#Basics of Remote Sensing

Introduction

"Remote Sensing is the art and science of acquiring information about the earth surface without having any physical contact with it. This is done by sensing and recording of reflected and emitted energy." "Remote" means far away and "Sensing" means believing or observing or acquiring some information.

<u>In short</u>- "Remote sensing means acquiring information of things from a distance" Remote sensing also known as the Earth observation.

Means observing the earth with sensors from high above its surface. Sensors are like simple cameras except that they not only use visible light but also other bands of the electromagnetic spectrum such as infrared, microwaves and ultraviolet regions. They are so high up that they can make images of very large area. Nowadays remote sensing is mainly done from space using satellites.

Milestones in the History of Remote Sensing

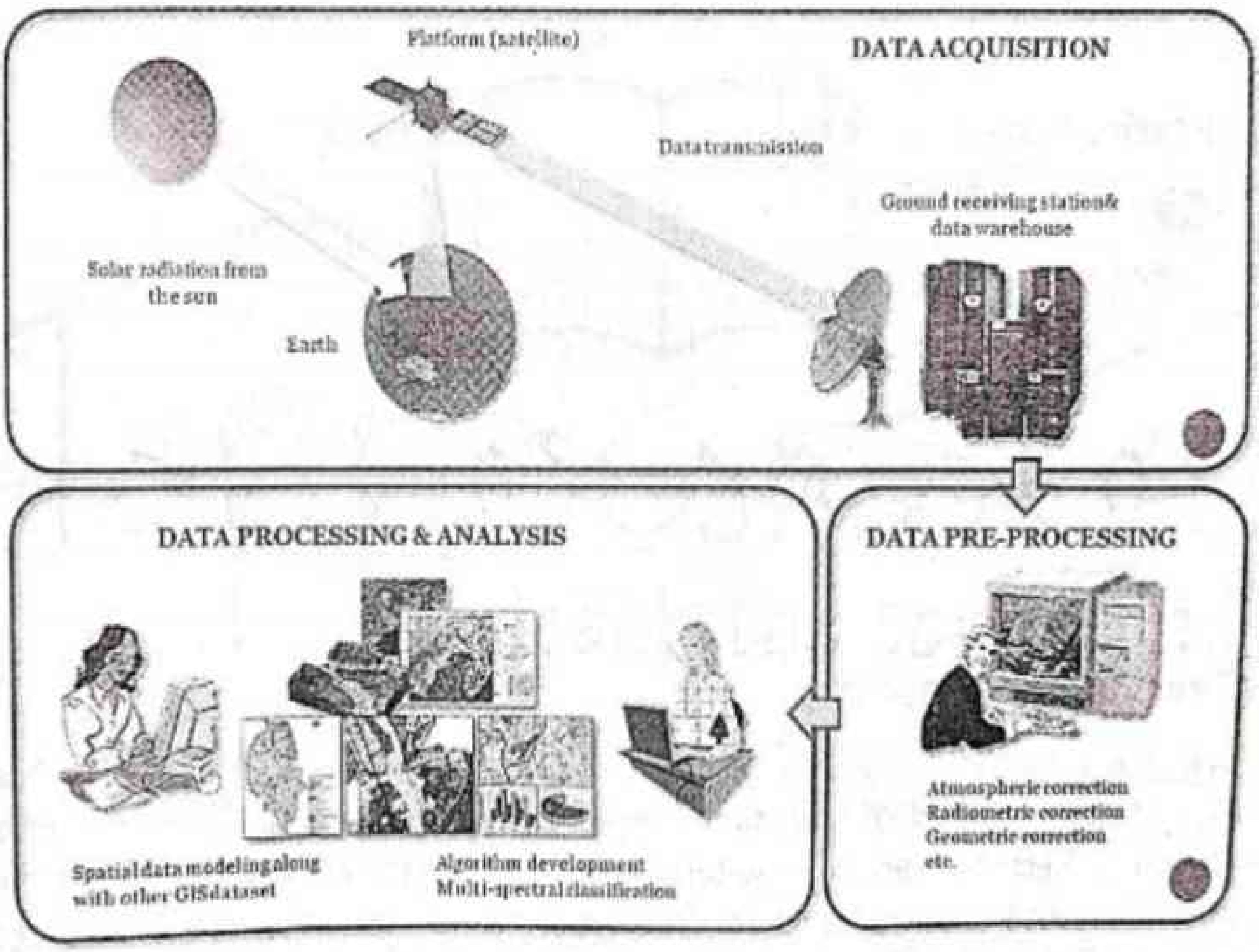
1. 1800 Discovery of Infrared by Sir W. Herschel
2. 1839 Beginning of Practice of Photography
3. 1847 Infrared Spectrum Shown by J.B.L. Foucault
4. 1859 Photography from Balloons
5. 1873 Theory of Electromagnetic Spectrum by J.C. Maxwell
6. 1909 Photography from Airplanes
7. 1916 World War I: Aerial Reconnaissance
8. 1935 Development of Radar in Germany
9. 1940 WW II: Applications of Non-Visible Part of. EMS
10. 1950 Military Research and Development
11. 1959 First Space Photograph of the Earth (Explorer-6)
12. 1960 First TIROS Meteorological Satellite Launched
13. 1970 Skylab Remote Sensing Observations from Space
14. 1972 Launch Landsat-1 (ERTS-1) : MSS Sensor
15. 1972 Rapid Advances in Digital Image Processing
16. 1982 Launch of Landsat -4 : New Generation of Landsat Sensors: TM
17. 1986 French Commercial Earth Observation Satellite SPOT
18. 1986 Development Hyperspectral Sensors
19. 1990 Development High Resolution Space borne Systems First Commercial Developments in Remote Sensing

