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Remote Sensing in Agriculture

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Abstract

"Remote sensing is the science of acquiring information about the Earth's surface without actually being in contact with it. This is done by sensing and recording reflected or emitted energy and processing, analyzing, and applying that information."

Remote sensing is defined as the art and science of gathering information about objects or areas from a distance without having physical contact with objects/areas being investigated. Remote sensing is the science and technology of making inferences about material objects from measurement made at a distance without coming into physical contact with the object under study. Remote sensing is a tool to monitor the earth's resources using space technology in addition to ground observations. Remote sensing is the science and technology of making inferences about material objects from measurement made at a distance without coming into physical contact with the object under study. Remote sensing, process involves an interaction between incident radiation and the targets of interest. This is exemplified by the use of imaging systems where the following seven elements are involved.

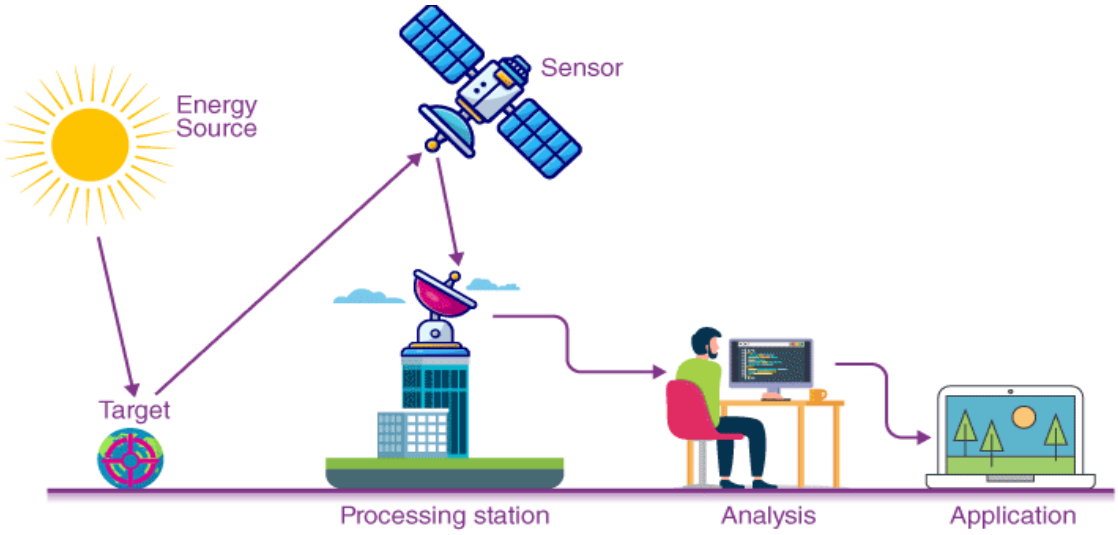
Key Words: Remote sensing, Agriculture, Application, Limitations

1. Introduction

The term remote sensing is often wrongly applied to satellite-borne imaging of the earth's surface only. Remote sensing is the common name for all methods used to collect data at a distance from the object under study by some kind of recording device. The use of remote sensing techniques is increasing rapidly, finding new fields of application as technology advances in developing the remote sensing systems.

The term remote sensing was first used in the early 1960s. Later, it was defined as the total processes used to acquire and measure the information of some property of objects and phenomena by a recording device (sensor) that is not in physical contact with the objects and phenomena in study Normally, if one comes across the term Remote Sensing, one wonders 'what does it mean'. 'Remote' means far away and 'Sensing' means believing or observing or acquiring some information. Remote sensing means acquiring information of things. In the world of geospatial science, remote sensing, also known as earth observation, means observing the earth with sensors from high above its surface. Remote sensing is used in numerous fields, including geography, land surveying and most Earth Science disciplines (for example, hydrology, ecology, oceanography, glaciology, geology); it also has military, intelligence, commercial, economic, planning, and humanitarian applications.

Remote sensing is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance from the targeted area. Remote sensing is the use of satellites, planes and other aerial technologies using advanced sensor technologies able to detect energy reflected from the Earth's surface. This makes it possible to collect data in inaccessible or dangerous areas where it would be too hazardous to bring in a team and equipment to collect data.



