UNIT I

REMOTE SENSING

DEFINITION AND PROCESS OF REMOTE SENSING

INTRODUCTION

Now-a-days the field of Remote Sensing and GIS has become exciting and glamorous withrapidly expanding opportunities. Many organizations spend large amounts of money on these fields. Here the question arises why these fields are so important in recent years. Two main reasons are there behind this. 1) Now-a-days scientists, researchers, students, and evencommon people are showing great interest for better understanding of our environment. Byenvironment we mean the geographic space of their study area and the events that take place there. In other words, we have come to realize that geographic space along with the datadescribing it, is part of our everyday world; almost every decision we take is influenced or dictated by some fact of geography. 2) Advancement in sophisticated space technology (which can provide large volume of spatial data), along with declining costs of computerhardware and software (which can handle these data) has made Remote Sensing and G.I.S.affordable to not only complex environmental / spatial situation but also affordable to anincreasingly wider audience.

REMOTE SENSING AND ITS COMPONENTS:

Remote sensing is the science of acquiring information about the Earth's surface without being in contact with it. This is done by sensing and recordingreflected or emitted energy and processing, analyzing, and applying that information." In much of remote sensing, the process involves an interaction between incident adiation and the targets of interest. This is exemplified using imaging systems where the following seven elements are involved. However, that remote sense also involves the sensing of emitted energy and the use of non-imaging sensors.

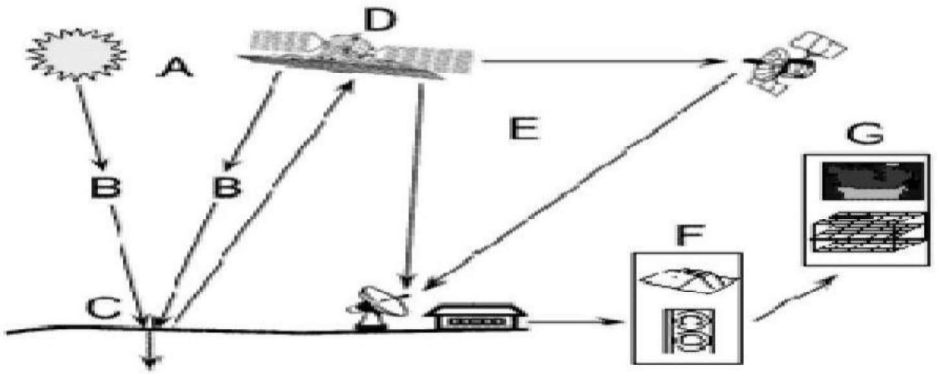

Fig 1.1- Components of Remote Sensing

- Energy Source or Illumination (A) – the first requirement for remote sensing is to have anenergy source which illuminates or provides electromagnetic energy to the target of interest.
- Radiation and the Atmosphere (B) – as the energy travels from its source to the target, it will come in contact with and interact with the atmosphere it passes through. This interactionmay take place a second time as the energy travels from the target to the sensor.
- Interaction with the Target (C) - once the energy makes its way to the target through the atmosphere, it interacts with the target depending on the properties of both the target and the radiation.
- Recording of Energy by the Sensor (D) - after the energy has been scattered by, or emitted from the target, we require a sensor (remote - not in contact with the target) to collect and record the electromagnetic radiation.
- Transmission, Reception, and Processing (E) - the energy recorded by the sensor has to be transmitted, often in electronic form, to a receiving and processing station where the data are processed into an image (hardcopy and/or digital).
- Interpretation and Analysis (F) - the processed image is interpreted, visually and/or digitally orelectronically, to extract information about the target which was illuminated.
- Application (G) - the final element of the remote sensing process is achieved when we apply the information, we have been able to extract from the imagery about the target in order to better understand it, reveal some new information, or assist in solving a particular problem.