20.1998 Towards Cheap One-Goal Satellite Missions
21.1999 Launch EOS : NASA Earth Observing Mission
22.1999 Launch of IKONOS, very high spatial resolution sensor system

Remote Sensing Overview

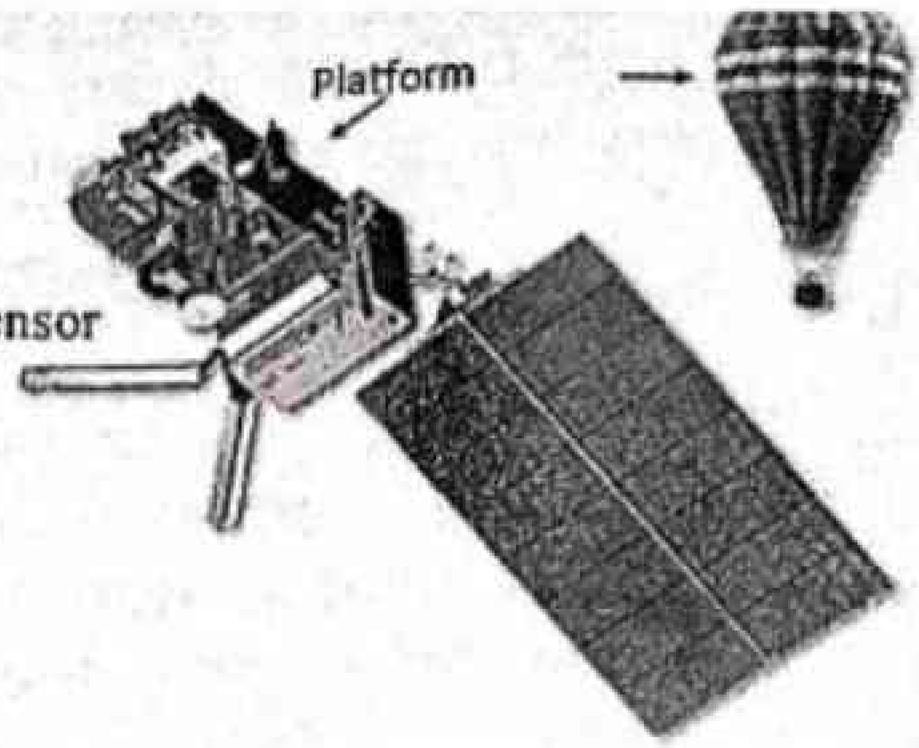
The science of acquiring information about the earth using instruments which are remote to the earth's surface, usually from aircraft or satellites. Instruments may use visible light, infrared or radar to obtain data. Remote sensing offers the ability to observe and collect data for large areas relatively quickly, and is an important source of data for GIS.

In fact, any information acquired from the object without touching is Remote Sensing.



