Remote Sensing Concepts and Applications in Agriculture

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Remote sensing Definition

- Remote sensing is the process of collecting information about an object or area without making physical contact
- Carried out using sensors mounted on satellites, aircraft, drones, or ground-based platforms
- These sensors detect and measure reflected or emitted energy in different wavelengths of the electromagnetic spectrum, such as visible light, infrared, or microwaves.

History

- Term Remote Sensing”was first used in1961 when U.S. Naval project on the study of Aerial photographs was renamed as“remote sensing”
- First satellite in remote sensing technology was launched in July1972 in U.S.A.
- In 1908 Airplane was used as a platform for Aerial Photography
- Satellite Age began in 1957 with the lunch of Sputnik by Russia
- July 1972 NASA launched ,Earth Resource Technology Satellite (ERTS -1) or Landsat -1 , Multispectral with 80 m resolution

Indian Scenario

- India launched INSAT 1 A in April 1982 and IRS 1A in March 1988
- India has its own satellites like Indian Remote Sensing Satellite (IRS) series-Resourcesat, Cartosat, Oceansat etc which provide required data for carrying out various projects.
- Data collected is used for several applications covering agriculture, water resources, Urban development, mineral prospecting, environment, forestry, drought and flood forecasting, ocean resources and disaster management
- Indian National Satellite (INSAT) System is the largest domestic communication satellite systems in Asia-Pacific region with nine operational communication satellites placed in Geo-stationary orbit

Key features of Remote Sensing

- Non-Invasive, Data collection happens without physical interaction.
- Enables monitoring of wide regions, even remote or inaccessible areas.
- Allows Repetitive Data Collection for monitoring changes over time (e.g.,deforestation, urban growth, or climate change).
- Multi spectral Imaging: Sensors can capture data in different wavelengths (visible, infrared, microwave) to reveal unique characteristics of objects

Electromagnetic Spectrum

- Remote sensing makes use of the Electro Magnetic Spectrum (EMS), of different wavelengths of radiation, such as visible light, infrared, microwave, and radio waves
- Different materials on Earth's surface (like crops, soil, and water) reflect or emit radiation at different wavelengths.
- Remote sensing systems detect and measure this radiation to capture information about the material being observed.

Spectral Signature

- Spectral signature is a pattern of reflected or emitted electromagnetic radiation that identifies a material or object.
- It is a plot of how much radiation a material reflects or absorbs at different wavelengths.
- A sensor detects the reflected wavelengths.
- Spectral signatures are used to identify and classify objects and materials on the Earth's surface

Sensors

- Remote sensing systems use sensors to detect electromagnetic radiation.
- These sensors can be installed on satellites, aircraft, drones, or ground-based platforms.

Resolution

- Spatial Resolution refers to the level of detail in an image (i.e., the size of the smallest object that can be detected).
- High-resolution sensors capture finer details, while lower resolution sensors capture broader areas.
- Spectral Resolution refers to number and width of spectral bands used to capture data.
- More spectral bands allow for more detailed analysis of materials on the surface.
- Radiometric Resolution is the ability of a sensor to distinguish different intensities of reflected radiation, providing more precise data for analysis.

Remote Sensing Sensors

Sensor Type	Wave Length Range	Primary use	Examples
Optical Multispectral	Visible to Near Infrared	Land use,,vegetation,water bodies mapping	Land sat Sentinel MODIS
Hyper spectral	Visible to shortwave IR	Detailed spectral analysis,mineral mapping	EO-1Hyperion,AVRIS
Thermal Infrared	5-14 micrometers	Surface temperature,heat monitoring ,fire detection	Landstat, TIRS,MODIS
Radar (SAR)	Microwave	Terrain mapping,flood detection,infrastructure mapping	Sentinel-1 RADARSAT-2
LIDAR (Light Detection and Ranging)	Laser (Near IR)	Topography,vegetation,3 D mapping	Airborne LIDAR ICEsat-2
Radar Altimeters	Microwave	Altitude measurement,sea level,surface topography	Jason,Cryosat

Platforms

- Satellites offer wider and global coverage, but at lower resolution compared to drones.
- Drones (Unmanned Aerial Vehicles - UAV provide high-resolution, localized data and flexibility for targeted field monitoring.
- Aircraft-mounted sensors offer more control over the data collection process and often capture high-resolution imagery, but are more costly and less flexible than drones.
- Ground-based sensors can complement remote sensing data by providing in-situ measurements of soil, temperature, humidity, and other environmental factors.

Remote sensing process

- Energy source or illumination provides electromagnetic energy to the target of interest.
- As the EMR travels from its source to the target it come in contact and interact with atmosphere.
- Energy interacts with the target depending on the properties of both the target and the radiation.
- Recording of energy by the sensor-after the energy has been emitted from the target ,a sensor is required to collect and record the electromagnetic radiation.
- Transmission and processing-the energy recorded by the sensor is transmitted, often in electronic form, to a receiving and processing station where the data are processed into an image (hard copy and/or digital).
- Interpretation and analysis-the processed image is interpreted, visually and/or digitally or electronically, to extract information about the target which was illuminated.
- Application–the final element of the remote sensing process is application after extracting the information from the image to solve a particular problem

Types of Remote Sensing

Passive Remote sensing

- Carried out with the help of electromagnetic radiation (signals) reflected by a natural body (sun and the earth). eg. visible, near infra red and microwave remote sensing

Active Remote sensing

- Carried out with a man made source of radiations which is used to illuminate a body and to detect the signal reflected form eg. Radar and Lidar remote sensing

Integration of Remote Sensing and Geographical Information Systems (GIS)

- Remote sensing techniques when integrated with Geographical Information Systems (GIS) play an important role in precision farming by providing continuous acquired data of crop growth and aids in evolving appropriate management strategies for optimizing yields

Applications of Remote Sensing in Agriculture

- Soil Properties like Texture, Structure, Soil Moisture , Nutrients.
- Plant population, crop stress and Nutrient Status
- Yield Monitoring Systems Crop Yield, Crop Moisture
- Variable Rate Technology Systems Fertilizer flow
- Mapping condition that affects plant health, yield, or quality of crop.
- Satellite imagery can be applied to Monitor variability within/between fields
- Detect and map weed and pest infestations
- Optimize crop inputs

References

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Thank You