AgriCos e-Newsletter
ISSN: 2582-7049
AgriCos e-Newsletter
Open Access Multidisciplinary Monthly Online Magazine
Volume: 02 Issue: 12 December 2021 Article No: 06

Remote Sensing Sensor System and Platform

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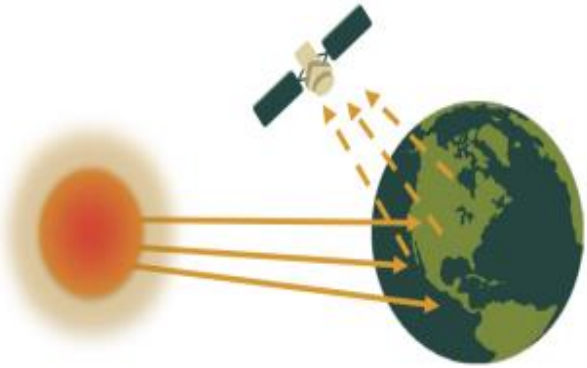
SUMMARY

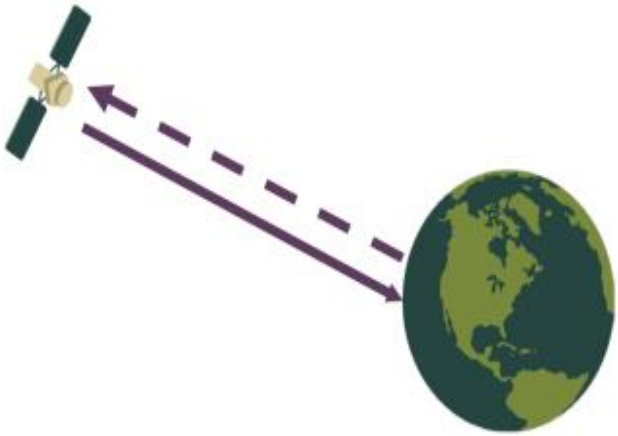
The base on which remote sensing sensors are mounted is called a remote sensing platform. It may be stationary like camera stand or mofing like balloons, helicopters, air crafts, rockets,m satellite etc. Aircrafts and spacecrafts (satellite) constitute the two important types of present day platforms. Typical platforms are satellites and aircraft, but they can also include radiocontrolled aeroplanes, balloons kits for low altitude remote sensing, as well as ladder trucks or 'cherry pickers' for ground investigations. The key factor for the selection of a platform is the altitude that determines the ground resolution and which is also dependent on the instantaneous field of view (IFOV) of the sensor on board the platform.

INTRODUCTION

Remote sensing sensors are mechanical devices which collect information, about objects or scenes from a distance, which are usually in storable form. All remote sensing sensors record variation in the amount of energy being reflected or emitted by various objects on the surface of the earth in selected wavelength bands. The vehicle or carrier for a remote sensor to collect and record energy reflected or emitted from a target or surface is called a platform. The sensor must reside on a stable platform removed from the target or surface being observed. Platforms for remote sensors may be situated on the ground, on an aircraft or balloon (or some other platform within the Earth's atmosphere), or on a spacecraft or satellite outside of the Earth's atmosphere.



Passive Sensors



Active Sensors

Factors Influence Capability of Sensors

The remote sensing technique for the study of the earth resources is based on the capability of the remote sensors to detect the variations in the reflectance between the objects as seen at the aircraft or satellite heights. The factors which influence this capability are

- Radiometric resolution of the sensor.
- Changes caused to the radiation while passing through the atmosphere.
- Surface roughness of the objects and
- Spatial variability of the reflectance within the scene.

Sensors used in the visible and the infrared wavelengths are based on the similar technology while the sensor systems operating in microwave region are quite different. Apart from the sensor systems used in space borne platforms, there are many other considerations in design those used on air borne platforms. The images of the earth's surface obtained by remote sensing detectors are completely digital in nature. A digital image consists of a large number of picture elements or pixels. Each pixel represents an elemental area of the scene and contains information about reflectance characteristics of the objects in one or more spectral bands. Thus one can think of resolution of the system.

Sensor Systems Used in Remote Sensing

There are three systems used in remote sensing sensors. They are

- Photographic system
- Scanning system
- Microwave system

Photographic System

Photography responds to the visible and near infrared parts of the electromagnetic spectrum. It is, in the context of remote sensing, a passive technique, in that it detects existing radiation (reflected sun- and skylight), and an imaging technique in that it forms a two-dimensional representation of the radiance of the target area. In this chapter we shall consider the construction, function and performance of photographic film, especially its use in obtaining quantitative information about the geometry of objects. Although film-based aerial photography is still dominant, digital photography is beginning (at the time of writing) to rival it, so the chapter includes a brief comparison of the two methods. The chapter then discusses the effects of atmospheric propagation, and concludes by describing the characteristics of some real instruments and giving a brief account of the applications of the technique.