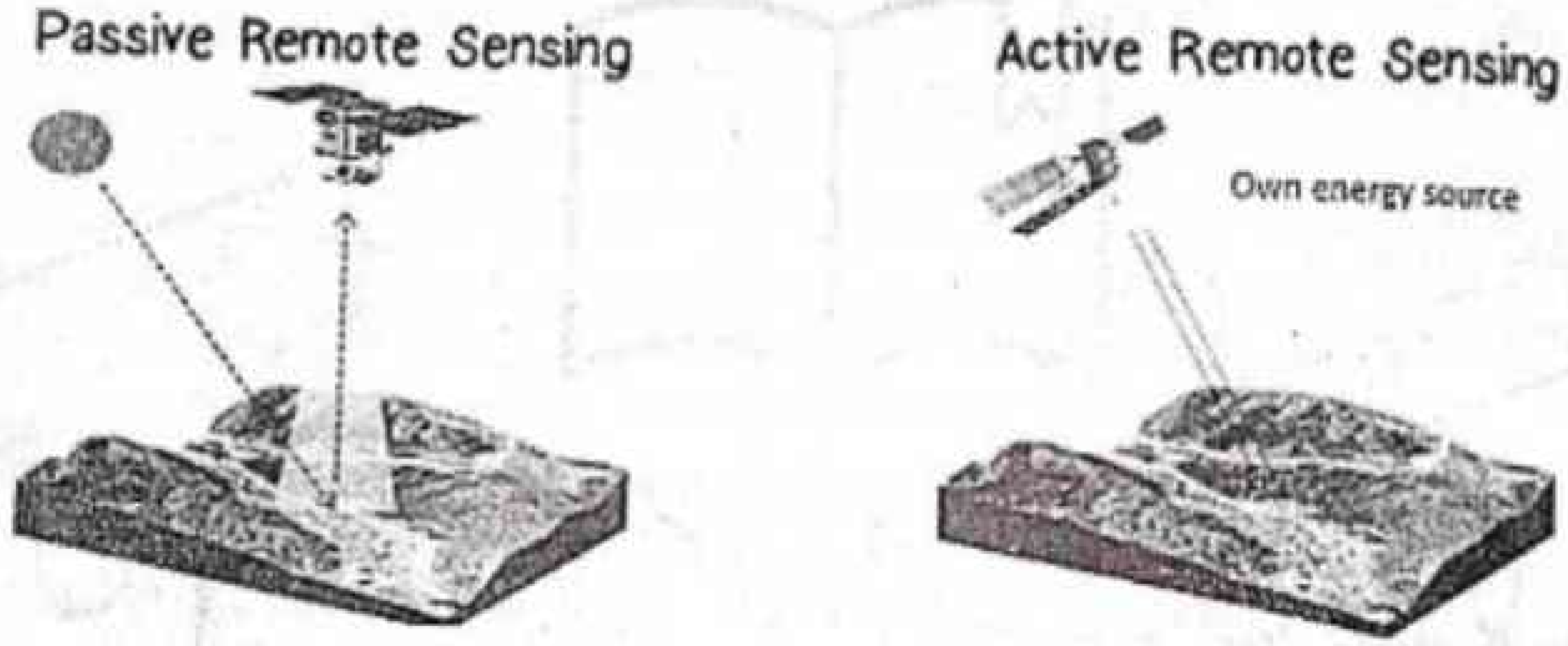
Components in Remote Sensing

* Platform: The vehicle which carries a sensor. I.E. Satellite, aircraft, balloon, etc...
* Sensors: Device that receives electromagnetic radiation and converts it into a signal that can be recorded and displayed as either numerical data or an image.



