5
UNIT

Remote Sensing and Digital Image Processing

CONTENTS

PART- 1

Concepts and Physical Basis of Remote Sensing.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 5.1. What do you understand by the term "Remote sensing" ? Discuss its advantages and limitations. **AKTU 2017-18, Marks 05**

Answer

A. Remote Sensing :

1. Remote sensing is, taking the pictures of any area, by a camera, without touching it *i.e.*, taking the pictures remotely.
2. The first remote sensing technique is the aerial photography. These photographs are taken from the air, by using aeroplanes.
3. The aerial photography has many applications e.g., for military purpose, for geological surveys, urban planning; disaster management like floods, landslides, forest fires, exploration of oil or minerals etc.

B. Advantages of Remote Sensing : Following are the advantages of remote sensing :

1. It gives a synoptic overview of the earth surface.
2. The data generated by remote sensing technique, is multi-spectral and have repetitive coverage.
3. It can collect the images and explain the intensity of the disaster and it aerial expansion.
4. This technique can help to collect the information in a little period of time.
5. The data generated by it can be used by multi-disciplines e.g., land use planning, forest development, geological surveys, urban planning, disaster management etc.

C. Limitations of Remote Sensing Techniques :

1. The aerial photographs and the satellite images do not have the facilities to correlate an aerial photograph with the ground.
2. It needs a skilled person to collect to analyse and to map the data.

3. It also includes data processing to extract information for the direct input to Geographic Information System (GIS).

Que 5.2. Explain the general process involved in electromagnetic remote sensing. Differentiate between active and passive remote sensing systems, under what condition each is preferable ?

AKTU 2014-15, Marks 10

Answer

A. Remote Sensing Process : A remote sensing imaging system may be considered to be comprised of following elements as shown in Fig. 5.2.1.

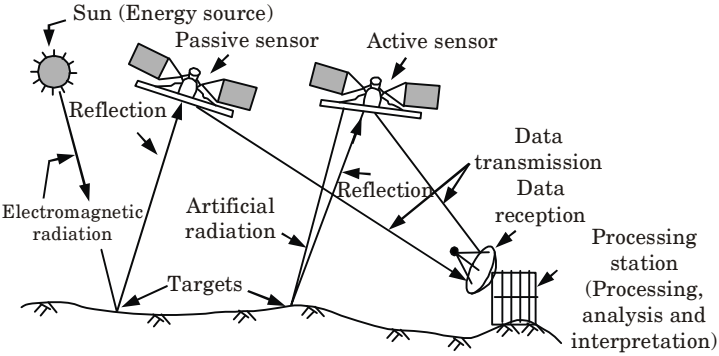


Fig. 5.2.1. Electromagnetic remote sensing process.

1. Energy Source or Illumination : An energy source that provides illumination or electromagnetic energy to the object of interest.

2. Radiation and the Atmosphere :

i. As the energy propagates from the source to the object, it will come in contact with the atmosphere it passes, and will interact with the atmosphere.

ii. The interaction will again take place while travelling back from object to the sensor.

iii. The atmospheric effects are caused through the mechanism of scattering and absorption.

3. Interaction with Earth Surface Features :

i. The energy will interact with the object depending upon the properties of the object and the radiation.

ii. The effects of the interaction of the incident energy with earth surface features may cause the energy to be reflected, transmitted, scattered, absorbed, and emitted.

4. Recording of Energy by the Sensor :

i. The scattered or emitted energy from the object is received, collected and recorded by the sensor.

ii. These are mounted on platforms, which are at a considerable height from the earth surface.

iii. The sensors may be passive or active.

5. Processing : The energy recorded by the sensor is transmitted in electronic form to a receiving and processing station where the data is processed into an image.

6. Interpretation and Analysis :

i. The processed image is interpreted visually and/ or digitally or electronically to extract information about the object which was illuminated.

ii. The information about the object extracted from the image helps to understand it better, reveal some new information, or assist in solving some new problem.

