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Study the Effect of Passive and Active Remote Sensing Types in Selecting Images used in Geographical Information Systems

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ألأية القرآنية

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

(يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنْكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ)

صَدَقَ اللهُ العَظِيم

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Approval by the supervisor

Supervisor approval

I certify that the subject of the research entitled "**Study the Effect of Passive and Active Remote Sensing Types in Selecting Images used in Geographical Information Systems**" and completed by the student **Hussein Salman Kazem** was conducted under our supervision in the Department of Physics, College of Science, University of Babylon, as a partial requirement for obtaining a Bachelor's degree in Physics Sciences for the period From 1/10/2023 until 1/4/2024

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The date: / /2024

الاهداء

من قال انا لها "نالها"

وانا لها إن ابت رغماً عنها اتيت بها .

لم تكن الرحلة قصيرة ولا ينبغي لا ان تكون لم يكن الحلم قريباً ولا الطريق كان محفوفاً بالتسهيلات لكنني فعلتها ونلتها بعد مسيره دراسية دامت سنوات حملت في طياتها الكثير من الصعوبات والمشقة والتعب ها انا اليوم اقف على عتبة تخرجي اقطف ثمار تعبي وارفع قبعتي بكل فحر والرؤية ضبابية من الدموع وانا اؤمن بمقولة ان لكل بداية نهاية وها انا ارى رحلتي الجامعية قد شارفت على الانتهاء بالفعل الحمد لله حباً وشكراً وامتناناً، ماكنت لأفعل هذا لولا فضل الله فالحمد لله على البدء وعلى الختام ...

اولاً اهدي هذا النجاح العظيم لنفسي التي كافحت واجتهدت وحاربت من اجل هذا اليوم....

الى من علمن ان الدنيا كفاح وسلاحها العلم والمعرفة الى من كرس في روحي مكارم الاخلاق وداعمي الاول وقوتي بعد الله ....

الى فخري واعتزازي (والدي)....

الى من جعل الله الجنة تحت اقدامها واحتضنني قلبها قبل يدها وسهلت لي الشدائد بدعائها الى القلب الحنون والشمة التي كانت في الليالي المظلمات ومصباح دربي (والدتي)....

الى من راهنو على نجاحي ....ويذكرني بمدى قوتي الذين كانوا عوناً وسنداً لكل التحديات التي واجهتني من اكملت معهم اجمل الايام التي لا تنسى (أصدقائي)....

فشكراً لكم وعلى ثقتكم ......

Abstract

Remote sensing refers to the identification of earth features by detecting the characteristics of electromagnetic radiation that is reflected or emitted by the earth surface. It is the science of acquiring and analyzing information about objects or phenomena from a distance without being in physical contact with them. Remote sensing process has four main essential components such as energy source or illumination interaction with the atmosphere, interaction with the target, recording of energy by the sensor, etc. This research aims to studying the fourth component relating to recording energy by the sensor and studying types of sensors. Remote sensing systems can be classified as passive or active based on the used energy source. Passive sensors record the reflected energy of electromagnetic radiation or the emitted energy from the earth (e.g. Camera, multispectral scanner). However, active sensors provide their own energy source for illumination(e.g. Radar, sonar). Remote sensing systems can also be classified as airborne systems and spaceborne system. Airborne system are carried out using sensors that are mounted on aircraft while spaceborne systems are carried using sensors that are mounted on satellites. This project also aims to examine the effect of geographic information system (GIS) on acquired images using sensors and aims to illustrates the capabilities of GIS.

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1. 1 Introduction

Remote sensing is a technique to observe the earth surface or the atmosphere from out of space using satellites (space borne) or from the air using aircrafts (airborne). Remote sensing uses a part or several parts of the electromagnetic spectrum. It records the electromagnetic energy reflected or emitted by the earth's surface. The amount of radiation from an object (called radiance) is influenced by both the properties of the object and the radiation hitting the object (irradiance). The human eyes register the solar light reflected by these objects and our brains interpret the colours, the grey tones and intensity variations. In remote sensing various kinds of tools and devices are used to make electromagnetic radiation outside this range from 400 to 700 nm visible to the human eye, especially the near infrared, middle-infrared, thermal-infrared and microwaves. Remote sensing imagery has many applications in mapping land-use and cover, agriculture, soils mapping, forestry, city planning, archaeological investigations, military observation, and geomorphological surveying, land cover changes, deforestation, vegetation dynamics, water quality dynamics, urban growth, etc. [1].

In 1859 Gaspard Tournachon took an oblique photograph of a small village near Paris from a balloon. With this picture the era of earth observation and remote sensing had started. His example was soon followed by other people all over the world. During the Civil War in the United States aerial photography from balloons played an important role to reveal the defense positions in Virginia (Colwell, 1983). Likewise other scientific and technical developments this Civil War time in the United States speeded up the development of photography, lenses and applied airborne use of this technology [2].

1.2 Components of Remote sensing

Remote sensing systems have the following essential components that comprise the remote sensing process. Energy source or illumination, interaction with atmosphere, interaction with the target, recording of energy by the sensor, transmission, reception, and processing, interpretation and analysis and application. **Fig.(1)** displays these elements.

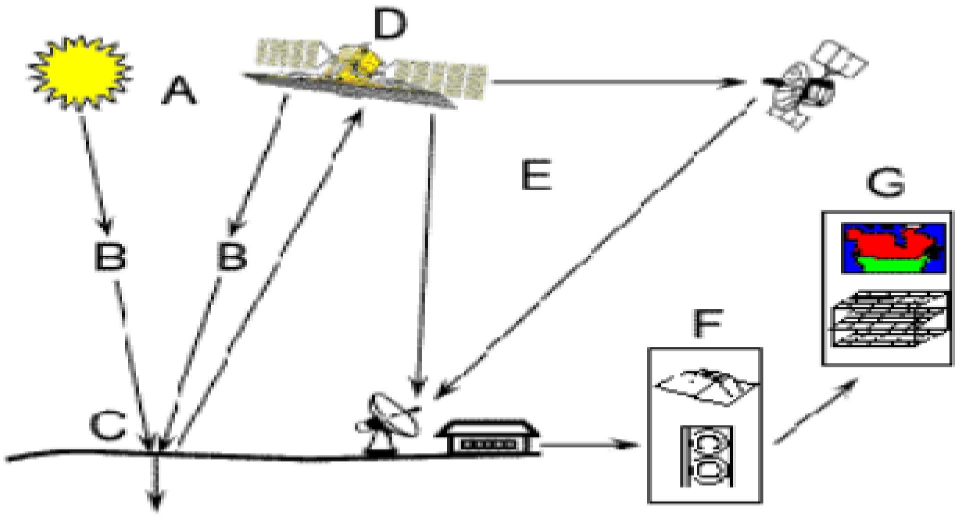


Figure (1): Elements of remote sensing process.