Types of Remote Sensing

Passive Remote Sensing and Active Remote Sensing

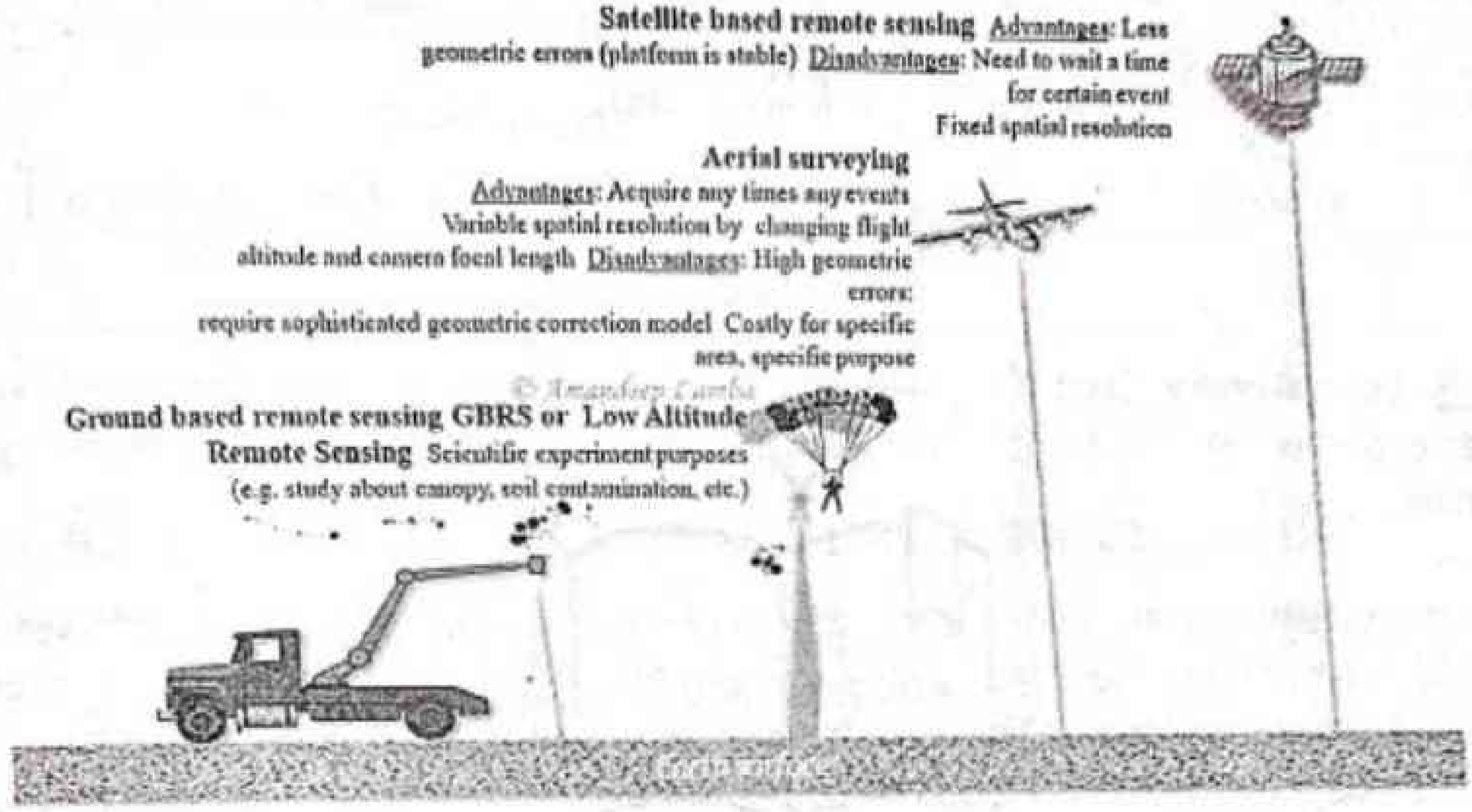


Passive vs. Active Sensing

1. Passive Sensing: The sun's energy is either reflected, as it is for visible wavelengths, or absorbed and then re-emitted, as it is for thermal infrared wavelengths. Remote sensing systems which measure energy that is naturally available are called passive sensors. Passive sensors can only be used to detect energy when the naturally occurring energy is available. For all reflected energy, this can only take place during the time when the sun is illuminating the Earth. There is no reflected energy available from the sun at night. Energy that is naturally emitted (such as thermal infrared) can be detected day or night, as long as the amount of energy is large enough to be recorded.
2. Active sensors: Active sensors, provide their own energy source for illumination. The sensor emits radiation which is directed toward the target to be investigated. The radiation reflected from that target is detected and measured by the sensor. Advantages for active sensors include the ability to obtain measurements anytime, regardless of the time of day or season. Active sensors can be used for examining wavelengths that are not sufficiently provided by the sun, such as

microwaves, or to better control the way a target is illuminated. However, active systems require the generation of a fairly large amount of energy to adequately illuminate targets. Some examples of active sensors are a laser fluorosensor and a synthetic aperture radar (SAR).