Definition of remote sensing

The term remote sensing was coined by Fischer in 1960 A.D. Remote sensing is defined as the art and science of gathering information about objects or areas from a distance without having physical contact with objects/areas being investigated. Remote sensing is the science and technology of making inferences about material objects from measurement made at a distance without coming into physical contact with the object under study. Remote sensing is a tool to monitor the earth's resources using space technology in addition to ground observations. It can be used in soil mapping, land use pattern, forest mapping, geological and hydrological purpose, drought & flood monitoring in addition to crop coverage crop output estimates. Remote sensing techniques are used in agriculture & allied fields. This involves collection of basic data, monitoring of crop growth, soil moisture condition irrigation drainage & outbreak of pest & disease infestation.

Concept of Remote Sensing

The concept of remote sensing involves six stages-

- Source of electromagnetic energy (EME), sun or transmitter is the source of energy.
- Transmission of the energy from the sources to the surface of the earth (as well as absorption & scattering by the atmosphere).
- Interaction of the energy with the objects on the surface of the earth
- Transmission of the energy to the remote sensing sensors.
- Generation of the data in pictorial &/or digital form.
- Analysis, interpretation & use of data.

Principles of Remote Sensing

The principles of remote sensing involve detection and measurement of the radiations of different wavelengths which are reflected or emitted from the surface of distant objects or materials, which helps in their identification and categorization.

It has four basic components to measure, which include:

1. Energy source
2. Transmission path
3. Target
4. Satellite sensor

Types of Remote Sensing

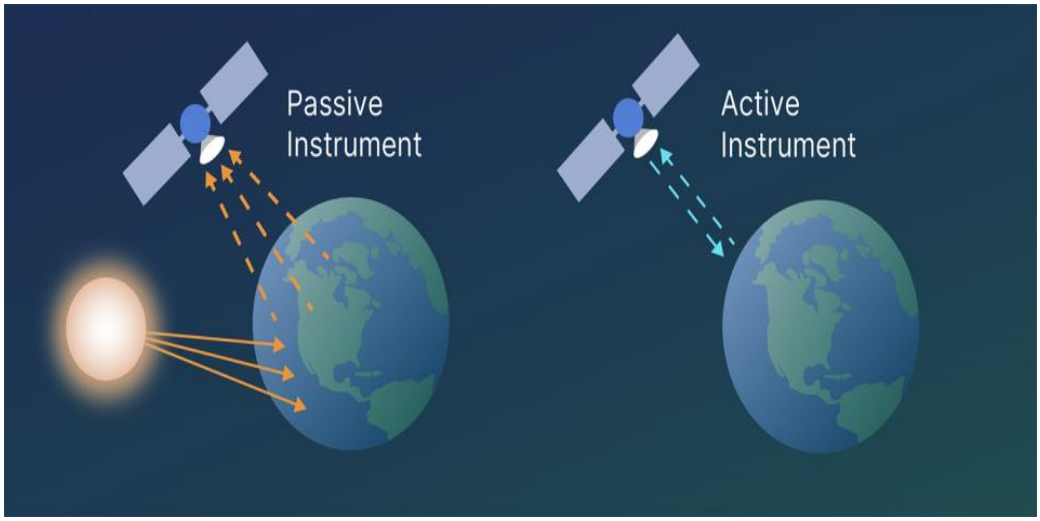
There are two types of Remote Sensing Systems namely Active and Passive sensing.

Passive sensor receives naturally emitted EM energy within its field of view (FIV) and performs measurement using it.

- Examples: remote sensing satellite, SPOT-1, LANDSAT-1 etc.
- Passive sensors rely on other sources such as sun for its operation.
- Passive sensors obtain measurements only in day time.

Active sensor emits their own EM (Electromagnetic) energy which is transmitted towards the earth and receives energy reflected from the earth. The received EM energy is used for measurement purpose.