1.2.1 Energy Source or Illumination (A)

The first requirement for remote sensing is to have an energy source, which illuminates or provides electromagnetic energy to the target of interest. Sensors can be classified as passive or active, based on the energy source they are using. Sensors, which sense natural radiations, either emitted or reflected from the Earth, are called passive sensors (e.g. Aerial Camera, Multispectral Scanner). Most of the remote sensing sensors are passive in nature, which measure the solar radiation reflected from the target. On the other hand, the sensors which produce their own electromagnetic radiation, are called active sensors (e.g. LIDAR, RADAR) [3].

1.2.2 Interaction with Atmosphere (B)

Before radiation used for remote sensing reaches the Earth's surface. it has to travel through some distance of the Earth's atmosphere. Particles and gases in the atmosphere can affect the incoming light and radiation. These effects are caused by the mechanisms of scattering and absorption.

1.2.2.1 Scattering.

It occurs when particles or large gas molecules present in the atmosphere interact with electromagnetic radiation and cause the electromagnetic radiation to be redirected from its original path. How much scattering takes place depends on several factors including the wavelength of the radiation, the abundance of particles or gases, and the distance the radiation travels through the atmosphere. as shown in **Fig.(2)** There are three types of scattering which take place

1. **Rayleigh scattering:** occurs when particles are very small compared to the wavelength of the radiation. These could be particles such as small specks of dust or nitrogen and oxygen molecules.
2. **Mie scattering:** occurs when the particles are just about the same size as the wavelength of the radiation. Dust, pollen, smoke and water

vapour are common causes of Mie scattering which tends to affect longer wavelengths than those affected by Rayleigh scattering.

3. **nonselective scattering:** This occurs when the particles are much larger than the wavelength of the radiation. Water droplets and large dust particles can cause this type of scattering

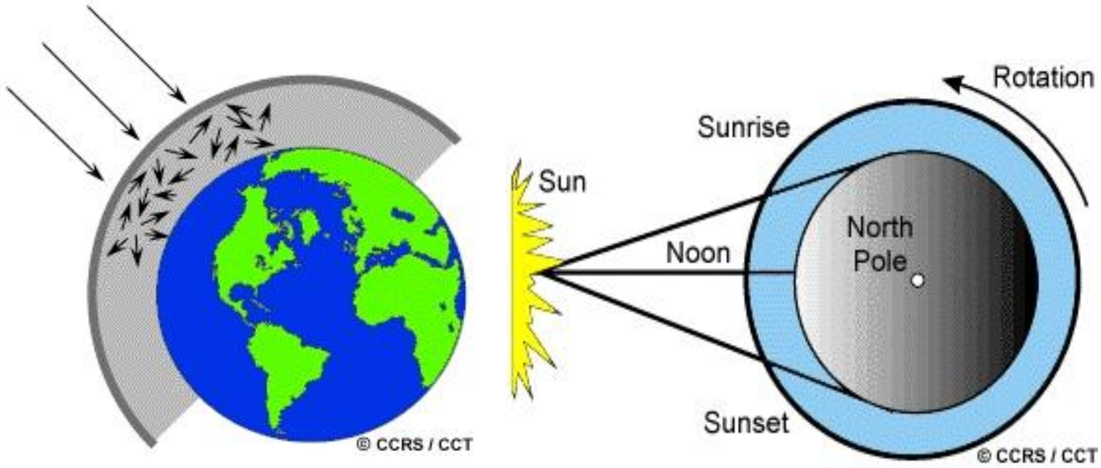


Figure (2): Energy Interaction with Atmosphere

At sunrise and sunset he light has to travel farther through the atmosphere than at midday and the scattering of the shorter wavelengths is more complete; this leaves a greater proportion of the longer wavelengths to penetrate the atmosphere.

1.2.2.2 Absorption

Is the other main mechanism at work when electromagnetic radiation interacts with the atmosphere. In contrast to scattering, this phenomenon causes molecules in the atmosphere to absorb energy at various wavelengths[4].

1.2.3 Interaction with the Target (C)

Radiation that is not absorbed or scattered in the atmosphere can reach and interact with the Earth's surface. There are three forms of interaction that can take place when energy strikes, or is **incident(I) (** upon the surface. These are **Absorption(A)** occurs when radiation (energy) is absorbed into the target while .**transmission(T)** occurs when radiation passes through a target. **Reflection(R)** occurs when radiation "bounces" off the target and is redirected. In remote sensing, as show **Fig.(3)** we are most interested in measuring the radiation reflected from targets. We refer to two types of reflection, which represent the two extreme ends of the way in which energy is reflected from a target: specular reflection and diffuse reflection [5].

Figure (3): Energy interaction with the target

1.2.4 Recording of energy by the sensor (D)

After the energy has been reflected/scattered by, or emitted from the target, we require a sensor (mounted on a satellite orbiting in space) to collect and record the electromagnetic radiation(EMR). The sensors are popularly known by the EMR region they sense. Remote sensing can be broadly classified as optical and microwave[6].In optical remote sensing, sensors detect solar radiation in the visible, near-, middle- and thermal-infrared wavelength regions, reflected/scattered or emitted from the earth **Table(1**) shows the spectral regions On the other hand, when the sensors work in the region of electromagnetic waves with frequencies between 109 and1012 Hz, it is called microwave remote sensing. This is highly useful, as it provides observation of the earth's surface, regardless of day/night and the atmospheric conditions. The Radar is an active microwave remote sensing system, which illuminates the terrain with electromagnetic energy, detects the scattered energy returning from the terrain (called radar return) and then records it as an image. Intensity of radar return, for both aircraft and satellite-based systems, depends upon radar system properties and terrain properties [7].

Table(1): The spectral regions used in satellite based remote sensing

Region	Wavelength	Property
Visible(blue, red, green)	0.4–0.7 µm	Reflectance
Reflective Infrared	0.7–3.0 µm	Reflectance
Thermal Infrared	3.0–15.0 µm	Radiative Temperature
Microwave	0.1–30 cm	Brightness Temperature(passive) Backscattering (Active)

The sensor, for taking observations, needs to be mounted on a platform. This platform can be ground-based, airborne or space borne, i.e. satellite based. The operational remote sensing systems are generally space borne.

1.2.5 Transmission, Reception, and Processing (E)

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).

1.2.6 Interpretation and Analysis (F)

The processed image is interpreted, visually and/or digitally or electronically, to extract information about the target which was illuminated [8].

1.2.7 Application (G)

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.

1.2.7.1 Meteorology

Study of atmospheric temperature, pressure, water vapor and wind velocity shown in **Fig.(4).**

Figure(4): application of remote sensing in meteorology

1.2.7.2 Forest fires

Overall, remote sensing applications in relation to forest fires play a crucial role in fire management efforts shown in **Fig.(5)** from early detection to post-fire assessments. These technologies provide valuable data and insights that help in minimizing the impact of forest fires on ecosystems and communities [9].