Multistage Remote Sensing Data Collection



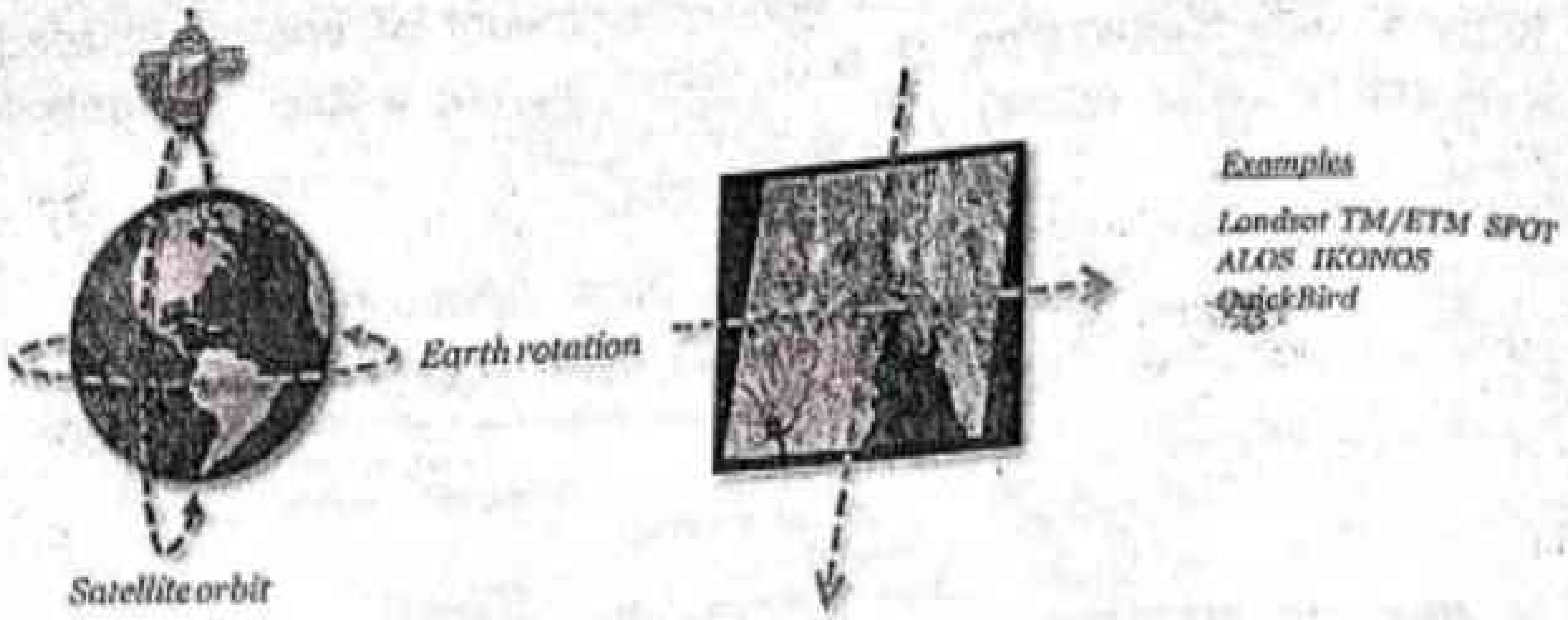
Types and Uses of Satellites

Types of satellites can be classified by their orbit characteristics.

Type 1: low earth orbits/satellites: normally used in spy satellite (military purposes)

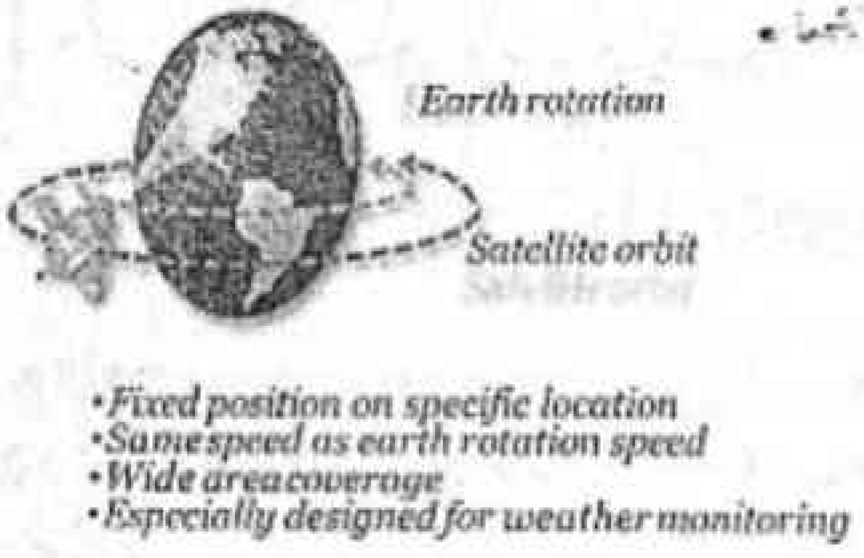
Type 2: Sun-synchronous orbits/satellites: a polar orbit where the satellite always crosses the equator at the same local solar time. Most of the earth resources satellites are sun-synchronous orbit.

Those that orbit from pole-to-pole. These are polar orbits which are synchronous with the Sun. A satellite in a sun synchronous orbit would usually be at an altitude of between 600 to 1000 km. Generally these orbits are used for Earth observation, solar study, weather forecasting as ground observation is improved if the surface is always illuminated by the Sun at the same angle when viewed from the satellite.



Type 3: Geostationary Orbits/Satellites: Satellites at very high altitudes, which view the same portion of the Earth's surface at all times. Especially used in metrological applications.

There are satellites that orbit the equator. A geostationary orbit, often referred to as a GEO orbit, circles the Earth above the equator from west to east at a height of 36 000 km. As it follows the Earth's rotation, which takes 23 hours 56 minutes and 4 seconds, satellites in a GEO orbit appear to be 'stationary' over a fixed position. Their speed is about 3 km per second.



The Electromagnetic Spectrum

The electromagnetic spectrum ranges from the shorter wavelengths (including gamma and x-rays) to the longer wavelengths (including microwaves and broadcast radio waves). There are several regions of the electromagnetic spectrum which are useful for remote sensing. The wavelength is the length of one wave cycle, which can be measured as the distance between successive wave crests. Wavelength is usually represented by the Greek letter lambda (λ). Wavelength is measured in meters (m) or some factor of meters such as nanometres (nm, 10^{-9} meters), micrometres (μm, 10^{-6} metres) and centimeters (cm, 10^{-2} meters). Frequency refers to the number of wave crests passing in a given point in Specific unit of time. It is normally measured in hertz (Hz).