B. Difference between Active and Passive Remote Sensing System :

S. No.	Active Remote Sensing System	Passive Remote Sensing System
1.	A system which utilizes manmade sources of energy for data collection is called an active system.	A system that uses an existing source of energy (e.g. sun ray) is called passive system.
2.	In this, system waves are propagated near the sensor and are bounced on the earth's surface to be recorded on their return.	It simple emitted and reflected radiation from ground surface when the energy source is independent of the recording instrument.
3.	In this system image of landscapes, derived from SLR or SLAR resemble aerial photographs with low angle solar illumination.	In this system without illumination from the sun, no photograph can be taken with a camera.

Que 5.3. **What are the characteristics of ideal remote sensing systems ? How do the real remote sensing systems differ from the ideal requirements ?** **AKTU 2013-14, Marks 10**

Answer

A. Characteristics : Following are the main characteristics of ideal remote sensing system :

1. It has uniform energy source.
2. It contains non-interfering atmosphere.
3. It uses distinct and unique spectral response patterns for every feature.
4. It includes super-sensor.
5. It has real time data acquisition.
6. It includes multiple users.

B. Difference : Following are the difference between ideal and real remote sensing system :

S. No.	Aspect	Ideal Remote Sensing System	Real Remote Sensing System
1.	Energy source	It has uniform energy source, irrespective of time and place.	Energy varies with time, place and objects in ways that cannot be fully predicted.
2.	Atmosphere	It has noninterfering atmosphere that would neither absorb nor scatter electromagnetic energy.	It varies according to latitude, season, time of day, local weather etc.
3.	Spectral response	Each object would have a unique and known spectral response every where on earth surface.	In practical, these may change and cannot always be distinguished.
4.	Sensing system	Sensing system that would be highly sensitive through all wavelength of interest.	No existing sensing system can operate in all wavelength of interest.

Que 5.4. Explain with the help of a neat sketch an idealized remote sensing system. **AKTU 2017-18, Marks 02**

Answer

The ideal remote sensing system comprises of the following :

1. **A Uniform EM Energy Source :** It should provide energy of all wavelengths with uniform intensity at known high level of output irrespective of time and place.
2. **A Non-interfering Atmosphere :** EM energy should propagate through the atmosphere without loss on its way to or back from the target so that the energy does not get modified in the atmosphere. Ideally, it should hold irrespective of wavelength, time, place and sensing altitude.

3. **A Series of Unique Energy (Matter Interactions at the Earth's Surface) :** These interactions generate reflected and emitted signals that are selective with respect to wavelength, invariant and unique to each and every earth surface features type and sub-type of interest.

4. **A Super Sensor :**

i. The sensor (air borne or space borne) should be highly sensitive to all wavelengths and yield spatially detailed data on the absolute brightness (radiance) of the target as a function of wavelength.

ii. The super sensor would be simple, reliable, require virtually no power or space and be accurate and economical to operate.

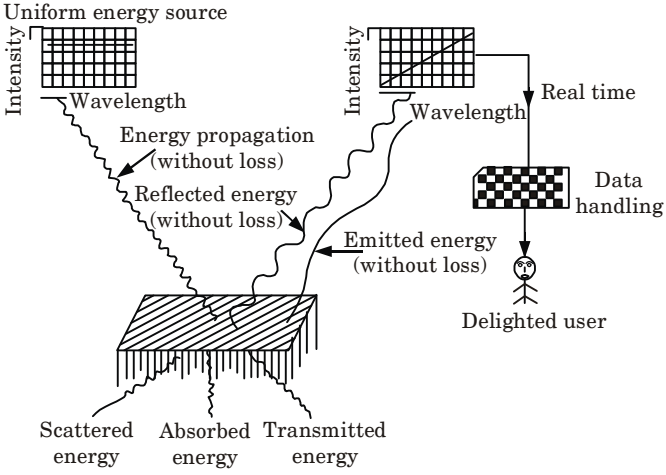


Fig. 5.4.1. Idealized remote sensing system.

5. **A Real Time Data Handling System :** The return signal from the target reaching a sensor is recorded and processed in real time (nearly instantaneously) by the data recorder. The data is then processed into a format useful for interpretation.

6. **Multiple Data Users :**

i. These people would have knowledge of great depth both of their respective disciplines and of remote sensing data acquisition and analysis techniques.

ii. The same set of data would become various forms of information for different users.