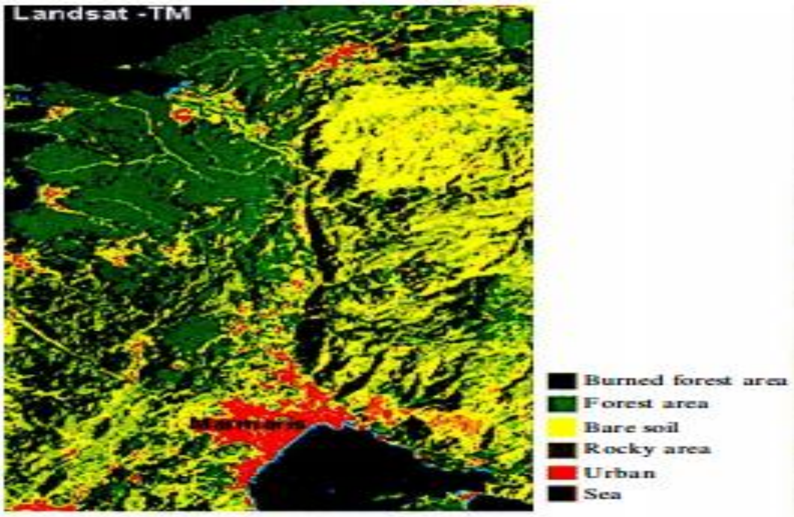


Figure (5): Application of remote sensing in forest fires

1.3 Passive remote sensing systems

Remote sensing systems record the reflected energy of electromagnetic radiation or the emitted energy from the earth, like cameras and thermal infrared detectors [10]. The sun is an important source of electromagnetic radiation used in passive remote sensing. Examples of passive remote sensing systems are aerial camera, video camera, Multispectral scanner, imaging spectrometer, and Thermal scanner. **Fig. (6)** shows passive remote sensing .

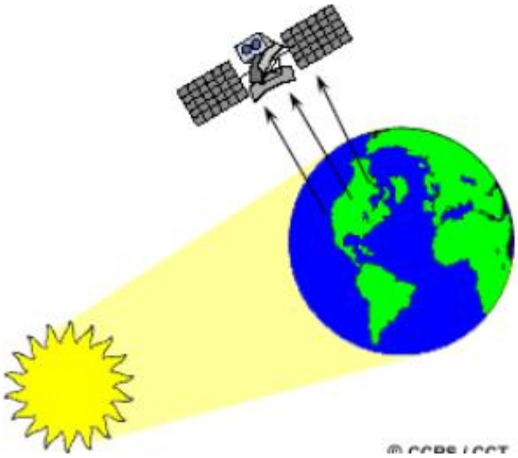


Figure (6): Passive remote sensing

1.3.1 Aerial camera

The camera system (lens and film) is mostly found in aircraft for aerial photography. Low Orbiting Satellites and NASA Space Shuttle missions also apply conventional camera techniques. The film types used in the camera enable electromagnetic energy in the range between 400 nm and 900 nm to be recorded. Aerial photographs are used in a wide range of applications. The possibility to acquire stereo-photography has enabled the development of photogrammetric procedures for obtaining precise 3D coordinates. Although aerial photos are used in many applications, principal applications include medium and large scale (topographic) mapping and cadastral mapping. Today, analogue photos are often scanned to be stored and processed in digital systems.

1.3.2 Video Camera

Video cameras are sometimes used to record image data. Most video sensors are only sensitive to the visible colours, although a few are able to record the near infrared part of the spectrum. Until recently, only analogue video cameras were available. Today, digital video cameras are increasingly available, some of which are applied in remote sensing. Mostly, video images serve to provide low cost image data for qualitative purposes, for example, to provide additional visual information about an area captured with another sensor (e.g., laser scanner or radar)[11].

1.3.3 Imaging spectrometer

The principle of the imaging spectrometer is similar to that of the multispectral scanner, except that spectrometers measure only very narrow (5–10 nm) spectral bands. This results in an almost continuous reflectance curve per pixel rather than the values for relatively broad spectral bands. The spectral curves measured depend on the chemical composition of the material. Imaging spectrometer data, therefore, can be used to determine mineral composition of the surface or the chlorophyll content of the surface water [12]

1.3.4 Multispectral scanner

Many electronic (as opposed to photographic) remote sensors acquire data using scanning systems which employ a sensor with a narrow field of view 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[13] .

1.3.4.1 Across-track

scanners scan the Earth in a series of lines The lines are oriented perpendicular to the direction of motion of the sensor platform (i.e. across the swath). Each line is scanned from one side of the sensor to the other, using a rotating mirror. As the platform moves forward over the Earth, successive scans build up a two-dimensional image of the Earth's surface.

So, the Earth is scanned point by point and line after line. These systems are referred to as whiskbroom scanners. The incoming reflected or emitted radiation is separated into several spectral components that are detected independently. A bank of internal detectors, each sensitive to a specific range of wavelengths, detects and measures the energy for each spectral band and then, as an electrical signal, they are converted to digital data and recorded for subsequent computer processing.

1.3.4.2 Along-track

scanners also use the forward motion of the platform to record successive scan lines and build up a two-dimensional image, perpendicular to the flight direction. However, instead of a scanning mirror, they use a linear array of detectors (so-called charge-coupled devices, CCDs) located at the focal plane of the image formed by lens systems, which are “pushed” along in the flight track direction (i.e. along track) These systems are also referred to as push broom scanners, as the motion of the detector array is analogous to a broom being pushed along a floor. A separate linear array is required to measure each spectral band or channel. For each scan line the energy detected by each detector of each linear array is sampled electronically and digitally recorded. Regardless of whether the scanning system used is either of these two types, it has several advantages over photographic systems [14].

1.3.5 Thermal scanner

Many multispectral (MSS) systems sense radiation in the thermal infrared as well as the visible and reflected infrared portions of the spectrum. However, remote sensing of energy emitted from the Earth’s surface in the thermal infrared (3 µm to 15 µm) is different from the sensing of reflected energy. Thermal sensors use photo detectors sensitive to the direct contact of photons on their surface, to detect emitted thermal radiation. The detectors are cooled to temperatures close to absolute zero in order to limit their own thermal emissions. Thermal sensors essentially measure the surface temperature and thermal properties of targets. Thermal Imagers are typically across-track scanners that detect emitted radiation in only the thermal portion of the spectrum. Thermal sensors employ one or more internal temperature references for comparison with the detected radiation, so they can be related to absolute radiant temperature. **Table (2)** Displays thermal sensors.

Table (2): Thermal Sensors .

