

- **Regular Maintenance and Recalibration:** Schedule regular maintenance and recalibration intervals based on the sensor's usage and environmental conditions. Regular recalibration ensures continued accuracy over time.

8. HIGH RESOLUTION SENSORS:

- A high-resolution sensor can detect small changes in a measurement, while a low-resolution sensor may not be able to detect small changes.
- For example, a laser light grid with a low resolution will only detect or report displacements in whole centimetres.
- High-resolution sensors refer to sensors that can capture and provide data with a high level of detail and precision.
- These sensors are designed to record information with greater accuracy, finer granularity, and increased sensitivity compared to standard sensors.
- High resolution is particularly valuable in various fields and applications where detailed data is crucial.

8.1 Types of High-Resolution Sensors and Their Applications:

➤ High Resolution Imaging Sensors:

- ✓ **Applications:** In the field of photography, satellite imaging, aerial surveys, and medical imaging, high-resolution cameras and sensors capture detailed visual information. This is crucial for applications such as mapping, surveillance, and diagnostics.

➤ High Resolution Remote Sensing Sensors:

- ✓ **Applications:** Earth observation satellites equipped with high-resolution sensors can provide detailed information about land use, environmental changes, and natural disasters. This is valuable for urban planning, agriculture, forestry, and disaster response.

➤ High Resolution Lidar Sensors:

- ✓ **Applications:** Lidar (Light Detection and Ranging) sensors with high resolution are used in autonomous vehicles, robotics, and mapping applications. They provide detailed 3D mapping and precise distance measurements, enabling accurate navigation and object detection.

➤ High Resolution Radar Sensors:

- ✓ **Applications:** Radar sensors with high resolution are employed in a variety of fields, including aviation, weather monitoring, and defence. They can detect small objects, provide detailed weather information, and offer improved target discrimination.

➤ High Resolution Spectroscopy Sensors:

- ✓ **Applications:** Spectroscopy sensors with high resolution are used in scientific research, environmental monitoring, and industrial processes. They can analyse the composition of materials with greater precision, leading to more accurate results.

➤ **High Resolution Temperature Sensors:**

- ✓ **Applications:** In scientific research, industrial processes, and climate monitoring, high-resolution temperature sensors provide precise temperature measurements. This is crucial for maintaining quality control, optimizing processes, and understanding environmental changes.

➤ **High Resolution Pressure Sensors:**

- ✓ **Applications:** These sensors find use in various industries, including aerospace, automotive, and medical fields. High-resolution pressure sensors can provide accurate pressure measurements, enabling better control and monitoring of systems.

➤ **High Resolution Positioning Sensors:**

- ✓ **Applications:** In navigation systems, robotics, and virtual/augmented reality, high-resolution positioning sensors (such as high-precision GPS receivers) are essential for accurate location tracking and movement.

8.2 Benefits of High-Resolution Sensors:

- **Precision:** High-resolution sensors provide detailed and accurate data, allowing for precise analysis and decision-making.
- **Improved Detection:** Small and subtle changes or objects can be detected and analyzed with greater sensitivity.
- **Enhanced Mapping:** High-resolution imaging sensors contribute to detailed mapping, whether in geographic mapping or mapping the human genome.
- **Scientific Research:** In fields such as astronomy, physics, and biology, high-resolution sensors enable researchers to observe and analyse phenomena at a finer scale.

8.3 Challenges:

- Increased data volume
- The need of sophisticated processing and storage capabilities.
- The cost of high-resolution sensors can be higher compared to lower-resolution alternatives.

