UNIVERSITY OF LUCKNOW

FACULTY OF ENGINEERING & TECHNOLOGY

E-Content : B. Tech.

CIVIL ENGINEERING (SEM – IV)

Geo-informatics

(CE- 403)

Er. Nidhi Srivastava

16 CHAPTER

REMOTE SENSING

16.1 INTRODUCTION

Remote sensing is broadly defined as science and art of collecting information about objects, area or phenomena from distance without being in physical contact with them. In the present context, the definition of remote sensing is restricted to mean the process of acquiring information about any object without physically contacting it in any way regardless of whether the observer is immediately adjacent to the object or millions of miles away. Human eye is perhaps the most familiar example of a remote sensing system. In fact, sight, smell and hearing are all rudimentary forms of remote sensing. However, the term remote sensing is restricted to methods that employ electromagnetic energy (such as light, heat, microwave) as means of detecting and measuring target characteristics. Air-craft and satellites are the common *platforms* used for remote sensing. Collection of data is usually carried out by highly sophisticated *sensors* (*i.e.* camera, multispectral scanner, radar etc.). The information carrier, or communication link is the electromagnetic energy. Remote sensing data basically consists of wavelength intensity information by collecting the electromagnetic radiation leaving the object at specific wavelength and measuring its intensity. Photo interpretation can at best be considered as the *primitive form* of remote sensing. Most of the modern remote sensing methods make use of the reflected infrared bands, thermal infrared bands and microwave portion of the electromagnetic spectrum.

Classification of Remote Sensing

Remote sensing is broadly classified into two categories:

(*i*) Passive remote sensing and (*ii*) Active remote sensing.

Passive remote sensing : It uses sun as a source of EM energy and records the energy that is naturally radiated and/or reflected from the objects.

Active remove sensing : It uses its own source of EM energy, which is directed towards the object and return energy is measured.

16.2 HISTORICAL SKETCH OF REMOTE SENSING

Remote sensing became possible with the invention of camera in the nineteenth century. Astronomy was one of the first fields of science to exploit this technique. Although, it was during

the first World War that free flying air-crafts were used in a remote sensing role, but the use of remote sensing for environmental assessment really became established after the Second World War. It not only proved the value of aerial photography in land reconnaissance and mapping, but had also driven technological advances in air borne camera design, film characteristics and photogrammetric analysis.

However, upto early 1960's air borne missions were one of the expensive surveys, providing data for relatively small area at a single instant of time. Moreover, all the photographs were black and white. Colour photography came into existence after the invention of infrared films in 1950. From about 1960, remote sensing underwent a major development when it extended to space and sensors began to be placed in space. From 1970's started the new era of remote sensing. The first designated earth resources satellite was launched in July 1972, originally named as ERTS-1 which is now referred as Landstat-1. It was designed to acquire data from earth surface as systematic, repetitive and multi-spectral basic. The first Radar remote sensing satellite, SEASAT, was launched in 1978.

Prior to mid 1980's, the majority of satellites had been deployed by USA and USSR. France launched first of SPOT series in 1985 and in 1988, first Indian Remote Sensing Satellite (IRS-1A) was put into orbit. Satellites launched by Japan include JERS (Japanese Earth Resources Satellite) and MOS (Marine Observation Satellite). Radar satellites have been launched in 1991 and 1995 by European Consortium (ERS) and by Canada in 1995 (RADARSAT).

The human eye is perhaps the most familiar example of a remote-sensing system. We can see an object only when it reflects light. During daytime, the source is the sun whose radiation is reflected by the object and which travels through the space between the object and the human eye. Here, the human eye is the sensor which detects the object by its image formed at the retina by the electromagnetic energy. Obviously, the human eye is a sensor (which is sensitive only to visible part of the electromagnetic spectrum) and the head is the platform on which the sensor is placed. The nervous system carries the information to the brain which acts as interpreter for identification of the object. In doing so, the brain recalls past experiences, acts like a computer/processing unit and completes the cycle of viewing and understanding.

The human-eye-brain system described above, however works only under visible light which is a very small part of the bandwidth of the electromagnetic spectrum. For obtaining information in the other parts of electromagnetic spectrum, sensors are required. In fact, sight, smell and hearing are all rudimentary forms of remote sensing.