Scanning System

Many electronic (as opposed to photographic) remote sensors acquire data using scanning systems, which employ a sensor with a narrow field of view (i.e. IFOV) that sweeps over the terrain to build up and produce a two-dimensional image of the surface. Scanning systems can be used on both aircraft and satellite platforms and have essentially the same operating principles. A scanning system used to collect data over a variety of different wavelength ranges is called a multispectral scanner (MSS)**,** and is the most commonly used scanning system. There are two main modes or methods of scanning employed to acquire multispectral image data - across-track scanning, and along-track scanning**.**

Microwave System

Microwave sensing encompasses both active and passive forms of remote sensing. The microwave portion of the spectrum covers the range from approximately 1cm to 1m in wavelength. Because of their long wavelengths, compared to the visible and infrared, microwaves have special properties that are important for remote sensing. Longer wavelength microwave radiation can penetrate through cloud cover, haze, dust, and all but the heaviest rainfall as the longer wavelengths are not susceptible to atmospheric scattering which affects shorter optical wavelengths. This property allows detection of microwave energy under almost all weather and environmental conditions so that data can be collected at any time.

Types of Sensors

There are two basic types of sensors

- Optical sensors
- Microwave sensors

Optical Sensors

Optical sensors observe visible lights and infrared rays (near infrared, intermediate infrared, thermal infrared). There are two kinds of observation methods using optical sensors

- Visible or Near infrared sensors
- Thermal infrared sensors

Visible or Near Infrared Sensors

The observation method to acquire visible light and near infrared rays of sunlight reflected by objects on the ground. By examining the strength of reflection, we can understand a conditions of land surface, e.g.,

distribution of plants, forests and farm fields, rivers, lakes, urban areas. During period of darkness, this method cannot be observe. Also, clouds block the reflected sunlight, so this method cannot be observed areas under clouds.

Thermal Infrared Sensors

The observation method to acquire thermal infrared rays, which is radiated from land surface heated by sunlight. Also it can observe the high temperature areas, such as volcanic activities and fires. By examining the strength of radiation, we can understand surface temperatures of land and sea, and status of volcanic activities and forest fires. This method can observe at night when there is no cloud.

Microwave Sensors

Microwave sensors receive microwaves, which is longer wavelength than visible light and infrared rays, and observation is not affected by day, night or weather.

There are two types of observation methods using microwave sensor. They are

- Passive sensors
- Active sensors

Passive Sensors

Passive sensors record radiation reflected from the earth's surface. The source of this radiation must come from outside the sensor; in most cases, this is solar energy. Because of this energy requirement, passive solar sensors can only capture data during daylight hours. The Thematic Mapper (TM) sensor system on the Landsat satellite is a passive sensor. The land cover and change analysis data provided on this CD-ROM were classified using Landsat TM imagery.

Active Sensors

Active sensors are different from passive sensors. Unlike passive sensors, active sensors require the energy source to come from within the sensor. For example, a laser-beam remote sensing system is an active sensor that sends out a beam of light with a known wavelength and frequency. This beam of light hits the earth and is reflected back to the sensor, which records the time it took for the beam of light to return. Topographic LIDAR laser beach mapping data included on this CD-ROM were collected with an active sensor.

Imaging and Non-Imaging Sensors

The active and passive sensors can be classified as imaging and non-imaging sensors. Imaging sensors are sensors that build up a digital image of the field of view, with some information about how the input varies in space, not just in strength. Generally this is done with some sort of pixellated sensor, like a CCD camera. The spatial distribution of the signal strength will be recorded in the spatial distribution of the sensor's response. Non-imaging sensors return a signal based on the intensity of the whole field of view. The response of the sensor doesn't record how the input varies across the field of view. To an extent, a non-imaging sensor is the limit of an imaging sensor as the number of pixels goes to 1.

Platform

A platform is the vehicle or carrier for remote sensors for which they are borne In Meteorology platforms are used to house sensors which are obtain data for remote sensing purposes, and are classified according to their heights and events to be monitored. In this paper we are going to discuss the various types of platforms their advantages and disadvantages.

Types of Platform

There are three types of platform according to placement of the sensor. They are

- Ground based platforms
- Aerial platforms
- Space platforms

Ground Based Platforms

Ground based platforms are used to record detailed information about the object or surface. They are

- **Mobile hydraulic platform**
- **Portable masts**
- **Towers**
- **Weather surveillance radar**

Mobile Hydraulic Platform

They carried on vehicles. Extendable to a height of 15m above the surface. At the top of the platform there are: Spectral reflectance meters, Photographic systems, IR or Microwave scanners. Linked to data loggers in the vans.