- Examples: communication satellite, earth observation satellite (e.g. RADARSAT-1), LISS-1 etc.
- Active sensors use their own source of energy for operation.
- Active sensors can obtain measurements anytime (Day & Night)



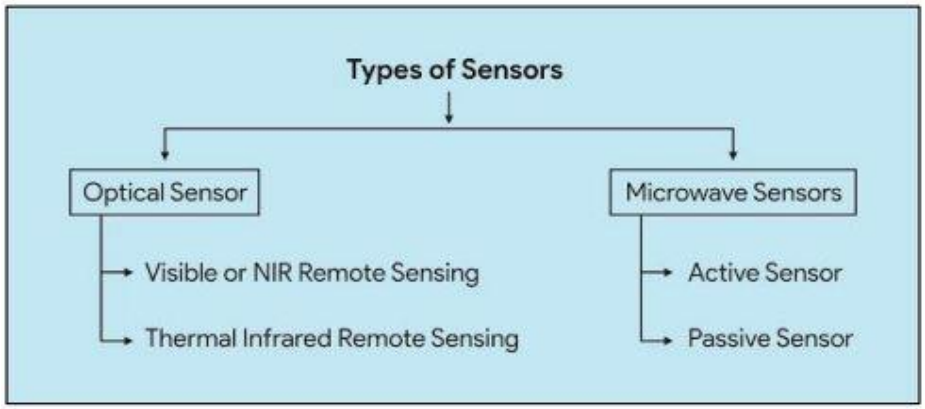
Remote Sensing Platforms:

There are three types of remote sensing platforms

1. **Ground-based**
    - can be placed on ladder, tall building, crane
    - The data collected by this platform are used for bridge and am monitoring landslide and soil erosion mapping, architectural restoration , crime and accident scene analysis etc.
2. **air-borne platform**
    - primarily used for aerial photographs and airplanes helicopters balloons even rockets are commonly used to collect very detailed images
    - they are capable of operating over a wide range of altitude ranging from sea level to stratosphere
3. **space-borne platform**
    - In space borne remote sensing sensors are mounted on board a space craft (space shuttle or satellite) orbiting the earth
    - They are used for remote sensing , weather monitoring communication and navigation purposes

Sensors

Sensors are classified in to following types they are as follows-



Optical Sensor

The term "optical sensor" refers to a sensor that can distinguish between three different forms of infrared radiation, including near infrared, intermediate infrared, and hot infrared. Consequently, an optical sensor performs two types of remote sensing, namely:

A. **Visible radiation or Infrared remote sensing-**
Remote sensing using visible or near infrared radiation occurs when an optical sensor picks up sunlight's backscattered visible and near infrared (NIR) radiation. Analyzing the surface characteristics of the object of interest is made easier by the reflection's strength. However, this sensing technique has several limitations, such as interruptions during periods of heavy cloud cover or nighttime.

B. **Thermal Infrared remote sensing-**

Thermal infrared remote sensing occurs when an optical sensor picks up heat-emitting thermal infrared radiation from an object's surface. This sensing technique aids in the investigation of any occurrence involving the emission of heat, such as wildfires, volcanic eruptions, surface temperatures of various objects, etc. Even at night, optical sensors can detect heat radiation, although cloud cover also impairs this technique of observation

Microwave Sensor:

The microwave sensor is the sensor that can track and record microwaves. Since microwave radiation has a longer wavelength than visible light or heat infrared radiation, it can be detected regardless of the presence of clouds, the time of day, or other environmental factors. Two types of sensors perform the role to detect and record microwave radiations, viz. Active sensors and Passive sensors.

Here are two types of Remote sensing based on source of energy used i.e., Active remote sensing and Passive remote sensing. Remote sensing systems usually involve both active and passive sensors. Active sensors emit their own signals that are measured after they are reflected off of the Earth's surface.

A. Passive Remote Sensing Sensor:

A passive sensor picks up solar radiation that is reflected or given off by anything on Earth's surface. As passive sensors rely on the Sun's light to illuminate their target and do not need their own energy source, they are often smaller pieces of equipment. While certain passive optical sensors may record nocturnal lights, clouds, as well as energy discharged from the Earth's surface, most passive optical sensors are constrained by the fact that they need daylight to function. Since these sensors work in the visible and infrared spectrum, the weather and cloud cover have a negative effect on their performance. Finally, it is challenging to assess plant structure beneath a canopy since sunlight is often reflected from a feature's top, such a forest. In such cases active sensors are used to acquire this kind of data. The passive remote sensors include Accelerometer, Hyperspectral radiometer, Spectrometer, Imaging radiometer, Sounder, Spectroradiometer, Radiometer, etc.

B. Active Remote Sensing Sensor:

Active sensors supply their own electromagnetic radiation source to illuminate the target item. The sensor itself emits radiation in the direction of the phenomena or object, and when that radiation is reflected or backscattered from the target, it is once more detected and recorded. Active remote sensors include LIDAR (Light Detection and Ranging), Radar, Sounder, Scatter meter, Laser altimeter, and others.