7. **Linear Sensor :** A sensor which responds linearly to EM energy of all wavelength.

PART-2

Electromagnetic Spectrum, Atmospheric Effects, Image Characteristics.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 5.5. What do you understand by electromagnetic spectrum ? State the wavelength regions along with their uses for remote sensing applications.

Answer

A. Electromagnetic Spectrum :

1. Visible light is the most obvious manifestation of EM radiation, other forms also exist.
2. EM radiation can be produced at a range of wavelengths and can be categorized according to its position into discrete region which is generally referred to electromagnetic spectrum.
3. Thus the electromagnetic spectrum is the continuum of energy that ranges from meters to nano-meters in wavelength travels at the speed of light and propagates through a vacuum like the outer space.
4. All matter radiates a range of electromagnetic energy, with the peak intensity shifting toward progressively shorter wavelength at an increasing temperature of the matter.

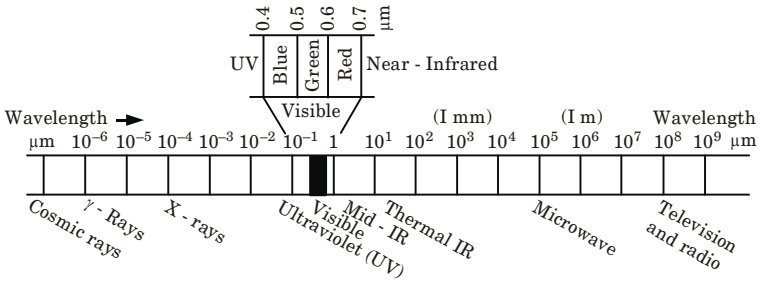


Fig. 5.5.1. Electromagnetic spectrum.

B. Wavelength Regions and their Applications in Remote Sensing :

Table. 5.5.1.

S. No.	Region	Wavelength (μm)	Principal Applications
A.	**Visible Region**		
1.	Blue	0.45 – 0.52	Coastal morphology and sedimentation study, soil and vegetation differentiation, conifers and deciduous vegetation discrimination.
2.	Green	0.52 – 0.60	Vigor assessment of vegetation, rock and soil discrimination, turbidity and bathymetry studies.
3.	Red	0.63 – 0.69	Plant species differentiation.
B.	**Infrared Region**		
4.	Near infrared	0.70 – 1.75	Vegetation, biomass, delineation of water features, landforms/geomorphic studies.
5.	Mid-infrared	1.55 – 1.75	Vegetation, moisture content, soil moisture content, snow and cloud differentiation.
6.	Mid-infrared	2.08 – 2.35	Differentiation of geological materials and soils.
7.	Thermal IR	3.0 – 5.0	For hot targets, *i.e.*, fire and volcanoes.
8.	Thermal IR	10.4 – 12.5	Thermal sensing, vegetation discrimination, volcanic studies.

Que 5.6. Write a short note on atmospheric effects on remote sensing.

Answer

Effects of Atmosphere on Remote Sensing :

i. When electromagnetic radiation travels through the atmosphere, it may be absorbed or scattered by the constituent particles of the atmosphere.

ii. Molecular absorption converts the radiation energy into excitation energy of the molecules.

iii. Scattering redistributes the energy of the incident beam to all directions.

iv. The overall effect is the removal of energy from the incident radiation.

The various effects of absorption and scattering are outlined as follows :

1. Effects of Atmospheric Absorption on Remote Sensing Images :

i. Atmospheric absorption affects mainly the visible and infrared bands. Optical remote sensing depends on solar radiation as the source of illumination.

ii. Absorption reduces the solar radiance within the absorption bands of the atmospheric gases.

iii. The reflected radiance is also attenuated after passing through the atmosphere.

iv. This attenuation is wavelength dependent. Hence, atmospheric absorption will alter the apparent spectral signature of the target being observed.

2. Effects of Atmospheric Scattering on Remote Sensing Images :

i. Atmospheric scattering is important only in the visible and near infrared regions.

ii. Scattering of radiation by the constituent gases and aerosols in the atmosphere causes degradation of the remotely sensed images.

iii. Most noticeably, the solar radiation scattered by the atmosphere towards the sensor without first reaching the ground produces a hazy appearance of the image.

iv. This effect is particularly severe in the blue end of the visible spectrum due to the stronger Rayleigh scattering for shorter wavelength radiation.

