SURVEY ENGINEERING

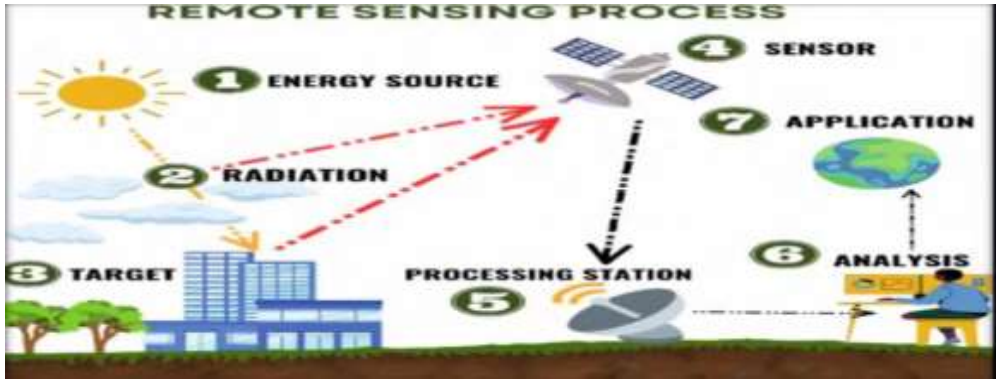
Topic : Remote Sensing, GPS and GIS

Notes

REMOTE SENSING :

Remote sensing means sensing of the earth's surface from space by making use of properties o e ectromagnetic waves emitted , reflecte , absorbed or transmitte by the sensed objects, for the purpose of improving resource management , land use and the protection o environment.

Remote sensing is Science (art) of acquiring information about Earth's surface without actually being in contact with it. This is done by sensing and recording reflected or emitted energy and processing analyzing & apply that information



Basic Component of Remote Sensing :

Energy Source or Illumination: Which illuminate or provide electromagnetic energy to target of Interest.

Radiation and Atmosphere: Energy travel from source to target it will come contact with atmosphere.

Interaction with target : Once energy make its way to target through atmosphere it interact with it.

Record of energy by Sensor : Energy scattered by emitted from target we require sensor to collect & record Electromagnetic radiation.

Transmission Reception and Processing: energy Recorded by sensor has to transmitted in electronic form to a receiving and processing station where data are procured into image.

Interpretation & Analysis: process image is interpreted & extract information.

Advantages of Remote Sensing :

1. Provide data for large Area
2. Provide data for very remote & inaccessible area
3. Able to obtain imagery of area over continuous period time
4. Possible to monitor any anthropogenic or Natural changes in landscape.
5. inexpensive compared to team of surveyors.

Disadvantages :

(1) Skill person Require
(2) Need Cross verification with ground survey data
(3) Data from multiple source may confuse creation
(4) Distortion may occur in an image

Remote Sensing Type :

There are multiple types of remote sensing systems used for surveying, including active and passive sensing, radar, hyperspectral imaging, and photogrammetry.

Applications of Remote Sensing :

Agriculture: Remote sensing is utilised for crop identification, production forecasting, damage and progress assessment, soil mapping and moisture estimation, and mapping of agricultural water resources.

Coastal: Monitor shoreline changes, track sediment transport, and map coastal features. Data can be used for coastal mapping and erosion prevention.

Ocean: Monitor ocean circulation and current systems, measure ocean temperature and wave heights, and track sea ice.

Hazard assessment: Track hurricanes, earthquakes, erosion, and flooding. Data can be used to assess the effects of natural disasters and develop preparedness plans for both before and after a hazardous event.

Natural resource management: Track land use, map wetlands, and identify wildlife habitats. Data can be used to reduce the environmental impact of urban development and to determine the best way to protect natural resources.

Weather Forecasting: It is extensively used to study weather patterns, precipitation, and temperature changes.

ISRO has launched many operational remote sensing satellites. Some of the recently launched remote sensing satellites are mentioned below in the table:

Name	Launch Year	Application
EOS-07	2023	Earth Observation
EOS-06	2022	Earth Observation
EOS-04	2022	Earth Observation
EOS-02	2021	Earth Observation
EOS-01	2020	Disaster Management System, Earth Observation
RISAT-2BR1	2019	Disaster Management System, Earth Observation
Cartosat-3	2019	Earth Observation
HysIS	2018	Earth Observation

GLOBAL POSITIONING :

GPS is a spaced based all weather radio navigation system that provide quickly , accurately the time, position and velocity of the object anywhere on the globe at any time .