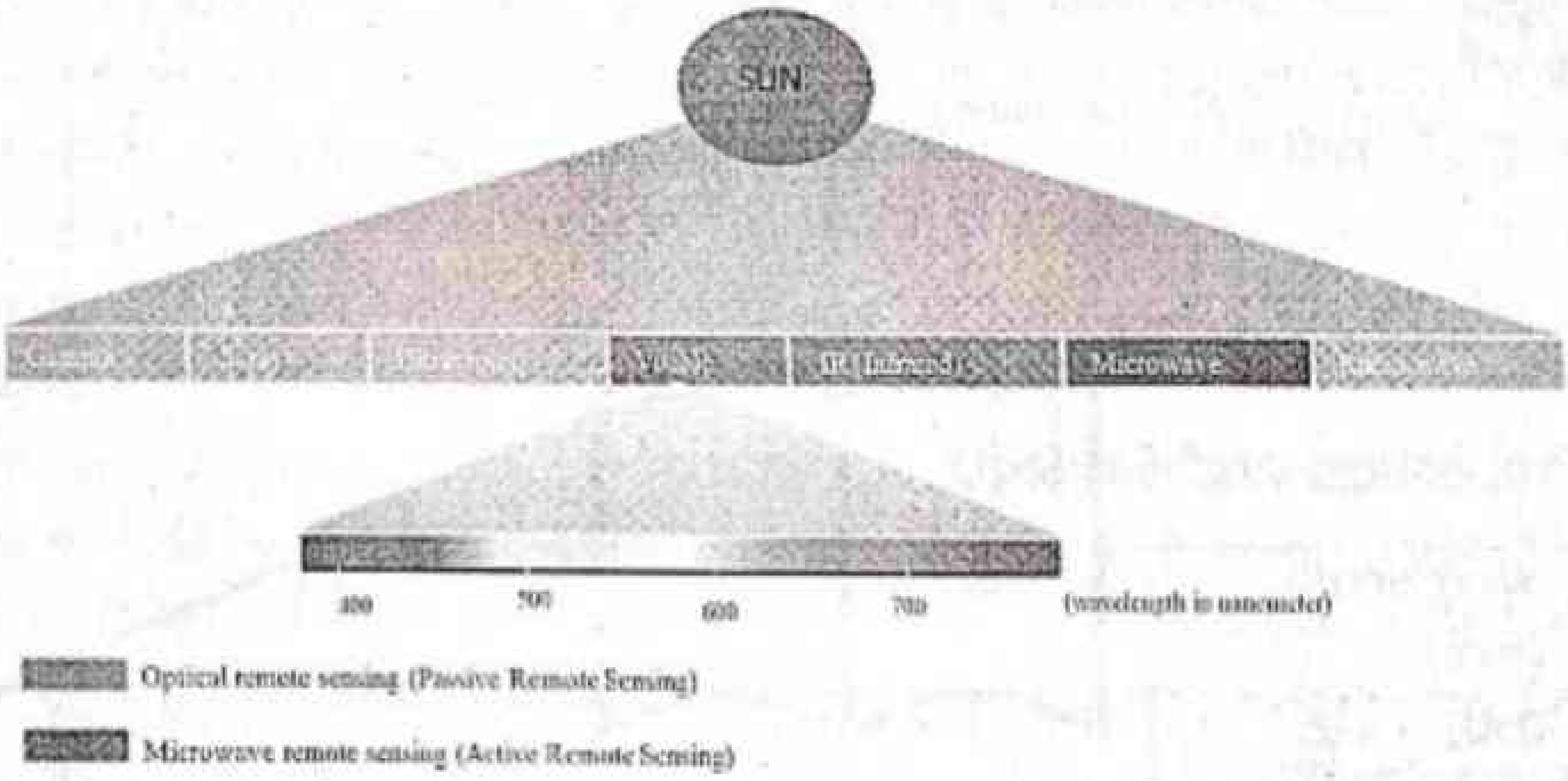
Wave length and frequency is related to following formula