Role of Remote Sensing in Agriculture

Agriculture resources are important renewable dynamic natural resources. In India, agriculture sector alone sustain the livelihood around 70 percent of the population and contributes nearly 35 percent of the net national product. Increasing agriculture productivity has been the main concern since scope for increasing area under agriculture is rather limited. This demands judicious and optimal management of both land and water resources. During the last two decades, remote sensing techniques are applied to

explore agriculture application such as crop growth monitoring comprehensive and reliable information on land use\cover, forest area, soils, geological information, extent of wastelands, agriculture crops, water resources both surface and underground and hazard\natural calamities like drought and floods required. Season-wise information on crops, their acreage, vigor and production enables the country to adopt suitable measures to meet shortages, if any, and implement proper support and procurement policies.

- Ground bases: Infrared thermometer, spectral radiometer, Pilot-Balloons and radars.

- Air Bases: Aircraft air based remote sensing tools.

- Satellite based: The digital image processing, using powerful computers, is the key tool for analyzing and interpretation of remotely sensed data. Since the ground based and air based platforms are very costly and have limited use, space based satellite technology has become handy for wider application of remote sensing techniques. Remote Sensing technology provides many advantages over the traditional method in agriculture resources survey. There are many application of remote sensing in the agriculture sectors, some of these applications are stated below:

Crop Production Forecasting:

Remote sensing is used to forecast the expected crop production and yield over a given area and determine how much of the crop will be harvested under specific conditions. Researchers can be able to predict the quantity of crop in a given farmland over a given period.

Assessment of Crop Damage and Progress:

In the event of crop damage or crop progress, remote sensing technology can be used to penetrate the farmland and determine exactly how much of a given crop has been damaged and the progress of the remaining crop in the farm.

Crop Identification:

Remote sensing has played a vital role in crop identification especially in cases where the crop under observation shows some mysterious characteristics. The collected data will be taken to labs where various aspects of crop including the crop culture are studied.

Crop Acreage Estimation:

Remote sensing has also played a very important role in the estimation of the farmland on which a crop has been planted. This is usually a cumbersome procedure if it is carried out manually of the vast sizes of the land being estimated.

Crop yield Modelling and Estimation:

Remote sensing also allows farmers and experts to predict the expected crop yield from a given farmland by estimating the quality of the crop and the extent of the farmland. This is then used to determine the overall expected yield of the crop.

Identification of Pests and Disease Infestation:

Remote sensing technology plays a significant role in identification of pests in farmland and gives data on the right pests control mechanism to get rid of the pests and diseases on the farm.

Soil Mapping:

Soil mapping is one most important uses of remote sensing, through soil mapping, farmers are able to tell which soil are ideal for which crops and which soil require irrigation and which one do not.

Monitoring of Droughts:

Remote sensing technology is used to monitor the weather pattern of given area. The technology also monitors drought pattern area too. The information can be used to predict the rainfall patterns of an area and also tell the time difference between the current rainfall and the next rainfall which helps track of the drought.

Remote Sensing Applying Areas

1. General application:

- Agricultural land use mapping
- Agricultural population distribution
- Soil survey and water resource survey
- Cropped area
- Crop production forecasting
- Mapping of wasteland

2. Application to livestock survey:

- Population of cattle, sheep, pig and poultry.
- Distribution of animals
- Animal behavior.
- Health of animal.

3. Specific application:

- Crop identification.
- Crop growth rate and crop maturity.
- Date of planting and harvesting.
- Soil problem like salinity.
- Drought prediction.
- Disease, pest, nematodes, insect and diseases.

Limitations of remote sensing

The major limitation of remote sensing is its inability to measure some Physical parameters, such as temperature, humidity, wind speed, and Direction. Also, remote sensing cannot provide direct measurements of soil Moisture content.

•Understanding the application limit: The biggest restriction of this method Is that its functionality is frequently overstated. Remote sensing cannot

Provide all of the information required for any scientific study on its own.
These tools and techniques' applicability is limited to the selection of appropriate sensors, resolutions, data collection time, and appropriate post-processing procedures.
•Expensive technique: The collection and explanation of remote sensing data is costly due to the specific instrumentation and skills required. However, the enormous benefits of this technique far outweigh this limitation.
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