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Remote Sensing, its Components, Different Platforms and Applications

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SUMMARY

The article discusses the importance of remote sensing in the modern day agriculture. As the traditional field management includes only the site-specific information, there is a need to integrate it with the spatial data to get better outputs. There are two types of remote sensing processes such as active remote sensing and passive remote sensing. Remote sensing involves seven components which interacts with one another to give the required output. There are different kinds of platforms available for mounting the sensors used in acquiring the data, such as ground based, air borne and space borne platforms. The use of hyperspectral data improves the precision in agriculture which can also be used by the policy makers in numerous ways.

INTRODUCTION

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. In much of remote sensing, the process involves an interaction between incident adiation and the targets of interest. This is exemplified by the use of imaging systems where the following seven elements are involved. However, that remote sensing also involves the sensing of emitted energy and the use of non-imaging sensors.

Components of Remote Sensing

- Energy Source or Illumination – the major requirement for remote sensing is having an energy source which illuminates or provides electromagnetic energy to the target of interest.
- Radiation and the Atmosphere – as the energy from the source travels to the target, it will come in contact with the atmosphere it passes through and also interacts with it. This interaction may take place a second time as the energy travels from the target to the sensor.
- Interaction with the Target - 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 - 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 - 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 - the processed image is interpreted, visually and/or digitally or electronically, to extract information about the target which was illuminated.
- Application - 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.

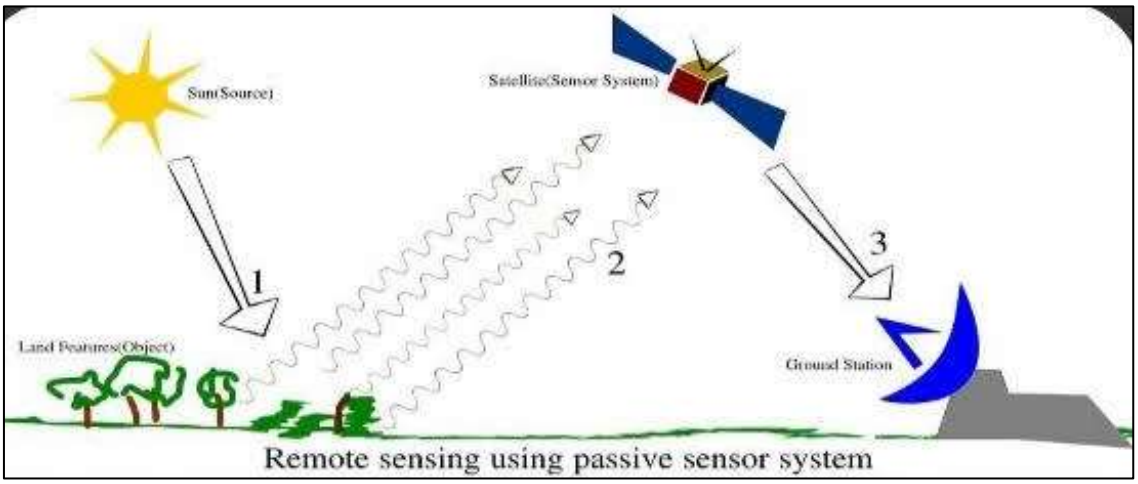
Types of Remote sensing

There are 2 types of remote sensing, Passive and Active Remote Sensing. Depending on the source of electromagnetic energy, remote sensing can be classified as passive or active remote sensing.