HISTRY OF REMOTE SENSING:

1839 - first photograph

1858 - first photo from a balloon1903 - first plane

1909 first photo from a plane1903-4 -B/W infrared filmWW I and WW II1960 – space

Passive/ Active Remote Sensing

Depending on the source of electromagnetic energy, remote sensing can be classified as passive or active remote sensing.

In the case of passive remote sensing, sources of energy is naturally available such as the Sun. Most of the remote sensing systems work in passive mode using solar energy as the sourceof EMR. Solar energy reflected by the targets at specific wavelength bands are recorded usingsensors on board air-borne or space borne platforms.

To ensure ample signal strength received at the sensor, wavelength / energy bands capable of traversing through the atmosphere,without significant loss through atmospheric interactions, are generally used in remote sensingAny object which is at a temperature above 0o K (Kelvin) emits some radiation, which is approximately proportional to the fourth power of the temperature of the object.

Thus, the Earthalso emits some radiation since its ambient temperature is about 300o K. Passive sensors can also be used to measure the Earth ‘s radiance but they are not very popular as the energy contentis very low.

In the case of active remote sensing, energy is generated and sent from the remote sensing platform towards the targets. The energy reflected from the targets are recorded using sensors on board the remote sensing platform. Most of the microwave remote sensing is done through active remote sensing.

As a simple analogy, passive remote sensing is similar to taking a picture with an ordinary camera whereas active remote sensing is analogous to taking a picture with camera having built-in flash.

What is Sensor Platform?

Platform is a stage where sensor or camera is mounted to acquire information about a target under investigation. According to Lillesand and Kiefer (2000), a platform is a vehicle, from which a sensor can beoperated. For remote sensing applications, sensors should be mounted on suitable stable platforms as the platform height increases the spatial resolution and observational area increases.

The types or characteristics of platform depend on the type of sensor to be attached and itsapplication.

Type of Platforms:

Platforms can vary from stepladders to satellites. There are different types of platforms based on their altitude above earth surface.Three types of platforms are used to mount the remote sensors.

1. Ground based Platform
2. Air - borne Platform, and
3. Space-borne Platform Ground based Platforms:

Ground Based Platform:

- Ground based platforms are used to record detailed information about the objects or features of the earth’s surface.

- These are developed for the scientific understanding on the signal-object and signal-sensor interactions.
- It includes both the laboratory and field study, used for both in designing sensors and identification and characterization of land features.
- Example: Handheld platform, cherry picker, towers, portable masts and vehicles etc.
- Portable handheld photographic cameras and spectroradiometers are largely used in laboratory and field experiments as a reference data and ground truth verification.
- Crane, ground based platform (cherry Picker Platform extend up to approx. 15m).

Air- borne/ based Platforms:

- Airborne platforms were the sole non-ground-based platforms for early remote sensing work.
- Aircraft remote sensing system may also be referred to as sub-orbital or airborne, or aerial remote sensing system.
- At present, airplanes are the most common airborne platform.
- observation platforms include balloons, drones (short sky spy) and high-altitudesounding rockets. Helicopters are occasionally used.

Balloons:

- Balloons are used for remote sensing observation (aerial photography) and nature conservation studies.
- The first aerial images were acquired with a camera carried aloft by a balloon in 1859.
- Balloon floats at a constant height of about 30 km.
- Balloons as platforms are not very expensive like aircraft. They have a great variety of shapes, sizes and performance capabilities.
- The balloons have low acceleration, require no power and exhibit low vibrations.
- It consists of a rigid circular base plate for supporting the entire sensor system which is protected by an insulating and shock proof light casing.
- The payload used for Indian balloon experiment of three Hasselblad cameras with different film filter combinations, to provide PAN, infra-red, black, and white and infra-red false color images.
- Flight altitude being high compared to normal aircraft height used for aerial survey, balloon imagery gives larger synoptic views.
- The balloon is governed by the wind at a floating altitude.
- There are three main types of balloon systems, viz. free balloons, Tethered balloons, and Powered Balloons.