9. LIDAR

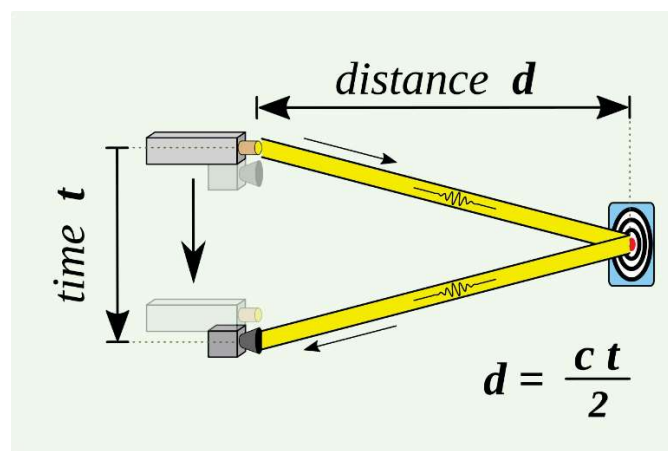
- LIDAR, which stands for Light Detection and Ranging, is a remote sensing technology that uses laser light to measure distances and generate precise, three-dimensional information about the shape and characteristics of objects in its range.
- LIDAR systems work by sending laser pulses towards a target and measuring the time it takes for the light to bounce back.
- This information, combined with the known speed of light, allows the system to calculate the distance to the target with high accuracy.
- It's a distance technology that samples with an incredible amount of accuracy and points.
- Lidar uses ultraviolet, visible, or near infrared light to image objects.

- It can target a wide range of materials, including non-metallic objects, rocks, rain, chemical compounds etc.
- A lidar determines the distance of an object or a surface with the formula.

$$d = \frac{c * t}{2}$$

- where

- ✓ c is the speed of light,
- ✓ d is the distance between the detector and the object or surface being detected,
- ✓ t is the time spent for the laser light to travel to the object or surface being detected, then travel back to the detector.



- The two kinds of lidar detection schemes are "incoherent" or direct energy detection and coherent detection.
- Some key points about LIDAR:

9.1 Components:

- A typical LIDAR system consists of a laser, a scanner, and a specialized GPS receiver.
- Some systems also include an inertial measurement unit (IMU) to account for the platform's motion.

9.2 Applications:

- **Surveying and Mapping:** LIDAR is widely used in topographic mapping, urban planning, and environmental monitoring.
- **Autonomous Vehicles:** LIDAR is a crucial component in many self-driving car systems, helping vehicles sense and navigate their surroundings.
- **Forestry and Agriculture:** LIDAR is used to assess forest structure, estimate biomass, and monitor crop health.
- **Meteorology:** LIDAR can be used to measure atmospheric conditions, such as cloud height and aerosol concentration.

9.3 Types of LIDAR:

- **Airborne LIDAR:** Mounted on aircraft, it is used for large-scale mapping and surveying.
- **Terrestrial LIDAR:** Stationary systems used for ground-based applications, like building and infrastructure modelling.
- **Mobile LIDAR:** Mounted on vehicles, it's used for mapping roadways and urban environments.

9.4 Advantages:

- **High Precision:** LIDAR provides accurate and detailed 3D data.
- **Versatility:** It can be used in various industries for different applications.
- **Speed:** LIDAR systems can quickly generate large amounts of data.

9.5 Challenges:

- **Cost:** High-quality LIDAR systems can be expensive.
- **Weather Dependence:** Adverse weather conditions, such as heavy rain or fog, can affect LIDAR performance.

9.6 Future Developments:

- Researchers and engineers are working on improving the size, cost, and performance of LIDAR systems, making them more accessible for widespread use, especially in applications like consumer electronics and robotics.

10. UAV

- Unmanned Aerial Vehicles (UAVs), commonly known as drones, have become increasingly popular in the field of remote sensing due to their ability to collect high-resolution, real-time data in a cost-effective and flexible manner.
- A UAV is an aircraft that does not carry a human operator. UAVs can be fully or partially autonomous but are more often controlled remotely by a human pilot.

➤ UAVs can be:

- ✓ Powered
 - ✓ Use aerodynamic forces to provide vehicle lift.
 - ✓ Fly autonomously or be piloted remotely.
 - ✓ Expendable or recoverable.
 - ✓ Carry a lethal or nonlethal payload.
 - ✓ Automated "drones" or remotely piloted vehicles (RPVs).
 - ✓ Military aircraft that is guided autonomously, by remote control, or both.
- UAVs can fly for long periods of time at a controlled level of speed and height. They have a role in many aspects of aviation, including warfare and surveillance.