Que 5.7. Explain various interactions of incident EM energy with the atmosphere and earth surface.

Answer

A Energy Interaction with Atmosphere : The atmospheric effects are principally caused through the mechanism of atmospheric scattering and absorption.

1. Scattering :

i. Atmospheric scattering is the unpredictable diffusion of radiation caused by the molecules of the gases, dust and smoke in the atmosphere.

ii. Scattering is basically classified as selective and non-selective, depending upon the size of particles with which the electromagnetic radiation interacts.

a. Non-selective Scattering : The non-selective scattering occurs when the diameter of particles with which electromagnetic radiation interacts, is several times (about 10 times) the wavelength. Water droplets, pollen grains, ice and snow crystals, cause non-selective scatter.

b. Selective Scattering : The selective scatter is classified as Rayleigh scatter and Mie scatter. The effect of Rayleigh scatter is inversely proportional to the fourth power of the wavelength. Mie scatter tends to influence the longer wavelengths.

2. Absorption :

i. A part of electromagnetic radiation is absorbed by the molecules of ozone, carbon dioxide and water vapours.

ii. The absorption of radiation occurs in specific wavelength intervals called absorption band and governs the regions of the spectrum to be used in remote sensing.

iii. Wavelengths shorter than 0.3 μm are completely absorbed by the ozone layer in the upper atmosphere which allows life on earth, a prolonged exposure to the intense energy of these wavelengths destroys living tissue.

iv. The aerosol-sized particles of liquid water in clouds absorb and scatter electromagnetic radiation at wavelengths less than about 0.3 μm.

v. Only radiations of microwave and longer wavelengths are capable of penetrating clouds without being scattered, reflected, or absorbed.

B. Energy Interaction with Earth Surface :

1. EM energy that strikes or encounters matter (object) is called incident radiation.

2. The EM radiation striking the surface may be (i) Reflected/Scattered, (ii) Absorbed, and/or (iii) Transmitted.

3. These processes are not mutually exclusive — EM radiations may be partially absorbed. Which processes actually occur depends on the following factors : (i) Wavelength of radiation, (ii) Angle of incidence, (iii) Surface roughness, and (iv) Condition and composition of surface material.

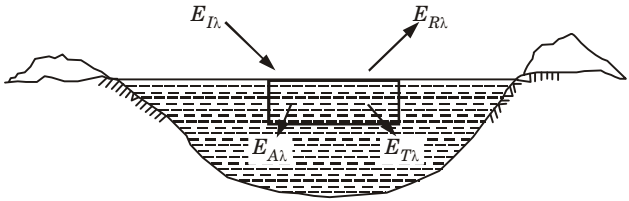


Fig. 5.7.1. Interaction mechanism.

4. Interaction with matter can change the following properties of incident radiation :

i. Intensity.

ii. Direction.

iii. Wavelength.

iv. Polarization.

v. Phase.

PART-3

Remote Sensing Systems, Spectral Signatures and Characteristics Spectral Reflectance Curves.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 5.8. Write a short note on spectral signature.

Answer

Spectral Signature :

1. It is the variation of reflectance or emittance of a material with respect to wavelengths.
2. The spectral signature of stars indicates the composition of the stellar atmosphere.
3. The spectral signature of an object is a function of the incidental EM wavelength and material interaction with that section of the electromagnetic spectrum.
4. The measurements can be made with various instruments, including a task specific spectrometer, although the most common method is separation of the red, green, blue and near infrared portion of the EM spectrum as acquired by digital cameras.
5. Calibrating spectral signatures under specific illumination are collected in order to apply a correction to airborne or satellite imagery digital images.

Que 5.9. Describe the EMR interaction with water, soil and vegetation.