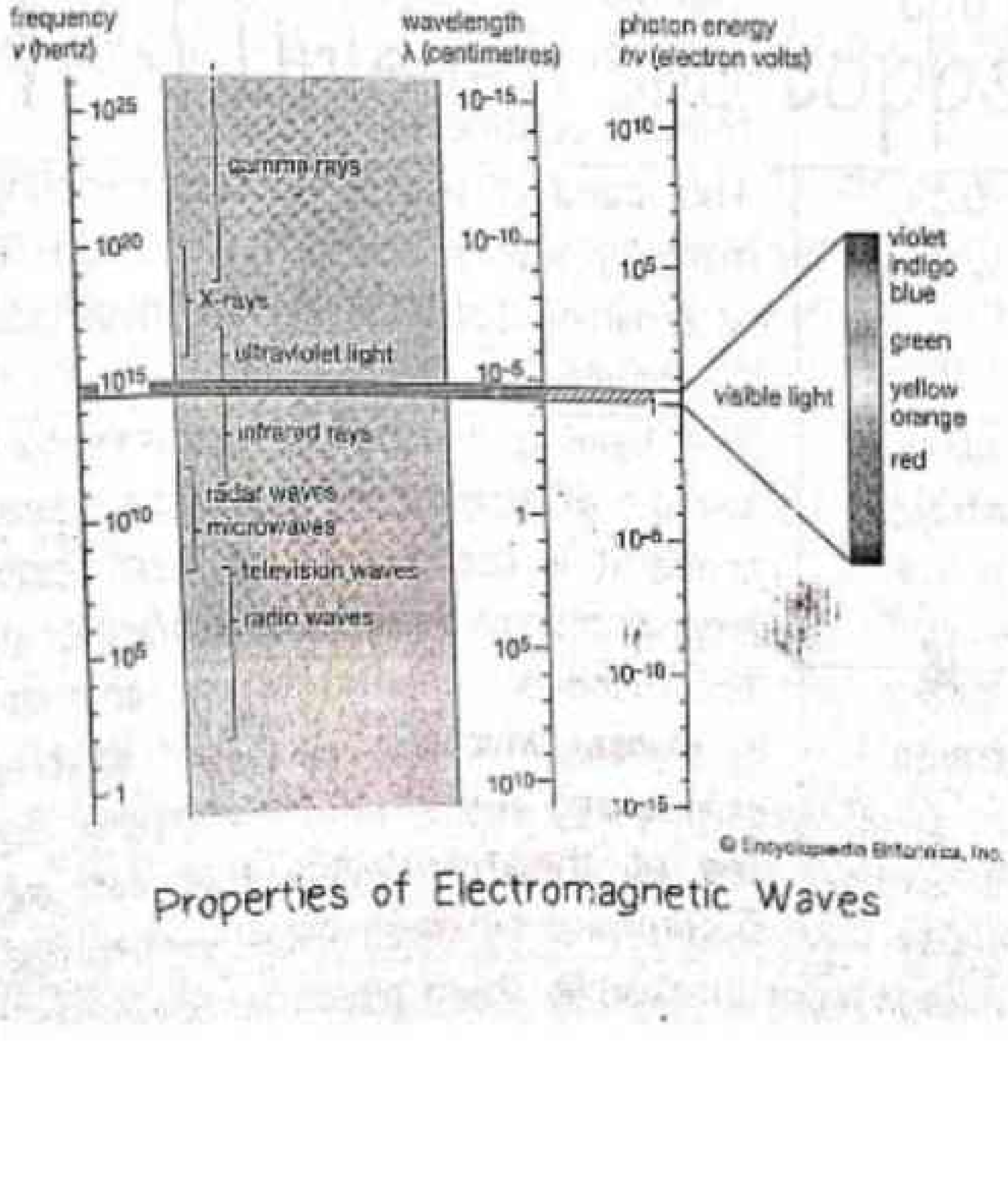
$$\nu = c / \lambda$$

v = Frequency c = Speed of Light λ = Wavelength

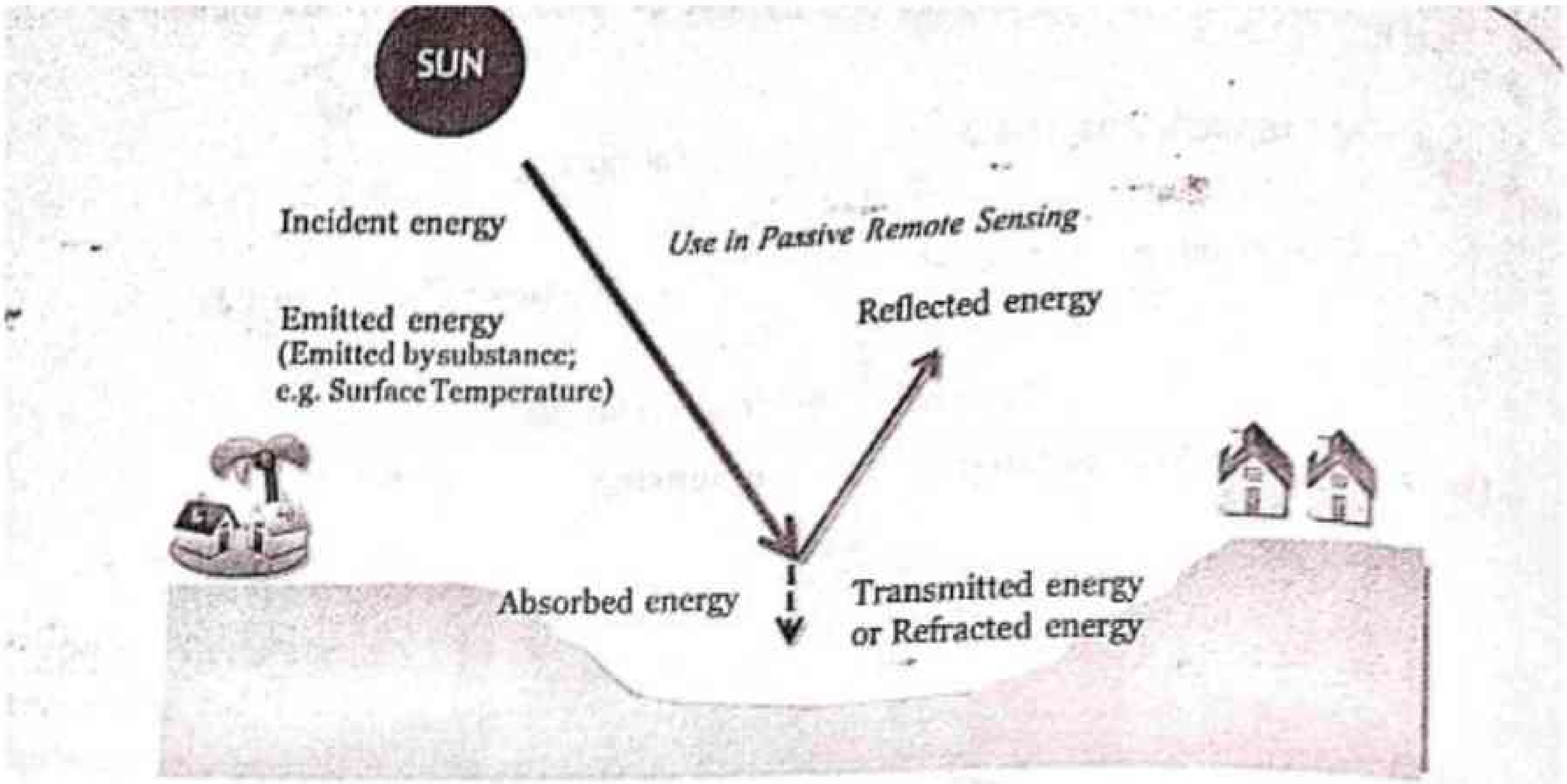
Remote Sensing Data Acquisition

Electromagnetic Waves Used in Remote Sensing





Properties of Electromagnetic Waves



Spectral Properties and Principal Applications

Band	Wavelength (mm)	Principal applications
B-1	0.45 - 0.52 (Blue)	This band is useful for mapping coastal water areas, differentiating between soil and vegetation, forest type mapping, and detecting cultural features.
B-2	0.52 - 0.60 (Green)	This band corresponds to the green reflectance of healthy vegetation. Also useful for cultural feature identification.
B-3	0.63 - 0.69 (Red)	This band is useful for discriminating between many plant species. It is also useful for determining soil boundary and geological boundary delineations as well as cultural features.
3-4	0.76 - 0.90 (Near-Infrared)	This band is especially responsive to the amount of vegetation Biomass present in a scene. It is useful for crop identification and emphasizes soil/crop and land/water contrasts.
-5	1.55 - 1.75 (Mid-Infrared)	This band is sensitive to the amount of water in plants, which is useful in crop drought studies and in plant health analyses. This is also one of the few bands that can be used to discriminate between clouds, snow, and ice

B-6	10.4 - 12.5 (Thermal infrared)	This band is useful for vegetation and crop stress detection, heat intensity, insecticide applications, and for locating thermal pollution. It can also be used to locate geothermal activity.
B-7	2.08 - 2.35 (Mid-Infrared)	This band is important for the discrimination of geologic rock type and soil boundaries, as well as soil and vegetation moisture content.

Visual Interpretation

As we noted above many of the Remote Sensing studies using human interpretation or visual interpretation techniques. How we can do a visual interpretation? There are certain elements are there which makes visual interpretation easier. They are