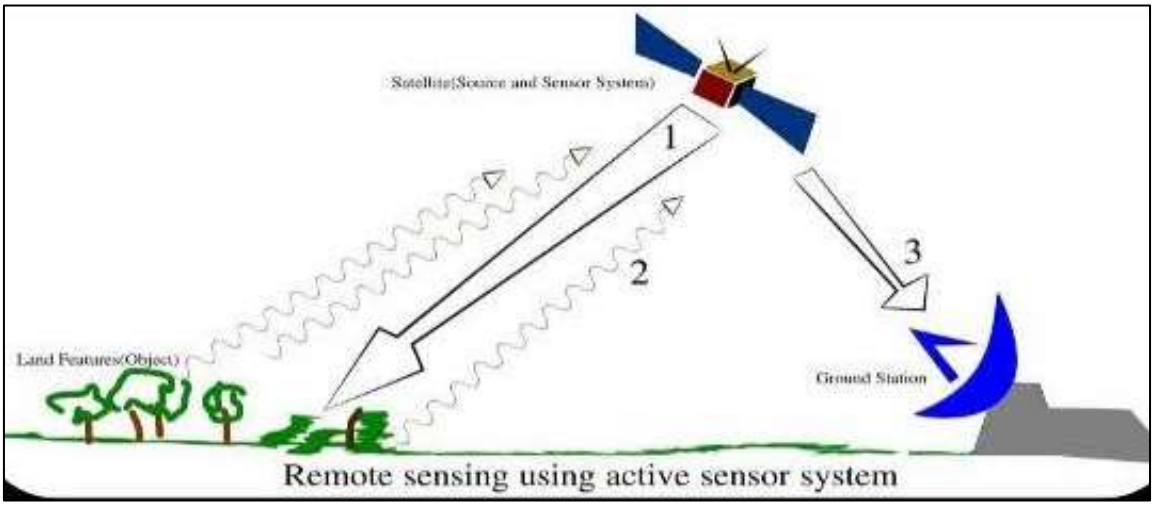
- In the case of passive remote sensing, source of energy is that naturally available such as the Sun. Most of the remote sensing systems work in passive mode using solar energy as the source of EMR. Solar energy reflected by the targets at specific wavelength bands are recorded using sensors on board air-borne or space borne platforms. In order 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 sensing Any object which is at a temperature above 0 K (Kelvin) emits some radiation, which is

approximately proportional to the fourth power of the temperature of the object. Thus the Earth also emits some radiation since its ambient temperature is about 300 K. Passive sensors can also be used to measure the Earth‘s radiance but they are not very popular as the energy content is 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 back 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.



Remote sensing using passive sensor system



Remote sensing using active sensor system

Type of Platforms:

Platforms can vary from stepladders to satellites. There are different types of platforms and based on its 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

I. Ground based Platforms:

- 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)

II. 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 altitude sounding rockets. Helicopters are occasionally used.

Balloons:

• Balloons are used for remote sensing observation (aerial photography) and nature conservation studies.
• Balloon floats at a constant height of about 30 km.
• Balloons as platforms are not very expensive like aircrafts. 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.

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 and TV 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 it vibrates 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.

III. 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 per unit area of coverage, can acquire imagery of entire earth without taking permission.
- Space-borne imaging ranges from altitude 250 km to 36000 km.

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 on with LANDSAT and SPOT satellites program, space photography received a higher impetus.

Applications of Remote sensing

- Identification & area estimation and monitoring the crops- The specific requirement of climate and soil conditions coupled with the specialized management practices make the distribution of plantation crops rather more localized in comparison to other agricultural crops
- Crop nutrient deficiency detection- The nutrient deficiency in plants affects the colour, moisture content and internal structures of the leaves and as a result their reflecting power changes
- Soil mapping- Soil properties that have been measured using remote or proximal sensing approaches include mineralogy, texture, soil iron, soil moisture, soil organic carbon, soil salinity and carbonate content
- Crop condition assessment- physiological changes that occur in a plant due to stress may change the spectral reflectance characteristics resulting in the detection of stress amenable to remote sensing techniques
- Agricultural drought assessment
- Reflectance modelling- Physical reflectance models for crops serve the important purpose of understanding the complex interaction between solar radiation and plant canopies
- Crop yield modelling and production forecasting- In order to obtain a reliable yield prediction, growth of crops has to be modelled by means of crop growth models

CONCLUSION:

The use of hyperspectral data could enhance precision agriculture by identifying stress patterns, and aid growers in making good decisions; for instance, allowing supplemental water and nutrient application to mitigate adverse stress effects. Accurate site-specific herbicide treatment maps were created according to different factors such as flight altitudes, camera types and weed thresholds, and then relevant herbicide savings were calculated using remote sensing. The image analysis based on satellite images can be the basis of crop phenological characterization in order to achieve predictive and decision making models.

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