	HCMM	**TM**
Operational period	1978 – 1980	1982 to present
Orbital altitude	620 mm	705 km
Image coverage	700 by 700km	185 by 170 km
Acquisition time ,day	1:30 p.m.	10:30 a.m.
Acquisition time night	2:30 p.m.	9:30 p.m.
Visible and reflected IR detectors		
Number of bands	1	6
Spectral range	0.5 – 1.1 μm	0.4 – 2.35 μm
Ground resolution cell	500 by 500 m	30 by 30m
Thermal IR detector		
Spectral range	10.5 12.5 μm	10.5 12.5 μm
Ground resolution Cell	600 by 600 m	120by 120 m 60 m by60 m in landsat 7

The data are generally recorded on film and/or magnetic tape and the temperature resolution of current sensors can reach 0.1 °C. For analysis, an image of relative radiant temperatures is depicted in grey levels, with warmer temperatures shown in light tones, and cooler temperatures in dark tones[15].

1.4 Active remote sensing systems

Active remote sensing provide their own energy source for illumination. The sensor emits radiation which is directed toward the target to be investigated. The radiation reflected from that target is detected and measured by the sensor ,as shown in **Fig. (7)** Advantages for active sensors include the ability to obtain measurements anytime, regardless of the time of day or season. Active sensors can be used for examining wavelengths that are not sufficiently provided by the sun, such as microwaves, or to better control the way a target is illuminated. However, active systems require the generation of a fairly large amount of energy to adequately illuminate targets. Some examples of active sensors are a laser scanner, Radar scanner, Imaging Radar, and sonar [16].

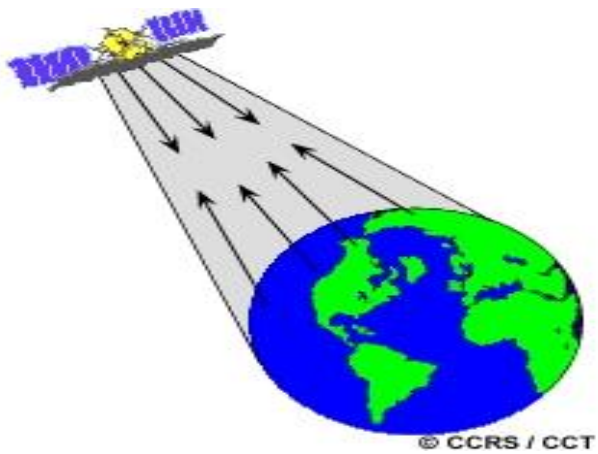


Figure (7): Active Remote Sensing System

1.4.1 Laser scanner

Laser scanners are mounted on aircraft and use a laser beam (infrared light) to measure the distance from the aircraft to points located on the ground. This distance measurement is then combined with exact information on the aircraft's position to calculate the terrain elevation. Laser scanning is mainly used to produce detailed, high-resolution, Digital Terrain Models (DTM) for topographic mapping. Laser scanning is increasingly used for other purposes, such as the production of detailed 3D models of city buildings and for measuring tree heights in forestry [17].

1.4.2 Radar altimeter

Radar altimeters are used to measure the topographic profile parallel to the satellite orbit. They provide profiles (single lines of measurements) rather than 'image' data. Radar altimeters operate in the 1–6 cm domain and are able to determine height with a precision of 2–4 cm. Radar altimeters are useful for measuring relatively smooth surfaces such as oceans and for 'small scale' mapping of continental terrain models[18].

1.4.3 Imaging radar

Radar operation remote sensing provides imagery that characterizes the physical properties (morphology, roughness, dielectric properties and geometric shapes) of the terrain surface, its cover and near-surface volume. Image enhancements are particularly suited to landform analysis from which geomorphological and geological inferences can be made. Because radars provide their own illumination, observations are independent of cloud cover, light rain, smoke haze and solar illumination, thus allowing all-time observation through all seasons and in all climatic regions. An important capability of radar is the ability to select the illumination geometry, that is, the incidence and azimuth angles, to highlight structure and other diagnostic properties of the terrain. A typical radar measures the strength and round-trip time of the microwave signals that are emitted by a radar antenna and reflected off a distant surface or object. The radar antenna alternately transmits and receives pulses at particular microwave wavelengths (in the range 1 cm to 1 m, which corresponds to a frequency range of about 300 MHz to 30 GHz) and polarizations (waves polarized in a single vertical or horizontal plane). At the Earth's surface, the energy in the radar pulse is scattered in all directions, with some reflected back toward the antenna. This backscatter returns to the radar as a weaker radar echo and is received by the antenna in a specific polarization (horizontal or vertical, not necessarily the same as the transmitted pulse). These echoes are converted to digital data and passed to a data recorder for later processing and display as an image. In radar imagery, surface roughness is the dominant factor in determining the amplitude of the return signal. Surface roughness is a measure of the irregularity of the terrain surface (both vertical and horizontal) compared with the radar wavelength. On radar images, surfaces can be classified as smooth, slightly rough, moderately rough or very rough, relative to the radar wavelength and angle of incidence. A consequence is that a surface that appears smooth at a long radar wavelength may appear rough at a short wavelength. The level of radar backscatter indicates the tone of an image - rough targets appear bright and smooth targets dark. The mean intensity of the radar backscatter from an area of interest is usually expressed in decibels (dB). Typical values (of $\sigma°$) for natural surfaces range from +5dB for very rough surfaces to -40db for very smooth surfaces. Other factors that influence the intensity are the transmitting frequency (wavelength), polarization of the transmitted and received signals, incidence angle between the transmitted signal and terrain surface, topographic slope and dielectrically properties of the surface and sub-surface materials. [19].

1.4.4 Sonar

Sonar is a popular sensor in robotics that employs acoustic pulses and their echoes to measure the range to an object. Since the sound speed is usually known, the object range is proportional to the echo travel time At ultrasonic frequencies the sonar energy is concentrated in a beam, providing directional information in addition to range. Its popularity is due to its low cost light weight, low power consumption, and low computational effort, compared to other ranging sensors **Table (3)** shows advantages and disadvantages of passive and active sensors [20].

