

Introduction to Remote Sensing

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An overview of the principles, components, and applications of remote sensing for Earth observation and beyond.

1. What Is Remote Sensing?

Aspect	Description
Definition	Acquisition of information about an object or area without physical contact, using sensors that detect and record electromagnetic (EM) energy reflected, emitted, or scattered from the target.
Key Idea	“Seeing from a distance” – satellites, aircraft, drones, or ground-based platforms collect data that can be transformed into maps, images, and quantitative measurements.
Primary Sources of Energy	1. Solar radiation (reflected sunlight) – most common for land and ocean studies. 2. Thermal emission (object’s own heat) – used for temperature and nighttime observations. 3. Artificial sources (radar, lidar) – emit their own signals and measure the return.

2. Components of a Remote Sensing System

1. **Energy Source** – Sun (passive) or onboard transmitter (active).
2. **Platform** – Vehicle that carries the sensor:
 - *Spaceborne* (e.g., Landsat, Sentinel, MODIS).
 - *Airborne* (aircraft, balloons, UAVs).
 - *Ground-based* (tower-mounted scanners).
3. **Sensor** – Device that records EM energy:
 - *Passive sensors*: optical cameras, multispectral/hyperspectral imagers, thermal infrared detectors.
 - *Active sensors*: radar (microwave), lidar (laser), sonar (acoustic).
4. **Data Acquisition & Transmission** – Onboard storage, real-time downlink, or relay via ground stations.

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5. **Data Processing** – Radiometric, geometric, and atmospheric corrections; conversion to usable products (e.g., reflectance, temperature).
 6. **Interpretation & Application** – Analysis using GIS, machine learning, or visual interpretation to extract information.
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3. Electromagnetic Spectrum & Remote Sensing

Spectral Region	Typical Wavelength (nm/μm)	Common Sensors & Uses
Visible (VIS)	400–700 nm	True-color imagery, vegetation health, water quality.
Near-Infrared (NIR)	700–1300 nm	Plant vigor (NDVI), soil moisture, land cover discrimination.
Short-Wave Infrared (SWIR)	1300–2500 nm	Mineral mapping, burn severity, moisture content.
Thermal Infrared (TIR)	8–14 μm	Surface temperature, urban heat islands, volcanic activity.
Microwave (Radar)	1 mm–30 cm	Surface roughness, flood mapping, all-weather, day/night capability.
Lidar (Laser)	1064 nm (near-IR) & others	High-resolution elevation, forest canopy structure, urban 3D modeling.

Key concept: Different materials interact uniquely with each spectral band, enabling discrimination of land-cover types, water quality, atmospheric constituents, etc.

4. Spatial, Spectral, Radiometric, and Temporal Resolutions

Resolution Type	Definition	Typical Values & Trade-offs
Spatial	Size of the smallest object that can be resolved (pixel size).	High: 0.3 m (WorldView-3); Medium