Remote Sensing – Introduction

EMR Spectrum

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Remote Sensing

Remote Sensing is the science and art of obtaining information about an object, area or phenomenon through the analysis of data acquired by a device that is not in physical contact with the object, area or phenomenon under investigation.

Examples
1. Eyes are living examples (EMR distribution)
2. Sonar (like bats): Acoustic wave distribution
3. Gravity Meter: Gravity force distribution

Evaluation

- Assignments (10%)
- Surprise Tests (15%)
- Class Test (15%)
- Seminar (20%)
- Final Test (40%)

Remote Sensing

Syllabus: Basic concepts of remote sensing; Airborne and space borne sensors; Digital image Processing; Geographic Information System; Applications to rainfall-runoff modeling, Watershed management, Irrigation management, soil moisture estimation, Drought and Flood monitoring, Environment and ecology; Introduction to Microwave remote sensing and Global Positioning System (GPS); Digital Elevation Modeling; Use of relevant software for Remote sensing and GIS applications.

References:
1. Remote Sensing and Image Interpretation
2. Remote Sensing - Principles and Interpretation
3. An Introduction to Geographical Information Systems
4. Remote sensing in water resources management: The state of the art

http://www.civil.iisc.ernet.in/~nagesh/rs_gis.htm
**Remote Sensing**

DATA ACQUISITION → DATA ANALYSES

- Sensing systems
- Data products
- Interpretation procedures
- Information products

**Electromagnetic Wave**

Sinusoidal Electric Wave (E) \[ \lambda = \frac{c}{f} \]

Magnetic Wave (M) \[ \lambda = \text{wave length (\(\mu\)m)} \]

Right angles to the source \[ c = \text{Celerity (3x10^8 m/s)} \]

**EMR Spectrum**

- EMR Spectrum

**EMR**

Diagram of EM waves at different frequencies.
**EMR Energy**

- Energy of a quantum
  \[ E = h f \]
  - \( E \) in Joules (J)
  - \( h \) – Planck’s constant, \( 6.626 \times 10^{-34} \) J sec
  - \( f \) – Frequency

- Energy of a quantum is inversely proportional to its wavelength
- The low energy content of long wavelength means that, in general, systems operating at long wavelength must ‘view’ large areas of the earth in order to obtain a detectable signal

**EMR Source**

- Sun is the primary source
- All matter at temperature above absolute zero (0°K or −273° C) continuously emit EMR
- Energy emitted is, among other things, a function of surface temperature.
- Stefan-Boltzmann Law (Black body)
  \[ W = \sigma T^4 \]
  - \( W \) – Total radiant emittance in W m\(^{-2}\)
  - \( \sigma \) – Stefan-Boltzmann constant, \( 5.6697 \times 10^{-8} \) Wm\(^{-2}\)K\(^{-4}\)
  - \( T \) – Absolute temperature (°K) of the emitting material
- Energy from an object varies as \( T^4 \)
  - Increases rapidly with increase in Temperature

A black body is a hypothetical ideal radiator that totally absorbs and re-emits all energy incident upon it

**Energy Interactions in the Atmosphere**

- All radiation detected by sensors passes through some distance of the atmosphere

**Scattering (Contd..)**

- **Scattering**
  - Scattering is unpredictable distribution of radiation by particles in the atmosphere
  - *Rayleigh scatter* is common when radiation interacts with particles which are smaller in diameter than the wavelength.
    - Inversely proportional to fourth power of wavelength
    - Short wavelengths get scattered more
    - A blue sky is a manifestation of Rayleigh scatter
    - Rayleigh scatter is primary cause for ‘haze’ in imagery (results in blush-gray photos) (Blue Filter)

- **Mie Scatter** is common when radiation interacts with atmospheric particles diameters which are essentially equal to the wavelength.
  - Water vapour and dust are major causes of Mie scatter
  - Influences longer wavelengths when compared to Rayleigh scatter
  - Mie scatter is significant in overcast conditions

- Nonselective scatter is common when radiation interacts with particles which are much larger in diameter than the wavelength.
  - Water droplets (5-100 µm) cause such scatter
  - Scatter all visible and reflected IR wavelengths
  - Fog and Clouds appear white
**Absorption**

- In contrast to scatter, atmospheric absorption results in effective loss of energy to atmospheric constituents.
  - Most efficient absorbers are water vapour, carbon dioxide and ozone.
  - As absorption occurs in specific wavelengths, they strongly influence “where we look” spectrally with any sensor.
  - Wavelength ranges in which the atmosphere is particularly transmissive of energy are called Atmospheric Windows.

**Spectral Characteristics …**

- Spectral sensitivity range of eye coincides with an atmospheric window and peak level of energy from the sun.
- Emitted heat energy from the earth, is sensed through the windows at 3 – 5 µm and 8 – 11 µm using Thermal scanners.
- Multi Spectral Sensors sense simultaneously through multiple, narrow wavelength ranges that can be located at various points in visible through the thermal spectral regions.
- Radar and Passive microwave systems operate through a window in the 1 mm to 1 m region.

**Sensor Selection**

- Spectral sensitivity of the sensors available.
- Presence or absence of atmospheric windows in the spectral range(s) in which one wishes to sense.
- Source, magnitude, and spectral composition of the energy available in these ranges.
- Manner in which the energy interacts with the features under investigation.