* Tone refers to the brightness or color of the image. Tone is an important element in identifying target. Variations in tone enable to identify the target along with other elements like shape, size etc.
* Shape the general form or structure of the individual objects. Shape is the most helpful interpretation technique. Shape of a sharp edge may be an agricultural field rather than a naturally created forest. Linear shape of the road and rail way makes it easy to identify.
* Size of objects in an image is function of scale. It is important o assess the size of the target relative to other objects in a scene, as well as he absolute size, to aid the interpretation of the target. For example if an interpreter identified an area having larger buildings such as factories or ware houses then it may be an industrial region while a clustering of small building indicates they may be a settlement area.
* Pattern means the spatial arrangement of visibly discernible objects in the image. Pattern helps to identify objects having similar characteristics like orchard have evenly spaced tress which may show a similar pattern which makes identification easier. Regularly spaced villas are another example of same pattern.
* Texture is the arrangement and frequency of tonal variations in particular area of an image. Several types of textures are there like rough texture and smooth texture. Smooth texture will have uniform, even surface and little tonal variations. Grassland is a typical example for smooth texture. While rough texture may change tonal variations abruptly. Texture is one of the most important elements for distinguishing features in Radar imagery.
* Shadow can help the interpretation easier at the same time it can reduce interpretation. It can provide the idea about the relative relief of the target which makes identification easier. While if the shadow falls on an object it will hide that object and it makes much difficult to interpreter.