sensor, wavelengths capable of traversing through the atmosphere without significant loss, are generally used

The Earth will also emit some radiation since its ambient temperature is about 300^{o} K.

- Passive sensors can also be used to measure the Earth's radiance
- Not very popular as the energy content is very low

Active Remote Sensing

Active remote sensing: Energy is generated and emitted from a sensing platform towards the targets

Energy reflected back by the targets are recorded

Longer wavelength bands are used

Example: Active microwave remote sensing (radar)

- Pulses of microwave signals are sent towards the target from the radar antenna located on the air / space-borne platform
- The energy reflected back (echoes) are recorded at the sensor

Remote Sensing Platforms

Ground level remote sensing

Very close to the ground (e.g., Hand held camera)

Used to develop and calibrate sensors for different features on the Earth's surface

Aerial remote sensing

Low altitude aerial remote sensing

High altitude aerial remote sensing

Space-borne remote sensing

Space shuttles

Polar orbiting satellites

Geo-stationary satellites

Air-borne Remote sensing

Downward or sideward looking sensors mounted on aircrafts are used to obtain images

Very high spatial resolution images (20 cm or less) can be obtained

Drawbacks:

- Less coverage area and high cost per unit area of ground coverage
- Mainly intended for one-time operations, whereas space-borne missions offer continuous monitoring of the earth features

LiDAR, analog aerial photography, thermal imagery and digital photography are commonly used in airborne remote sensing

Space-borne Remote sensing

Sensors are mounted on space shuttles or satellites orbiting the Earth

- Geostationary and Polar orbiting satellites
- Example: Landsat satellites, Indian remote sensing (IRS) satellites, IKONOS, SPOT satellites, AQUA and TERRA (NASA), and INSAT satellite series

Advantages:

- Large area coverage, less cost per unit area of coverage
- Continuous or frequent coverage of an area of interest
- Automatic/ semi-automatic computerized processing and analysis.

Drawback: Lower resolution

A Real Remote Sensing System- Shortcomings

Energy Source

Ideal system: Constant, high level of output over all wavelengths

Real system:

- Usually non-uniform over various wavelengths
- Energy output vary with time and space
- Affects the passive remote sensing systems
  - The spectral distribution of reflected sunlight varies both temporally and spatially
  - Earth surface features also emit energy in varying degrees of efficiency
- A real remote sensing system needs calibration for source characteristics

ATMOSPHERE

The Atmosphere

Ideal system: A non-interfering atmosphere

Real system:

- Atmosphere modifies the spectral distribution and strength of the energy transmitted through it
- The effect of atmospheric interaction varies with the wavelength associated, sensor used and the sensing application
- Calibration is required to eliminate or compensate these atmospheric effects

A Real Remote Sensing System…

The Energy/Matter Interactions at the Earth's Surface

Ideal system: A series of unique energy/matter interactions

Real system:

- Spectral signatures may be similar for different material, making the differentiation difficult
- Lack of complete understanding of the energy/matter interactions for surface features

The Sensor

Ideal system: A super sensor

Real system:

- Fixed limits of spectral sensitivity i.e., they are not sensitive to all wavelengths.
- Limited spatial resolution (efficiency in recording spatial details).
- Sensor selection requires a trade-off between spatial resolution and spectral sensitivity.
  - For example, photographic systems have very good spatial resolution , but poor spectral sensitivity. Non-photographic systems have poor spatial resolution

Advantages of Remote Sensing

Major advantages of remote sensing are

- Provides data for large areas
- Provide data of very remote and inaccessible regions
- Able to obtain imagery of any area over a continuous period of time
  - Possible to monitor any anthropogenic or natural changes in the landscape
- Relatively inexpensive when compared to employing a team of surveyors
- Easy and rapid collection of data
- Rapid production of maps for interpretation

Limitations of Remote Sensing

Some of the drawbacks of remote sensing are

- The interpretation of imagery requires a certain skill level
- Needs cross verification with ground (field) survey data
- Data from multiple sources may create confusion
- Objects can be misclassified or confused
- Distortions may occur in an image due to the relative motion of sensor and source

THANK YOU