Portable Masts

Used to support cameras and scanners E.g. a Land Rover fitted with an extending aerial • Limitation: very unstable in windy conditions.

Towers

Can be dismantled and moved from one place to another. • Offer greater rigidity than masts but are less mobile and require more time to erect.

Weather Surveillance Radar

A Weather Surveillance Radar is of the long range type which detects and tracks typhoons and cloud masses at distance of 400 kilometers or less. • This radar has a rotating antenna disk preferably mounted on top of a building free from any physical obstruction. 4 • Radio energy emitted by the transmitter and focused by the antenna shoots outward through the atmosphere in a narrow beam. • The cloud mass, whether it is part of a typhoon or not, reflects a small fraction of the energy back to the antenna. • This reflected energy is amplified and displayed visually on a radar scope. • The distance or slant range of the target from the radar is determined through the elapsed time the signal is transmitted and then received as an echo.

Aerial Platforms

Air crafts are used to acquire aerial photographs. These are used to collect very detailed images of any portion of earth at any time. They are

- Balloons
- Radiosonde
- Rawinsonde
- Wind finding radar

Balloon

High flying balloons provide an important tool for probing the atmosphere. Such balloon launches form an essential part of high altitude atmospheric research.

Radiosonde

Radiosonde, an airborne instrument used for measuring pressure, temperature and relative humidity in the upper air. The instrument is carried aloft by a meteorological balloon inflated with hydrogen.The radiosonde has a built-in high frequency transmitter that transmits data from the radiosonde meter and recorded on the ground by a specially designed radiosonde receiver.

Rawinsonde

The rawinsonde is an electronic device used for measuring wind velocity, pressure, temperature and humidity aloft. It is also attached to a balloon and as it rises through the atmosphere.

Wind Finding Radar

It determines the speed and direction of winds aloft by means of radar echoes. A radar target is attached to a balloon and it is this target that is tracked by ground radar. The bearing and time of interval of the echoes is evaluated by a receiver.

Space Platforms

In space borne remote sensing, sensors are mounted on-board a spacecraft (space shuttle or satellite) orbiting the earth. Space borne platforms include the following: Rockets, Satellites and space shuttles. Space borne platforms range from 100 to 36000 km above the earth's surface.

- Low level satellites: 700-1500 km
- High level satellites: About 36000 km

Low Level Satellites

They are also referred to as the Low level Earth observation satellites (LEO). LEO satellites are often sun synchronous i.e. they remain fixed with respect to the sun with the earth rotating under the satellite. These satellites are deployed as a special case of polar orbits, where each successive orbit crosses the equator at intervals of 15 degrees of longitude and precessing around the entire globe once per day. The satellite will pass over every location on earth at the same local solar time. These are the most common orbits for remote sensing satellites in order to provide illumination for passive sensors. Active sensors such as radar and lidar may not require the Sun's illumination for imaging, but they do rely on solar energy as a source of power. This reason and the global coverage provided by a polar orbit make a sun-synchronous orbit a good choice for a space borne laser profiler.

They are divided into two broad categories namely:

- Polar orbiting satellites
- Near polar orbiting satellites

Polar Orbiting Satellites

Polar Orbiting Environmental Satellites (POES) are placed in circular sunsynchronous orbits and their altitudes usually range from 700 to 800 km, with orbital periods of 98 to 102 minutes. 10 • Polar orbiting satellites pass above (or nearly above) each of the Earth's poles, and pass over the equator at a different longitude, on each revolution.

Near Polar Orbiting Satellites

A near polar orbit is one with the orbital plane inclined at a small angle with respect to the earth's rotation axis. A satellite following a properly designed near polar orbit passes close to the poles and is able to cover nearly the whole earth surface in a repeat cycle.

High Level Satellites

They must be placed at a very high altitude (~ 36,000 km) in order to produce an orbital period equal to the period of Earth's rotation. Any sensor onboard a geosynchronous satellite is viewing the same area of the Earth at all times, and because of the high latitude, this is usually a very large area. Communications and weather satellites are the most common examples of geosynchronous orbits.

CONCLUSION

This article investigated remote sensing sensor technology both broadly and in depth. It helps to understand that when a sensor is operated in a certain wavelength how environmental objects will react to it. In addition, we also highlighted the terahertz region of the spectrum. Optical imaging sensors and thermal imaging sensors, radar imaging sensors, and laser scanning were highlighted. In addition, commonly used remote sensing satellites, especially those from NASA and ESA, were detailed in terms of launched time, sensors, swath width, spectrum bands, revisit time and spatial resolution. Platforms have gradually developed from the simple ground based weather balloons to the more complex space borne satellite platforms.

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