GPS Comprises three segments:

I. Satellite Constellation called space segment

2. Ground Control Monitoring Network called operational control segment

3. User receiving equipment called user equipment segment.

1. SPACE SEGMENT :

The satellite constellation consist of nominal 24 satellites.

Satellites are positioned in 6 earth centered orbit plane with four satellite in each plane

The orbital radius is approximately 20,200km.

2. OPERATIONAL CONTROL SEGMNET :

The OCS has the responsibility of maintaining the satellites and their proper functioning

The control segment track all the satellites , ensure they are operating properly and compute their position in space.

3. USER SEGMENT :

The user receiving equipment , referred to as GPS receiver, receives and process the signal transmitted from satellite to determine user position,velocity & time.

Basic components : an antenna, an radio frequency section , microprocessor , control & display units, recording device etc.

Working Functions of GPS :

Generally the functions of a GPS are completed with 5 steps.

Step -I: Triangulating from Satellites.

Step-2: Measuring distance from a Satellite.

Step- 3: Getting Perfect Timing.

Step-4: Knowing where a Satellite is in Space.

Step-5: Correcting Errors:

The Global Positioning System (GPS) uses the principle of trilateration to calculate a location based on the distance to at least three known points.

Applications or Uses of GPS:

❖ GPS and Satellite Image: GPS has been widely used to prepare map from Satellite images especially topographic surveys and thematic mapping.
❖ Road Traffic Congestion: A navigation device has a GPRS receiver for receiving real time information about or slow average speed on a stretch of motorway, indicating congestion. The device calculates a new itinerary to avoid the congestion, based on historically record speeds on secondary roads weighed by the current average speed in the congestion area.
❖ GPS and Defense: Corps use GPS as a modern defensive purpose like trending and rescued.
❖ Accidental Purpose: To find and rescue any crashes ship and airplanes, GPS Plays very important role.
❖ Tectonics: GPS enables direct fault motion measurement of earthquake between earthquake GPS can be used to measure crustal motion and deformation to estimate seismic strain build up for creating seismic hazard maps.

❖ GPS and Terrorism: GPS is very important to determine the location of terrorist attacks. For example, on the surgical strike, Indian intelligence agencies had using the GPS and Indian Army carried out surgical strike against terror launch pads on and along the Line of Control (LoC) on 2016.

❖ GPS of Mining: The use of RTK GPS has significantly improved several mining operations such as drilling, shoveling, vehicle tracking and surveying, RTK GPS provides centimetre-level positioning accuracy.

❖ GPS and Climatology: GPS plays very important role to prepare weather map and computerized map.

❖ GPS and Tours: Location determines what content to display, for instance, information about an approaching point of interest.

❖ Navigation: Navigators value digitally precise velocity and orientation measurements. With the help of GPS roads or paths available, traffic congestion and alternative routes, roads or paths that might be taken to get to the destination. If some roads are busy then the best route to take, The location of food, banks, hotels, fuel, airports or other places of interests, the shortest route between the two locations, the different options to drive on highway or back roads etc. are easily getting better result using GPS.

❖ Surveying: Surveyors use absolute locations to make maps and determines property boundaries. The surveying and mapping community was one of the first to take advantage of GPS because it dramatically increased the productivity and resulted in more accurate and reliable data. Today, GPS is a vital part of surveying and mapping activities around the world.
❖ Distance and Height Measurement: GPS helps to calculate the distances and heights of different places on the earth surface.
❖ Automated Vehicle: With the help of GPS location and routes for cars and trucks to function without a human driver.
❖ Agriculture: GPS-based applications in precision farming are being used for farm planning, field mapping, soil sampling, tractor guidance, crop scouting, variable rate applications, and yield mapping. GPS allows farmers to work during low visibility field conditions such as rain, dust, fog, and darkness.
❖ GPS and Fishing: Synoptic maps of the main concentrations of fisherman villages, fishing ports and beach landing points, markets, processing, freezing and transshipment points, coastal landforms can be studied with the help of GPS.

DGPS : (Differential Global Positioning System)

Differential Global Positioning System (DGPS) is an enhancement to the GPS (Global Position System). GPS system based on the satellite technology can have the nominal accuracy of 15 meter whereas DPGS can bring accuracy around 10 cm.

