

Introduction to Remote Sensing

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Key concepts, components, and applications

1. What Is Remote Sensing?

- **Definition** – The acquisition of information about an object or area from a distance, typically using aircraft or satellites that capture electromagnetic energy reflected or emitted by the target.
 - **Why It Matters** – Enables large-scale, repeatable, and non-invasive observation of Earth’s surface, atmosphere, and oceans for scientific, commercial, and societal purposes.
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2. Fundamental Principles

Principle	Description	Example
Electromagnetic Spectrum (EMS)	Remote sensors detect radiation across wavelengths (UV, visible, NIR, SWIR, thermal, microwave).	Multispectral Landsat imagery uses visible-NIR bands to map vegetation.
Interaction with Surface	Energy can be reflected , absorbed , transmitted , or scattered depending on material properties.	Dark water absorbs most NIR, appearing dark in that band.
Resolution Types	Spatial – size of ground pixel (e.g., 10m).	High-spatial (WorldView-3, 0.31m), high-temporal (Sentinel-2, 5-day revisit).
	Spectral – number & width of wavelength bands.	
	Temporal – revisit frequency (days to weeks).	
Energy Sources	Radiometric – number of intensity levels (bits).	SAR (Synthetic Aperture Radar) penetrates clouds, works day/night.
	Passive – sensors detect natural radiation (sunlight, thermal emission).	
	Active – sensors emit their own signal (radar, LiDAR).	

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3. Major Sensor Types

Sensor	Platform	Wavelength	Key Uses
Optical (Multispectral / Hyperspectral)	Satellites (Landsat, Sentinel-2), UAVs	Visible–NIR–SWIR	Land cover classification, vegetation health, mineral mapping
Thermal Infrared (TIR)	Satellites (Landsat-8 TIRS, MODIS)	8–14 μm	Surface temperature, fire detection, urban heat islands
Synthetic Aperture Radar (SAR)	Satellites (Sentinel-1, RADARSAT)	Microwave (C, L, X bands)	Flood mapping, soil moisture, deformation monitoring
LiDAR (Light Detection and Ranging)	Aircraft, UAVs	Near-infrared laser	High-resolution elevation models, forest canopy structure
Passive Microwave Radiometer	Satellites (SMAP, AMSR)	Microwave	Soil moisture, sea ice concentration

4. Data Acquisition & Processing Workflow

1. Mission Planning

- Define study area, required resolution, revisit interval.
- Choose appropriate sensor (optical, radar, LiDAR).

2. Data Acquisition

- Download from archives (e.g., USGS EarthExplorer, Copernicus Open Access Hub) or schedule airborne campaigns.

3. Preprocessing

- **Radiometric correction** – convert digital numbers to at-sensor radiance/reflectance.
- **Geometric correction** – align imagery to a map projection (orthorectification).

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- **Atmospheric correction** – remove scattering/absorption effects (e.g., Dark Object Subtraction, MODTRAN).

4. Image Enhancement (optional)

- Contrast