The remote sensing of earth resources involves two basic processes as given below:

1. data-acquisition process, and
2. data analysis.

The data-acquisition process consists of (a) energy sources, (b) propagation of energy through the atmosphere, (c) energy interaction with earth surface features, (d) re-transmission of energy through the atmosphere, (e) airborne and/or space-borne sensors and (f) sensor's data in pictorial and/or digital form.

The data analysis process consists of (a) viewing and interpreting devices for pictorial data, and a computer to analyse digital sensor data, (b) completion of information in the form of hard-copy maps and tables, or as computer files and (c) presentation of the information to the users who apply it to their decision-making process.

Because of the extensive application of remote sensing for resource management a more appropriate definition of remote sensing than the one given earlier is as follows.

Remote sensing means sensing of the earth's surface from space by making use of properties of electromagnetic waves emitted, reflected, or defracted by the sensed objects, for the purpose of improving resource management, land use and the protection of environment.

6.1 REMOTE SENSING PROCESS

A remote sensing imaging system may be considered to be comprised of following elements, and are shown in Fig. 6.1.

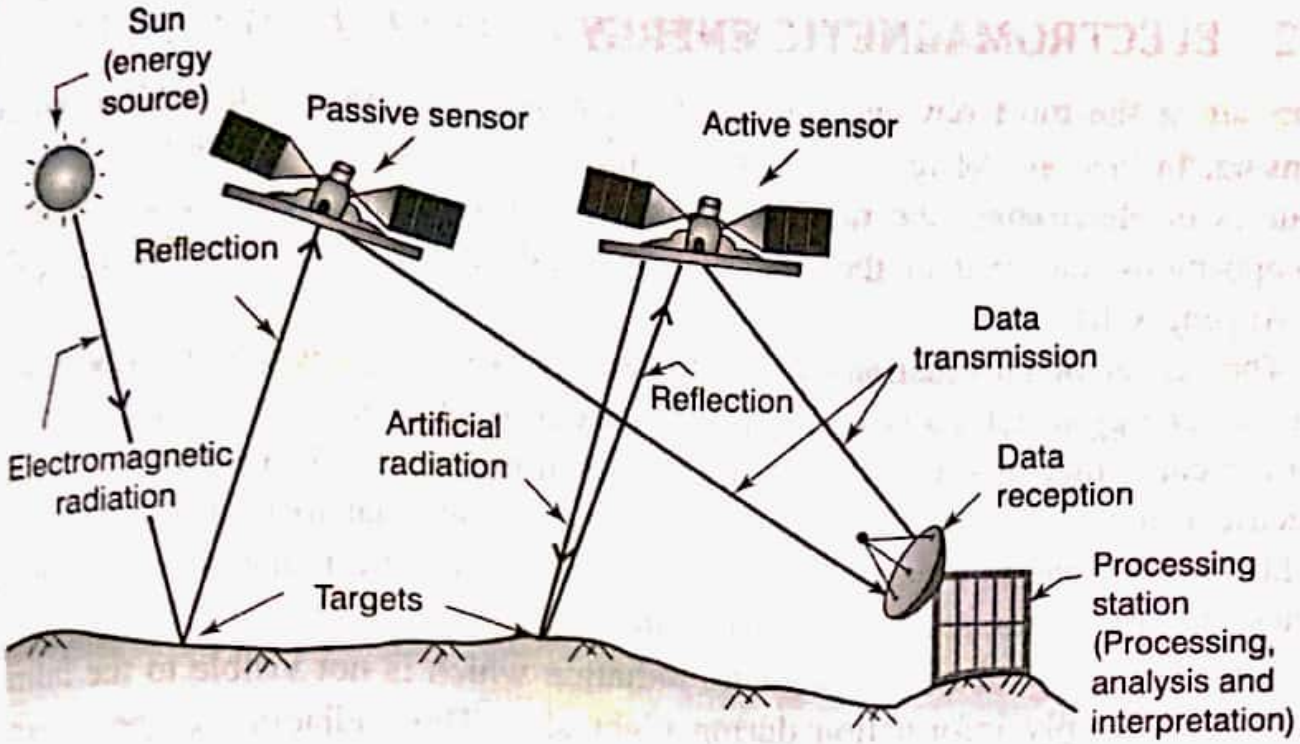

Fig. 6.1 *Electromagnetic remote sensing process*

1. *Energy source or illumination:* An energy source that provides illumination or electromagnetic energy to the object of interest.