- Some key points regarding UAVs in remote sensing:

➤ **High Spatial Resolution:**

- ✓ UAVs equipped with remote sensing instruments, such as cameras or multispectral sensors, can capture high-resolution imagery.
- ✓ This capability is especially useful for applications like agriculture, forestry, and environmental monitoring, where detailed spatial information is crucial.

➤ **Flexibility and Accessibility:**

- ✓ UAVs provide researchers and practitioners with the flexibility to collect data on-demand.
- ✓ They can be deployed quickly to specific locations, making them ideal for monitoring dynamic environmental conditions or responding to events like natural disasters.

➤ **Cost - Effectiveness:**

- ✓ Compared to traditional aerial or satellite remote sensing, UAVs can offer a more cost-effective solution for obtaining high-resolution data over small to medium-sized areas.
- ✓ This is particularly advantageous for research projects with limited budgets.

➤ **Real Time data Acquisition:**

- ✓ UAVs allow for real-time or near-real-time data acquisition.
- ✓ This rapid data turnaround is beneficial for time-sensitive applications, such as disaster response, crop monitoring, or environmental surveillance.

➤ **Versatility of sensors:**

- ✓ UAVs can carry a variety of sensors, including optical cameras, multispectral and hyperspectral sensors, thermal cameras, and LIDAR.
- ✓ This versatility enables researchers to choose the most suitable sensor for their specific remote sensing needs.

➤ **3D Modelling and Terrain Mapping:**

- ✓ UAVs equipped with LIDAR or photogrammetric cameras can generate high-precision 3D maps and terrain models.
- ✓ This capability is valuable for applications like topographic mapping, urban planning, and infrastructure assessment.

➤ **Environmental Monitoring:**

- ✓ UAVs are employed for monitoring and assessing environmental changes, including deforestation, land-use changes, and the health of ecosystems.
- ✓ The ability to capture frequent and high-resolution imagery facilitates detailed analysis of these changes.

10.1 Challenges and Considerations:

- **Regulations:** Strict regulations govern the use of UAVs, including altitude restrictions, airspace regulations, and privacy concerns.
- **Data Processing:** Managing and processing the large volumes of data collected by UAVs can be challenging and may require specialized software and expertise.

- **Battery Life and Flight Time:** Limited battery life and flight time can constrain the coverage area during a single flight.

10.2 Future Developments:

- Ongoing advancements in UAV technology, such as improvements in endurance, autonomous flight capabilities, and the development of more advanced sensors, are likely to further enhance the capabilities of UAVs in remote sensing applications.

11. ORBITAL AND SENSOR CHARACTERISTICS OF LIVE INDIAN EARTH OBSERVATION SATELLITES.

India has developed and launched a series of Earth observation satellites, primarily under the Indian Space Research Organisation (ISRO). Some notable ones include:

➤ ISRO's IRS Series (Indian Remote Sensing):

Orbit: Typically, these satellites are placed in sun-synchronous polar orbits, allowing for consistent imaging of the Earth's surface.

Sensors: These satellites carry various sensors, including optical and microwave sensors, for tasks such as agriculture monitoring, forestry mapping, urban planning, and disaster management.

➤ Cartosat Series:

Orbit: Sun-synchronous polar orbit.

Sensors: High-resolution panchromatic and multispectral cameras for cartographic applications.

➤ RISAT Series (RADAR Imaging Satellite):

Orbit: Generally, in sun-synchronous polar orbit.

Sensors: Synthetic Aperture Radar (SAR) for all-weather, day-and-night Earth observation.

➤ Resourcesat Series:

Orbit: Sun-synchronous polar orbit.

Sensors: Multispectral and hyperspectral imaging capabilities for resource monitoring.

➤ EOS Series (Earth Observation Satellite):

Orbit: Sun-synchronous polar orbit.

Sensors: Carries a variety of payloads for Earth observation, including cameras for high-resolution imaging.

➤ NavIC (Navigation with Indian Constellation):

Orbit: Geostationary orbit.

Sensors: While primarily a navigation satellite system, it also has applications in atmospheric and ionospheric studies.