Table 3 : The advantages and disadvantages of passive and Active sensors

Sensors		Advantages	Disadvantages
Passive	Visible spectrum Camera	Very rich in contents. Easy to interpret. Low price. No interference problems with the environment.	Not well suited for darkness condition
	Infrared Camera	Ability to measure the temperature. Independent of the light source.	Sensitive to weather conditions
Active	Laser	Having a high accuracy both in lateral and longitudinal direction	Acquisition price
	Sonar	Possibility to measure and speed of the target objects	Difficulties in interpreting the output signal returned by themselves. Acquisition price. Sensitive to weather conditions

	Radar	Images can be acquired day or night. Can operate in different environmental conditions without any strong limitations	Difficulties in interpreting the output signal returned by themselves. Acquisition price Sensitive to weather conditions

1.5 Platforms

In remote sensing, the sensor is mounted on a platform. In general, remote sensing sensors are attached to moving platforms such as aircraft and satellites. Static platforms are occasionally used in an experimental context. Airborne observations are carried out using aircraft with specific modifications to carry sensors. An aircraft that carries an aerial camera or a scanner needs a hole in the floor of the aircraft. Sometimes Ultra-Light Vehicles (ULVs),balloons, Airship or kites are used for airborne remote sensing. Airborne observations are possible from 100 m up to 30–40 km height. Until recently, the navigation of an aircraft was one of the most difficult and crucial parts of airborne remote sensing. In recent years, the availability of satellite navigation technology has significantly improved the quality of flight execution. For space borne remote sensing, satellites are used. Satellites are launched into space with rockets. Satellites for Earth Observation are positioned in orbits between 150–36,000 km altitude. The specific orbit depends on the objectives of the mission, e.g., continuous observation of large areas or detailed observation of smaller areas.

1.5.1 Ground platforms.

Wide varieties of ground-platforms are used in remote sensing. These platforms range from simple tripods to cranes, hand held cameras and towers. Ground Platforms raise the sensor above the earth's object to be sensed and can reach tens of meters above the Earth’s surface. Ground platforms are also known as Terrestrial -platforms because they remain in contact with the ground during the imaging of the Earth’s surface. The ground platforms are either static (on a stationary platform such as a tripod) or dynamic (on a moving vehicle) used for close-range, high accuracy applications. These ground platforms work at short range (50-100 meter), medium range (up to 250 meter) and long range (1000 meter). The purpose of short range platforms is the mapping of buildings and small objects. Medium range platforms, with millimeters accuracy is used for three dimensional modeling applications. Long range platforms are frequently used for topographic application. Images collected from a ground platforms have spatial resolutions much greater than those collected from the aircraft or satellites. The image data collected by ground platforms are used for: bridge and dam monitoring , landslide monitoring , soil erosion mapping ,study properties of a single plant , study properties of a small patch of grass [21].

1.5.2 Airborne remote sensing systems

Airborne remote sensing is carried out using different types of aircraft depending on the operational requirements and budget available. The speed of the aircraft can vary between 140–600 km/hour and is, among others, related to the mounted sensor system. Apart from the altitude, also the aircraft orientation affects the geometric characteristics of the remote sensing data acquired. The orientation of the aircraft is influenced by wind conditions and can be corrected for to some extent by the pilot. An Inertial Measurement Unit (IMU) can be installed in the aircraft to measure these rotations. Subsequently the measurements can be used to correct the sensor data for the resulting geometric distortions. Today, most aircraft are equipped with satellite navigation technology, which yield the approximate position (RMS-error of less than 30 m). More precise positioning and navigation (up to decimeter accuracy) is possible using so-called ‘differential approaches [22].

1.5.3 Spaceborne remote sensing systems

Space borne remote sensing is carried out using sensors that are mounted on satellites. The monitoring capabilities of the sensor are to a large extent determined by the parameters of the satellite’s orbit. Different types of orbits are required to achieve continuous monitoring (meteorology), global mapping (land cover mapping), or selective imaging (urban areas).For remote sensing purposes, the following orbit characteristics are relevant

1- Altitude, which is the distance (in km) from the satellite to the mean surface level of the Earth. Typically, remote sensing satellites orbit either at 600– 800 km (polar orbit) or at 36,000 km (geo-stationary orbit) distance from the Earth. The distance influences to a large extent which area is viewed and at which detail.

2- Inclination angle, which is the angle (in degrees) between the orbit and the equator. The inclination angle of the orbit determines, together with field of view of the sensor, which latitudes can be observed. If the inclination is 60^o then the satellite flies over the Earth between the latitudes 60^{o}South and 60^o North; it cannot observe parts of the Earth at latitudes above 60^o .

3- Period, which is the time (in minutes) required to complete one full orbit. A polar satellite orbits at 800 km altitude and has a period of 90 minutes. A ground speed of 28,000 km/hour is almost 8 km/s. Compare this figure with the speed of an aircraft, which is around 400 km/hour. The speed of the platform has implications for the type of images that can be acquired (time for 'exposure').

4- Repeat cycle, which is the time (in days) between two successive identical

orbits. The revisit time, the time between two subsequent images of the same area, is determined by the repeat cycle together with the pointing capability of the sensor. Pointing capability refers to the possibility of the sensor-platform to 'look' sideways. Push broom scanners, such as those mounted on SPOT, IRS and IKONOS (Section 5.4), have this possibility.

The following orbit types are most common for remote sensing missions:

A. Polar, or near polar, orbit. These are orbits with inclination angle between 80 and 100 degrees and enable observation of the whole globe. The satellite is typically placed in orbit at 600–800 km altitude.

B. Sun-synchronous orbit. An orbit chosen in such a way that the satellite always passes overhead at the same local solar time is called sun-synchronous. Most sun synchronous orbits cross the equator at mid-morning (around 10:30 h). At that moment the Sun angle is low and the resultant shadows reveal terrain relief. Sun-synchronous orbits allow a satellite to record images at two fixed times during one 24-hour period: one during the day and one at night. Examples of near polar sun-synchronous satellites are Landsat, SPOT and IRS.

C. Geostationary orbit. This refers to orbits in which the satellite is placed above the equator (inclination angle is 0_) at a distance of some 36,000 km. At this distance, the period of the satellite is equal to the period of the Earth. The result is that the satellite is at a fixed position relative to the Earth. Geostationary orbits are used for meteorological and telecommunication satellites. Today's meteorological weather satellite systems use a combination of geostationary satellites and polar orbiters see **fig. (8).** The geo-stationary satellites offer a continuous view, while the polar orbiters offer a higher resolution .

The data of spaceborne sensors need to be sent to the ground for further analysis and processing. Some older spaceborne systems utilized film cartridges that fell back to a designated area on Earth. In the meantime, practically all Earth Observation satellites apply satellite communication technology for downlink of the data. The acquired data are sent down to a receiving station or to another communication satellite that downlink the data to receiving antennæ on the ground. If the satellite is outside the range of a receiving station the data can be temporarily stored by a tape recorder in the satellite and transmitted

later. One of the trends is that small receiving units (consisting of a small dish with a PC) are being developed for local reception of image data [23].