OR

Discuss on the spectral reflectance characteristics of water and vegetation in spectral band. **AKTU 2015-16, Marks 15**

Answer

The EMR interaction with vegetation, soil and water is as follows :

A. Reflectance for Water :

1. Water has low reflectance at the most 10 % while vegetation may reflect up to 50 % and soil 30 – 40 %.
2. Water reflects in the visible and near IR range. Beyond 1.2 μm all energy is absorbed.
3. Turbid (silt laden) water has high reflectance.
4. Water containing plants with chlorophyll have peak reflectance in green wavelength.
5. Longer wave-lengths of visible and near IR radiation is absorbed by water than shorter wavelengths therefore due to reflection of shorter wavelengths, water looks blue or blue green if viewed in visible band and darker if viewed in IR wavelengths due to no reflection.

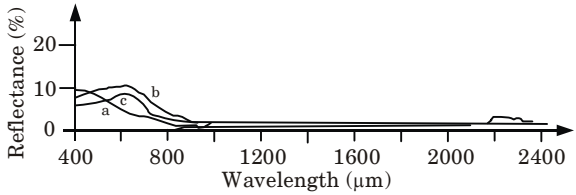


Fig. 5.9.1. Spectral reflectance curve of water.

6. Factors affecting variability of reflectance are depth of water, materials within water and surface roughness of water.

B. Reflectance in Bare Soils : Factors affecting reflectance in soils are (1) moisture content, (2) particle size, (3) organic matter content, and (4) iron oxide content.

1. Moisture Content :

i. Soils have different proportions of sand, silt and clay (particle size 0.05 to 2.0 mm ϕ, 0.002 to 0.005 mm ϕ respectively). Large numbers of particles are present in clay compared to sand.

ii. When moisture is there in clay, each particle will be covered by a very thin layer of water, millions of such particles will hold a large amount of water. Thus particle size and moisture holding capacity of the soils are interrelated.

iii. Fig. 5.9.2 shows typical reflectance curves of study soils with different levels of moisture content. It shows that there are no absorption bands for dry sandy soils.

iv. Moist soils have less reflectance than dry soils (reflectance decreases with presence of water).

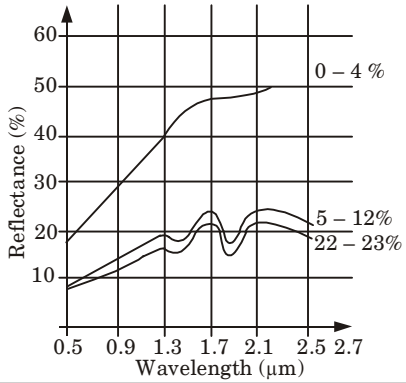


Fig. 5.9.2. Reflectance curves for a sandy soil at different levels.

2. Particle Size :

i. If particle size decreases, soil surface becomes smoother, more of the smoother energy is reflected.

ii. As particle size increases from 0.22 to 2.6 mm increase in absorption is 14 %.

3. Organic Matter :

i. It is an indication of amount and form of nitrogen in the soil organic content varies from 0.5 to 5 %.

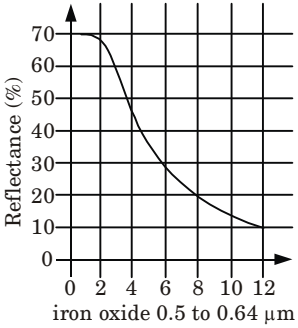
ii. A soil with 5 % organic matter appears dark brown or black in colour and with lower organic content light brown or light grey.

iii. Though this colour depiction with organic matter content changes with climatic and drainage conditions of the soil, which should also be considered.

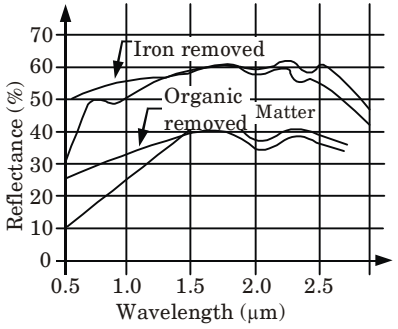
4. Iron Oxide Content :

i. It can cause significant decrease in reflectance in the visible spectrum.

ii. Fig. 5.9.3 shows an excellent inverse relationship between reflectance % and iron oxide in visible region (0.5 to 0.64 μm).



(*a*) Reflectance of iron oxide



(*b*) Influence of iron oxide and organic.