- Free balloons can reach almost the top of the atmosphere; hence, they can provide a platform at intermediate altitude between those of aircraft and spacecraft (shown in fig.)
- Have an altitude range of 22-40 km and can be used to a limited extent as a platform.

Drone:

- Drone is a miniature remotely piloted aircraft.
- It is designed to fulfill requirements for a low-cost platform, with long endurance, moderate payload capacity and capability to operate without a runway or small runway.
- Drone includes equipment of photography, infrared detection, radar observation andTV surveillance. It uses satellite communication link.
- An onboard computer controls the payload and stores data from different sensors and instruments.

Aircraft Platform:

- Aircraft are used to collect very detailed images.
- Helicopters can be for pinpoint locations, but they vibrate and lacks stability.
- Special aircraft with cameras and sensors on vibration less platforms are traditionally used to acquire aerial photographs and images of land surface features.
- While low altitude aerial photography results in large scale images providing detailed information on the terrain, the high-altitude smaller scale images offer advantage to cover a larger study area with low spatial resolution.
- Aircraft platforms offer an economical method of remote sensing data collection for small to large study areas with cameras, electronic imagers, across- track and along- track scanners, and radar and microwave scanners.
- Low Altitude Aircraft: It is most widely used and generally operates below 30,000 ft.
- It is suitable for obtaining image data for small areas having large scale.
- High altitude aircraft: It includes jet aircraft with good rate of climb, maximum speed,and high operating ceiling. It acquires imagery for large areas.

Rockets as Platforms:

- High altitude sounding rocket platforms are useful in assessing the reliability of the remote sensing techniques as regards their dependence on the distance from the target is concerned.
- Balloons have a maximum altitude of approximately 37 km, while satellites cannot orbit below 120 km. High altitude sounding rockets can be used to a moderate altitude above terrain.
- Synoptic imagery can be obtained from rockets for areas of some 500,000 square km.

Space-borne/ based Platforms:

- In space- borne remote sensing, sensors are mounted on-board a spacecraft (space shuttle or satellite) orbiting the earth.
- Space-borne or satellite platform are onetime cost effected but relatively lower cost perunit area of coverage, can acquire imagery of entire earth without taking permission.
- Space-borne imaging ranges from altitude 250 km to 36000 km.
- Space-borne remote sensing provides the following advantages:large area coverage.
- Frequent and repetitive coverage of an area of interest.
- Quantitative measurement of ground features using radiometrically calibrated sensors.
- Semi-automated computerized processing and analysis.
- Relatively lower cost per unit area of coverage.Spacecraft as Platform:
- Remote sensing is also conducted from the space shuttle or artificial satellites. Artificial satellites are manmade objects, which revolve around another object.
- Satellite can cover much more land space than planes and can monitor areas on a regular basis.
- Later, with LANDSAT and SPOT satellites program, space photography received ahigher impetus.

ELECTROMAGNETIC SPECTRUM

The first requirement for remote sensing is to have an **energy source to illuminate the target**(unless the sensed energy is being emitted by the target). This energy is in the form of electromagnetic radiation. All electromagnetic radiation has fundamental properties and behaves in predictable ways according to the basics of wave theory.

Electromagnetic radiation consists of an electrical field (E) which varies in magnitude in a direction perpendicular to the direction in which the radiation is traveling, and a magnetic field (M) oriented at right angles to the electrical field. Both these fields travel at the speed of light (c). Two characteristics of electromagnetic radiation are particularly important to understand remote sensing. These are the **wavelength and frequency.**

Electromagnetic radiation (EMR) as an electromagnetic wave that travels through space at the speed of light C which is $3x10^8$ meters per second.

Theoretical models of random media including the anisotropic effects, random distribution discrete scatters, rough surface effects, have been studied for remote sensing with electromagnetic waves. Ligh t - can be thought of as a wave in the 'electromagnetic field ' of the universe.