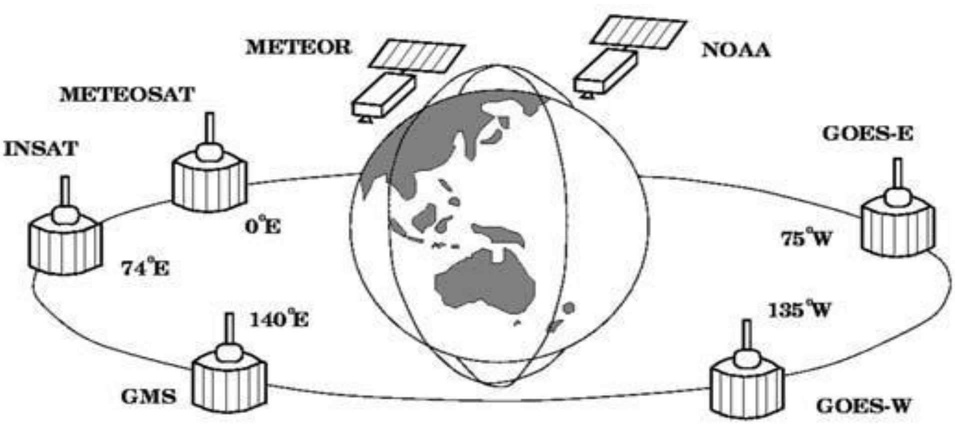


Figure (8): Meteorological observation system comprised of geo-stationary and polar satellite.

2.1 Introduction

The GIS history dates back to 1960 when computer based GIS have been used and their manual procedures were in life 100 years.

Throughout history there have been many methods of characterizing geographic space, especially maps created by artists, mariners, and others eventually leading to the development of the field of cartography It is no surprise that the digital age has launched a major effort to utilize geographic data, but not just as maps. A geographic information system (GIS) facilitates the collection, analysis, and reporting of spatial data and related phenomena. The capabilities of GIS are much more than just mapping, although map production is one of the most utilized features. GIS applications are relevant in a tremendous number of areas ranging from basic geographic inventories to simulation models [24].

This chapter shows an overview of the development, capabilities, and utilization of geographic information systems (GIS). There are nearly an unlimited number of applications that are relevant to GIS because virtually all human interactions, natural and man-made features, resources, and populations have a geographic component. Everything happens somewhere and the location often has a role that affects what occurs. This role is often called spatial dependence or spatial autocorrelation, which exists when a phenomenon is not randomly geographically distributed. GIS has a number of key capabilities that are required to conduct a spatial analysis to assess this spatial dependence. This chapter illustrates these. Capabilities (e.g., georeferencing, adjacency/distance measures, and overlays) and Provides a case study to illustrate how GIS can be used for both research and planning. Although GIS has developed into a relatively mature application for basic functions, development is required to more seamlessly integrate spatial statistics and models [25].

2.2 Elements of geographic information system GIS

GIS have mainly five components: Hardware, Software, Data, People, and Methods.

2.2.1 Hardware

Hardware used in GIS helps in supporting the activities which are essential for geospatial analysis. These activities range from the collection of GIS data upto the interpretation of that data. A workstation is a central equipment at which GIS software runs. Other ancillary equipments are attached to the workstation. Hard copy data is converted with the help of a digitizer to digital data. Web servers also make part of the hardware for web mapping purposes ordinary in GIS and so is handheld field technology that makes data collection easy. ArcGIS Server is a server-based computer where GIS software runs on the network computer or is cloud-based. For the computer to perform well, all hardware element must have high capacity. All hardware elements function together to run a GIS software smoothly [26].

1. Scanner

A scanner is a device that reads paper maps and converts them into very high-resolution files. The file is then used directly in the GIS as a raster backdrop or a scanned image may be vectorized using post-processing software. Scanners are typically divided into two groups:

flatbed scanners which. require the map to be laid out face down on a glass table; and, drum scanner . which requires the map to be attached face out to drum, that rotates.

2. Plotter

Inkjet plotters offer very high resolutions and quality colour reproduction for static displays. These plotters have entirely replaced the pen plotters and offer reliable, high-resolution, low maintenance colour plotting. These plotters usually make use of magenta, yellow, and black ink cartridges, which can be combined to produce any color in the spectrum. In newer models, the print head has been separated from the ink reservoir, to allow the plotter to print many plots before the reservoir needs to be replaced [27].

3. Monitor

It is the most common GIS output device that has the ability to display dynamic data in almost any colour. Depending on the amount of use, a monitor will receive many different available options. Nowadays, there are various types of monitor: CRT (Cathode Ray Tube), LCD (Liquid Crystal Display), LED (Light Emitting Diodes) and more . **Fig.(9)** displays the most common monitor GIS [28].

Figure(9): Computer monitor

4. Satellite Navigation system

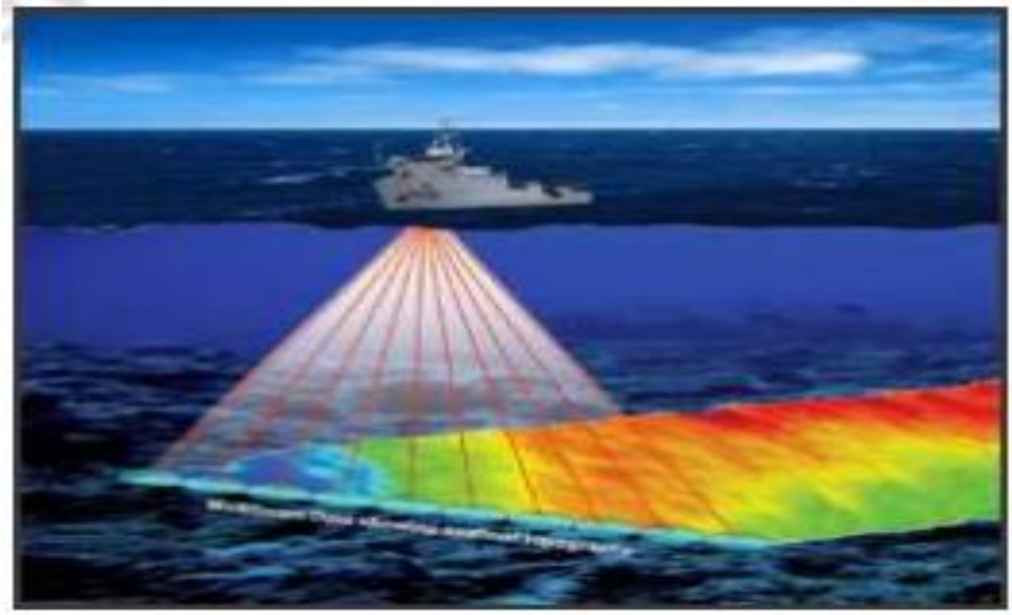
The Global Positioning System (GPS) is a satellite navigation system that allows the position of the receiver to be determined within meters or centimeters. GPS uses a constellation of 24 satellites having precisely known positions to enable a GPS receiver to calculate its position. Each satellite measures time accurately using an atomic clock and broadcasts a time-synchronized signal. The receiver receives the signal from four or more satellites and calculates the time differential to each satellite, which allows the distance to each satellite to be determined within a few meters. Since the satellite locations are known precisely, the receiver can then calculate its location [29].