Fig. 5.9.3.

iii. Fig. 5.9.3 shows that removal of iron oxide causes a marked increase in reflectance from 0.5 to 1.1 μm and reflectance is insignificant beyond 1.1 μm.

iv. Removal of organic matter causes a similar marked increase in reflectance over the same wavelengths.

v. In general there is an increasing level of reflectance of dry soils with increase in wavelength.

C. Vegetation :

1. Spectral reflectance curve of vegetation is distinctive.
2. Reflectance is low in blue and red regions of visible spectrum due to two chlorophyll absorption bands centered at 0.4 and 0.65 μm with reflectance peak at 0.5 μm. Chlorophyll absorbs radiation in red and blue wavelengths by reflection.
3. In near infrared region the reflectance is much increased beyond 0.7 μm to 1.3 μm wavelength region and is of the order of 40 – 50 % (absorption 5 %) with reflectance peaks in between.
4. The reflectance from multi-leaf layers is high compared to single leaf layer. With decrease in moisture content of the leaf, the reflectance increases.
5. In middle IR portion, there are water absorption bands at 1.4, 1.9 and 2.7 μm with reflectance peaks at 1.6 and 2.2 μm.

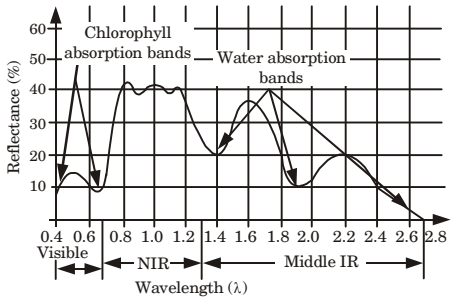


Fig. 5.9.4. Spectral reflectance curve of green vegetation.

6. Thus distinct spectral characteristics of green vegetation are :

i. There are distinct differences in the reflectance amongst visible, near IR and middle IR regions.

ii. In the visible portion pigmentation of leaves is the dominant absorbent.

iii. The internal leaf structure controls the reflectance in the near infrared where half is reflected and half transmitted.

iv. In the middle infrared, the total moisture content in the vegetation controls the reflectance where much of the incident energy is absorbed by the leaves. Green wavelengths leaves appear greenest to us in the summer when chlorophyll content is at its maximum.

v. In autumn, there is less chlorophyll in the leaves so there is less absorption and proportionality more reflection of red wavelengths making the leaves appear red or yellow.

Que 5.10. What do you mean by preprocessing of remote sensing data ? Explain in detail.

Answer

A. Preprocessing :

1. Geometric and radiometric correction in image rectification and restoration is called pre-processing.
2. These are the preliminary to produce a corrected image as close as possible to the original scene.
3. Geometric corrections are required to correct the distortions caused by variation in sensor-earth geometry to make the geometric representation of the image close to accurate representation of the earth.
4. It involves relating the spatial co-ordinates of the image *i.e.*, the column and row co-ordinates of a pixel to the corresponding spatial co-ordinates of the earth *i.e.*, latitude and longitude.

B. Types of Preprocessing : Following are various types of preprocessing :

1. Geometric Correction :

i. It is the process of rectification of geometric errors introduced in the image during the process of acquisition.

ii. The aim is to transform the remotely sensed image to have the scale and projection properties of a map.

iii. The main source of geometric error in satellite data is satellite path orientation (non-polar).

iv. The distortions may be systematic distortions—the effects that are constant, can be predicted in advance, or non-systematic—caused due to various in spacecraft variables, and atmospheric scatter.

2. Radiometric Correction :

i. When the image data contains errors in the measured brightness values of the pixels, it limits the ability of the analyst to visually interpret or quantitatively process and analyse the images.

ii. The potential sources of errors are : periodic drift or malfunctioning of a detector; electronic interference between sensor components; and intermittent disruptions in data transmission and recording.

3. Noise Removal : The unwanted disturbance in image data due to limitations in the sensing, signal digitization or data recording process also required correction in remote sensing.

4. **Georeferencing :** It is the process of assigning real world co-ordinates to each pixel of the raster. It may be applied to any kind of object or structure that can be related to a geographical location.