➢ GPS accuracy is around 15 meters whereas DGPS is around 10 cm.
➢ GPS instrument can be used globally where as DGPS are meant locally may be within 100km. DGPS accuracy will start to degrade once instrument distance from ground based transmitters start to increase. Best results by the United States Department of Transportation were 0.67 m error growth within 100 km.
➢ GPS system is affordable compare to DGPS system which is why all smart phones have built-in GPS system.
➢ In GPS satellite transmit signal in frequency ranging from 1.1 to 1.5 GHz. In DGPS frequency varies by agencies, here is the list of frequency used by different agency.
➢ GPS accuracy is highly depending upon the number of satellites used for the calculation, for example there will be better accuracy on open space compare to the forested area. DGPS accuracy is not affected by these variables. It might be affected by the distance between transmitters and the instrument (rover).
➢ Most of the time coordinate system used in GPS will be WGS84 in Longitude and Latitude format where as DGPS might have local coordinate system.

Basis for Comparison	GPS	DGPS
Number of receivers used	Only one, i.e., Stand-alone GPS receiver	Two, Rover and stationary receivers
Accuracy	15-10 m	10 cm
Range of the instruments	Global	Local (within 100 km)
Cost	Affordable as compared to DGPS	Expensive
Frequency range	1.1 - 1.5 GHz	Varies according to agency
Factors affecting the Accuracy	Selective availability, satellite timing, atmospheric conditions, ionosphere, troposphere and multipath.	Distance between the transmitter and rover, ionosphere, troposphere and multipath.
Time coordinate system used	WGS84	Local coordinate system
Range	GPS's instruments range is global.	While DGPS's instruments range is local.

GIS (Geographical Information System) :

GIS (Geographical Information system) is a computer based system which involves collecting/capturing, storing, processing and manipulating, analysing, managing and retrieving and displaying geospatial data or information.

Components of GIS :

Hardware : A computer on which GIS Operate
Software: it provide function & tools needed to store analyse & display the data
Data : (we get from satellites or GPS system)

History of GIS development :

The idea of portraying different layers of data on a series of base maps, and relating things geographically, has been around much older than computers invention. Thousands years ago, the early man used to draw pictures of the animals they hunted on the walls of caves. These animal drawings are track lines and tallies thought to depict migration routes. While simplistic in comparison to modern technologies, these early records mimic the two-element structure of modern geographic information systems, an image associated with attribute information.

Applications of GIS :

1. Mapping

Mapping is considered as the central function of GIS. It is the visual representation of data that is stored by GIS in the database. Maps are the basic requirement for several entities in current situation.

2. Telecom Services

Telecom services benefit a lot from GIS in terms of efficient planning and operational decision making. GIS data facilitates the wireless telecom sector by helping them incorporate geospatial data into the complex network design and optimization activities.

3. Urban Planning

As populations grow, so do urban settlements. This gives the planners much lesser space and resources to develop the infrastructure. Also, the planners need to account for the impact this makes on the flora and fauna in the region. The urban planners depend on GIS to a great extent to minimize the negative impact on existing historic structures or natural spaces while responsibly accommodating humans.

4. Smart City

The smart city concept is emerging as the next big player around the world to improve the efficiency and security of urban development. GIS is responsible for integrating all the major aspects of city planning and management. It provides a common operating platform to all the sectors of the region.

5. Environmental Management

GIS is useful in environmental management as it facilitates monitoring of the changes in soil, water, air and tree cover. It helps in environmental conservation, waste management and mitigation of disasters.

6. Water management

At present, GIS is being used in monitoring of natural and man-made water bodies, managing water supply, modelling sewer systems, modelling groundwater, modelling storm water and nonpoint source pollution modelling for urban and agricultural areas.

7. Agricultural Applications

GIS is used for monitoring of crops and prediction of their possible production in agriculture.

Software for GIS :

1. ArcGIS Pro
2. QGIS 3
3. ArcGIS Desktop
4. Hexagon Geomedia
5. MapInfo Professional
6. Global Mapper
7. QGIS 2

A drone survey :

A drone survey also known as drone-based mapping, is the use of an unmanned aerial vehicle (UAV) to collect data from the air to create a map or 3D model of an area.

Features of Drone Mapping and Surveying :

During drone survey, the ground is photographed several times from different angles, and each captured image is tagged with certain coordinates.

The collected data are processed using drone mapping software to create construction assets like 3D models, 2D maps, digital elevation models, from which highly accurate measurements and volumetric calculations are taken.

Drone captures highly precise data quickly, without the need for surveying staff to walk over dangerous terrain or height to collect the information.

The two common types of drone mapping methods are photogrammetry and LiDAR.

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