5. Remote Sensors

The device that can obtain data about an object without coming into physical contact with that object using electromagnetic radiations is commonly known as remote sensor. Remote sensing systems are classified as passive and active [30].

6. Multibeam Ecosounders

It is an advanced version of depth sounders which is used in many recreational vessels and marine mapping applications. It uses multiple beams to map the ocean depths not only directly beneath the ship, but also to each side as shown in the **Fig. (10).** In the present times, two varieties of multibeam ecosounder are used. The first transmit wave from a transducer which is received by an array of microphones that are towed behind the ship; and, second transmits sound waves from a transducer and receives a reflected waves using an array of microphones that are attached to the hull of the ship [31].



Figure(10): Anomaly detection in multibeam Eco sounder seabed scans

2.2.2 Software

GIS software helps to store, analyze and display geographic information in the form of maps and reports. It provides the Graphic User Interface (GUI) for easy display and access to tools for input, visualizing, processing, editing, analyzing and querying geographic data. Data is accessed and managed through Data Management System (DBMS). Example of GIS software is ArcView 3.2, QGIS, SAGA GIS. The software elements are described below [32].

1. Relational Database Management System (RDBMS)

RDBMS is a type of database in which data is organized across one or more tables. The tables are associated with each other through a standard field called keys. In contrast to other database structures, RDBMS requires few assumptions about how data is related or how it is extracted from the database. The relational model has relationship between tables using primary keys, foreign keys and indices. Thus, the fetching and storing of data becomes faster. RDBMS is widely used by the enterprises and developers for storing complex and large amount of data. GIS Software retrieve from RDBMS or insert data into RDBMS.

2.Query Tools

The Query Tool is a production quality add-in that allows users of the ArcGIS Viewer for query a layer or table within an ArcGIS Server map service. With the add-in, users of the application builder can interactively build queries, end-users presenting with a simple dialog box that prompts for values to plug into the queries. The tool can be configured to query multiple fields, and query statements can be combined using logical operators.

3. Graphical User Interface (GUI)

GUI is a type of user interface that allows the users to interact with electronic devices through graphical icons and visual indicators such as secondary notation, typed command labels or text navigation instead of text-based user interfaces. GUI introduced in reaction to the perceived steep learning curve of command-line interfaces (CLI), which require commands to be typed on a computer keyboard.

4. Layout

Layout refers to the elemental arrangement on a map such as a title, legend, north arrow, scale bar, and geographic data [33].

2.2.3 GIS DATA

GIS data is the most important and expensive component of the GIS. It is an integration of graphics and tabular data. The graphic may be vector or raster. These data can be created in-house using GIS software or purchased from other data sources. Digitization is the process of creating the GIS data from the analog data or paper format. Digitization process involves registering of raster image using GCP (ground control point) or known coordinates. This process is widely known as georeferencing. Polygon, lines and points are created by digitizing raster image. Raster image itself registered with coordinates which are widely recognized as rectifying the image. Registered image are mostly exported in TIFF format. GIS data is two type that is spatial data and attribute data[34] .

1. **Spatial data:** refer to the real-world geographic objects of interest, such as streets buildings, lakes, and countries, and their respective locations. In addition to location, each of these objects also possesses certain traits of interest.
2. **Attributes:** , such as a name, number of stories, depth, or population. GIS software keeps track of both the spatial and attribute data and permits us to link the two types of data together to create information and facilitate analysis. One popular or way to describe and to visualize a GIS is picturing it as a cake with many layers. Each layer of the cake represents a different geographic theme, such as water features, buildings, and roads, and each layer is stacked one on top of another see **Fig.(11).** A GIS as a Layered Cake [35].