Que 5.11. **Explain the following :**

A. Atmospheric window.

B. Multi-spectral scanner. **AKTU 2017-18, Marks 04**

OR

Write short notes on (*a*) Multi spectral scanner (*b*) Along and across track scanner.

Answer

A. Atmospheric Windows :

1. The atmosphere transmits its energy through the certain wavelength regions (bands) throughout the entire electromagnetic spectrum.
2. These spectral bands, through which the atmosphere is relatively transparent and has least absorption by water vapour, carbon dioxide and other gases is known as the "Atmospheric window".
3. The atmospheric windows are used for recording the reflected or emitted energy. They are present in the visible spectrum *i.e.*, form 0.4 mm to 0.76 mm of EMR. They are also present in IR and in the microwave regions.
5. Wavelengths less than 0.3 μm are not available for remote sensing because these radiations do not reach the earth and are used or absorbed in upper atmosphere only wavelengths 0.3 μm to 30 cm have atmospheric windows as under :

Ultravoilet	0.3 – 0.4 μm
Visible Near IR	0.4 – 0.7 μm
	1.2 – 1.3 μm
Middle IR	1.5 – 1.8 μm
	2.0 – 2.5 μm
Thermal IR	3.0 – 5.0 μm
	8.0 – 14.0 μm
Microwave	10 mm – 100 mm

B. Multi-spectral Scanner :

1. A multispectral scanner (MSS) simultaneously acquires images in multiple bands of the EMR spectrum. It is the most commonly used scanning system in remote sensing.
2. For example the MSS onboard the first five landsat missions were operational in 4 bands : 0.5-0.6, 0.6-0.7, 0.7-0.8, 0.8-1.1 mm.

3. Similarly, IRS LISS-III sensors operate in four bands (0.52-0.59, 0.62-0.68, 0.77-0.86, 1.55-1.70 mm) three in the visible and NIR regions and one in the MIR region of the EMR spectrum.
4. Airborne or space-borne MSS systems generate two-dimensional image of the terrain beneath the aircraft.
5. Two different approaches are adopted for this : Across-track (whiskbroom) scanning and Along-track (push broom) scanning.

i. Across-track Scanning :

a. Across-track scanner is also known as whisk-broom scanner. In across track scanner, rotating or oscillating mirrors are used to scan the terrain in a series of lines, called scan lines, which are at right angles to the flight line.

b. As the aircraft or the platform moves forward, successive lines are scanned giving a series of continuous narrow strips.

ii. Along-track Scanner :

a. Along-track scanner is also known push-broom scanner.

b. 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.

c. However, along-track scanner does not use any scanning mirrors, instead a linear array of detectors is used to simultaneously record the energy received from multiple ground resolution cells along the scan line.

d. This linear array typically consists of numerous charged coupled devices (CCDs). A single array may contain more than 10,000 individual detectors.

PART-4

Salient Features of Some of Remote Sensing Satellites Missions.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 5.12. Write characteristics of any one satellite with its sensor, band, swath, resolution, altitude and repeativity.

Answer

IRS P6/Resourcesat-1 and Resourcesat-2 :

1. The IRS (Indian Remote Sensing) satellites form a large family of Earth observation satellites operated by the Indian space agency.
2. IRS P6/Resourcesat-1 and Resourcesat-2 ensure continuity of medium and high resolution data supply provided by the twin satellites IRS-1C and IRS-1D. These two, launched in 1995 and 1997 respectively, have completed their missions after more than 10 years of service.
3. Like their predecessors, Resourcesat satellites carry a LISS-III sensor as well as a wide field AWiFS sensor, but the high resolution (5.8 m) LISS-4 sensor replaces the panchromatic sensor.
4. The high resolution data are useful for applications such as urban planning and mapping, while the average resolution is used for vegetation discrimination, land mapping, and natural resources management.

i. **Altitude :** 816-818 km

ii. **Inclination :** 98.6 degrees

iii. **Orbit:** Sun-synchronous polar

iv. **Orbit Period (Repeativity) :** 101 minutes

v. **Revisit Time (LISS-4 et AWiFS) :** 5 days

vi. **Swath Width :** 23.9 km – 70.3 km (LISS-IV) ; 140 km (LISS-III); 740 km (AWiFS)

vii. **Satellites :** IRS-P6/Resourcesat-1 (17/10/2003 – operational)

Resourcesat-2 (20/04/2011– operational)

LISS-III Sensor :

1. The LISS-III (Linear Imaging Self Scanning Sensor) sensor is an optical sensor working in four spectral bands (green, red, near infrared and short wave infrared). It covers a 141 km-wide swath with a resolution of 23 metres in all spectral bands.