2. *Radiation and the atmosphere:* As the energy propagates from the source to the object, it will come in contact with the atmosphere it passes, and will interact with the atmosphere. The interaction will again take place while travelling back from object to the sensor. The atmospheric effects are caused through the mechanism of scattering and absorption.

3. *Interaction with earth surface features:* The energy will interact with the object depending upon the properties of the object and the radiation. The effects of the interaction of the incident energy with earth surface features may cause the energy to be reflected, transmitted, scattered, absorbed, and emitted.

4. *Recording of energy by the sensor:* The scattered or emitted energy from the object is received, collected and recorded by the sensor. These are mounted on platforms, which are at a considerable height from the earth surface. The sensors may be passive or active.

5. *Processing:* The energy recorded by the sensor is transmitted in electronic form to a receiving and processing station where the data is processed into an image (photographic film and videotape or digital data on magnetic tape).

6. *Interpretation and analysis:* The processed image is interpreted visually and/or digitally or electronically to extract information about the object which was illuminated. The information about the object extracted from the image helps to understand it better, reveal some new information, or assist in solving some new problem.

REMOTE SENSING PLATFORMS—

A platform is the vehicle on which the instrument (or sensor) is carried. It depends upon the type of target, cost, availability of resources & time constraints.

Together, these platforms introduce the concept of multilevel remote sensing. This wide range of platforms (and sensors) means that the right system can be selected for each project. It is when the wrong system is used that the results of remote sensing projects fail to meet expectations. In the past this had led to remote sensing receiving a poor reputation, while in reality, it was inexperience on behalf of the user that was to blame.

Platforms are broadly classified into three classes:

1. Ground-based platforms
2. Aerial platforms
3. Satellite platforms

14.8.1 Ground-Based Platforms

Remote sensing platforms that position the sensor at the earth's surface are called ground-based platforms. These systems are fixed to the earth and the sensors are often standard tools used to measure environmental conditions such as air temperature, wind characteristics, water salinity and earthquake intensity.

Ground-based sensors can be placed on tall structures such as towers, scaffolding or buildings to elevate the platform (see Fig. 14.9). Ground-based sensors are generally less expensive to operate and maintain than aircraft or satellite sensors, but they do not provide the aerial extent of the airborne platforms. Ground-based sensors are often used to record detailed information about the surface, which is compared with the information collected from aircraft or satellite sensors.

14.8.2 Aerial Platforms

Aerial platforms are mostly sensors mounted on fixed-wing aircraft, though other airborne platforms, such as balloons, rockets and helicopters, can be used. Aircraft are often used to collect very detailed images of the earth's surface and facilitate the collection of data virtually over any portion of the earth's surface at any time. Aerial systems elevate the sensor above the earth's surface to increase its aerial coverage. They also allow researchers to monitor very large areas of the surface, which would be impractical with ground-based sensors or impossible or dangerous to visit.

14.8.3 Satellite Platforms

In space, remote sensing is conducted from satellites. Satellites are launched for remote sensing, communication and telemetry (location and navigation) purposes. Satellites permit repetitive coverage of the earth's surface on a continuing basis because of their designed orbits. Cost is often a significant factor in choosing among the various platform options.

In the early 1960s, researchers started mounting sensors on satellites placed into orbit over the earth and ushered in a new era of environmental remote sensing that continues to grow at a rapid pace today. Satellites can be operated remotely from the ground and data from the satellite sensors must be transmitted to the surface. The communication technology in remote sensing are very complex and very expensive.

Environmental satellites have contributed greatly to our understanding of the earth's environment and continue to be used extensively for remote sensing research. For example, weather satellite technology, one of the first practical applications of satellite remote sensing, has vastly expanded our understanding of the earth's weather by providing a large scale view of our weather systems that was previously impossible. It was only after the advent of satellites that weather patterns such as hurricanes and mid-latitude cyclones were fully understood. Prior to satellites, any knowledge of these storms was collected through ground level observations, which unfortunately, did not provide the necessary information to adequately understand them. The contribution of satellites to our understanding of dangerous weather events has saved countless number of lives since the early 1960s.