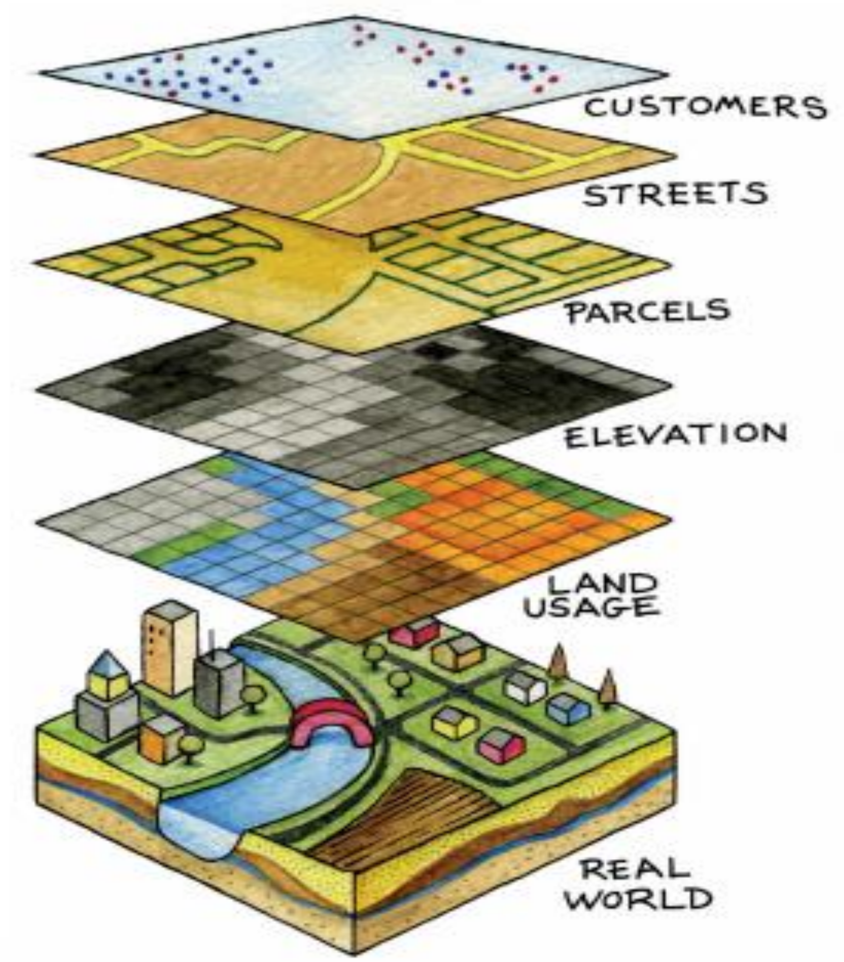


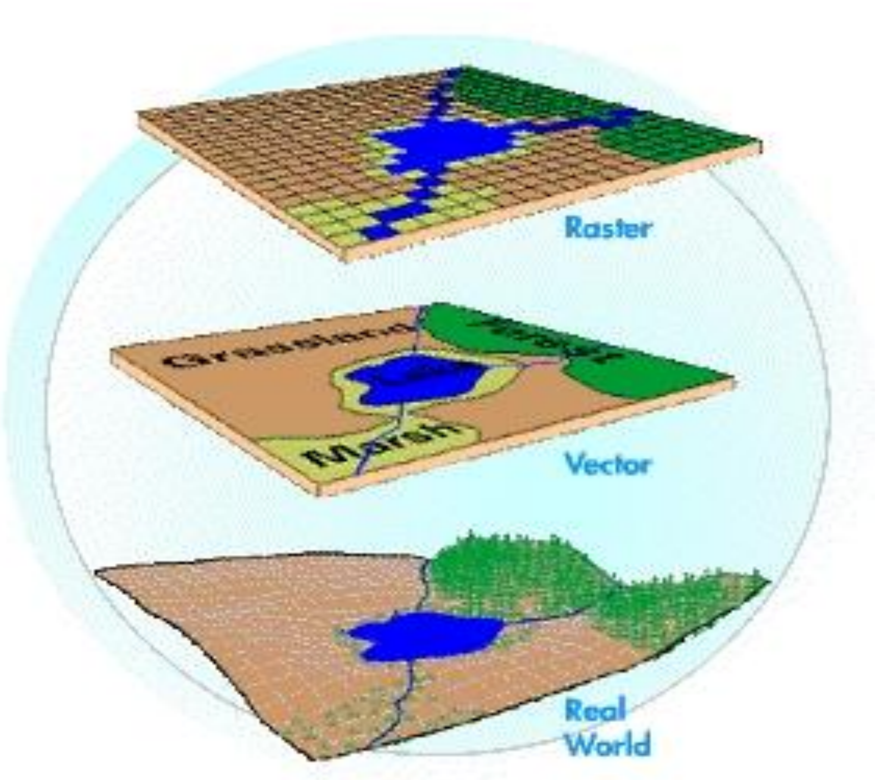
Figure (11): A GIS as a Layered Cake(Spatial data two type that vector Data and Raster Data)

1.Vector Data

Vector data provides a way to represent discrete data or real world features within the GIS environment. These data store information in x, y coordinate format. Vector data are of three types: Lines, Points and Area.

2. Raster Data

Raster data store information in a cell based manner. It can be an aerial photo or a satellite image, Digital Elevation Model (DEM). Raster images normally store continuous data [34] .



Figure(12): Representation of Vector and Raster Data For GIS data

2.2.4 People(Users)

People are the key component of GIS without which nothing else would work. They are also the most complex element in the GIS; arguably the segment most prone to failure, and the only component in the system that is self-correcting and able to repair other components.

People in GIS are generally technical persons such as GIS manager, database administrators, specialist, programmers, analyst or a general user.

2.2.5 Methods

Methods include how the data will be retrieved, input into the system, stored, managed, transformed, analyzed and finally presented in a final output. The method component of GIS includes the steps taken to answer the queries or questions that need a resolution. GIS can perform spatial analysis and answer the questions pertaining to spatial domain; and this is what differentiates this type of system from any other information systems. The transformation processes includes tasks such as setting a projection, adjusting the coordinate system, correcting any digitized errors in a data set and converting data from vector to raster or raster to vector. For successful GIS operation, a well-designed plan and business operation rules are important. Methods can vary for different organizations [36].

2.3 Capabilities of GIS

Capabilities of GIS range from indigenous people, communities, research institutions, environmental scientists, health organizations, businesses and government agencies, and land use planners at all levels. Some example of GIS Capabilities given below:

2.3.1 Cartography

GIS can produce very high-quality maps that match or exceed the cartographic quality of maps created using traditional processes. Standard cartographic tools are available in many GIS. However, for the production of entirely new cartographic representations, or non-spatial data representations such as cartograms; GIS data or maps need to be exported to an illustration tool such as Photoshop

2.3.2 Mapping

This is a central function of GIS, which provides a visual interpretation of data. GIS store data in a database and then represent it visually in the form of maps [37].

2.3.3 Telecom and Network Services

GIS is excellent planning and decision making tool for telecom industries. GDi GISDATA enables wireless telecommunication organizations to incorporate geographic data into the sophisticated network design, planning, optimization, maintenance and activities[38].

2.3.4 Urban Planning

This technology is used to analyze the urban growth and its direction of expansion and to find suitable sites for further urban development [39].

2.3.5 Environmental Impact Analysis (EIA)

Human activities produce potential adverse environmental effects which include the construction and operation of highways, rail roads, pipelines, airports, radioactive waste disposal sites and so on. EIA is usually required to contain specific information on the magnitude and characteristics of environmental impact. The EIA can be carried out efficiently with the help of GIS and by integrating various GIS layers, assessment of natural features can be performed[40].

2.3.6 Agricultural Applications

GIS can be used to create more effective and efficient farming techniques. It can also analyze soil data and help in determining the best suited crop types besides other applications. GIS helps government agencies to manage agricultural programs that support farmers and protect the environment. It also helps in increasing food production by means of suitability analysis in different parts of the world [41].

2.3.7 Disaster Management and Mitigation

GIS is a well-developed and successful tool in disaster management and mitigation. It can help in risk management and analysis by displaying which areas are prone to natural or man-made disasters[42].

2.3.8 GIS in Dairy Industry

GIS is used in various applications in the dairy industry, such as the distribution of products, production rate, the location of shops and their selling rate[43].

2.3.9 Traffic Density Studies

It can be effectively used for the management of traffic problems that has been increasing in recent years due to ever-increasing number of vehicles plying on the roads[44].

2.3.10 GIS for Business

It is also used for managing business information based on its location. GIS can keep track of customers' location, site business, target marketing campaigns and optimize sales territories and model retail spending patterns [45].

3.1 conclusions

This project has focused on studying the effect of passive and active sensors in remote sensing. Based on our study, we have concluded that most of the remote sensing sensors are passive in nature. However, active sensors have advantages more than passive sensors. Active systems include the ability to obtain measurements about earth surfaces any time, regardless of the time of day or season. They can also be used for examining wavelengths that are not sufficiently provided by the sun, such as microwaves. However, active sensors require the generation of a large amount of energy to adequately illuminate targets. This research also focused on studding the effect of a geographic information system (GIS) on images measured by sensors. We have concluded that, GIS facilitates the collection, analysis, and reporting spatial data and phenomena. The capabilities of GIS are much than these, it produces mapping, georeferecing, adjacency/distance measure and overlays of selected images.

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وزارة التعليم العالي والبحث العلمي

جامعة بابل ــ كلية العلوم

قسم الفيزياء

مشروع بحث التخرج

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للطالب

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بكالوريوس علوم فيزياء

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