Band	Spectral Band	Resolution
2	0.52 - 0.59 μm	23 × 23 m
3	0.62 - 0.68 μm	23 × 23 m
4	0.77 - 0.86 μm	23 × 23 m
5	1.55 - 1.70 μm	23 × 23 m

LISS-IV Sensor :

1. LISS-IV can work either in panchromatic or in multispectral mode with the same bands as LISS-III (except SWIR). However, the resolution is much better (5.8 m).

2. For Resourcesat-1, the swath width varies from 23.9 km in multispectral mode to 70.3 km in panchromatic mode.
3. For Resourcesat-2, the multispectral swath is enhanced to 70 km. The linear array sensor can be steered up to 26 degrees across-track, enabling stereoscopic imaging.

Mode	Spectral Band	Resolution
Panchromatic	0.50 - 0.75 μm	5.8 × 5.8 m

Mode	Band	Spectral Band	Resolution
Multispectral	2	0.52 - 0.59 μm	5.8 × 5.8 m
	3	0.62 - 0.68 μm	5.8 × 5.8 m
	4	0.77 - 0.86 μm	5.8 × 5.8 m

AWiFS Sensor :

AWiFS (Advanced Wide Field Sensor) is an optical sensor with intermediate spatial resolution.

Band	Spectral Band	Resolution
1	0.52 - 0.59 μm	56 × 56 m
2	0.62 - 0.68 μm	56 × 56 m
3	0.77 - 0.86 μm	56 × 56 m
4	1.55 - 1.70 μm	56 × 56 m

Que 5.13. Describe multi-concept in remote sensing. Explain how remote sensing helps in flood related studies.

AKTU 2014-15, Marks 05

AKTU 2017-18, Marks 07

Answer

A. Multi Concept : Multi concept means taking multi images with respect to a particular parameter. The multi concept of remote sensing data consists of the following :

1. **Multi Station Images :** These are successive overlapping pictures along a flight path of an air craft or a space craft for better perception of three dimensional features and improved signal to noise ratio.
2. **Multi Band Images :** When images taken in different wavelength bands are suitably combined, it is possible to unambiguously identify specific terrestrial features.

3. Multi Date Images : Comparative study of images taken on series of different dates can help to identify features since many features exhibit dynamic characteristics.

4. Multi Stage Images :

i. It is obtaining more detailed information from successively smaller sub-samples of the area.

ii. A three step process involving observations from space, aircraft and ground is normally used.

5. Multi Polarization Images :

i. It enables distinguishing objects based on the polarization of the reflected radiation.

ii. Some features like water body may reflect strongly polarized radiation while others like vegetation or fractured rock may reflect weakly polarized radiation.

6. Multi Enhancement Images : These are the composite images generated by combining multi band, multi date and multi polarization images to suitably generate composite images.

7. Multi Disciplinary Analysis : It is analyzing the data by two or more analyst from different disciplines to obtain a more accurate and complete information about the total earth resource of an area. Such multi disciplinary information is usually presented in a set of multi themes.

B. Remote Sensing helps in Flood Related Studies : Following are the areas where remote sensing helps in flood related studies :

1. Planning :

i. GIS is useful in helping with forward planning.

ii. It provides the framework for planners and disaster managers to view spatial data by way of computer based maps.

2. Mitigation :

i. Representation of high risk areas.

ii. Facilitates the implementation of necessary mechanism to lessen the impact.

3. Preparedness :

i. Identification of emergency areas.

ii. Positions of related departments, agencies, and human resources.

iii. Make it easier for security and shelters to plan the strategies.

4. Response :

i. Provide accurate information on exact location of an emergency situation.

ii. Time saving during the determination of trouble areas (quick response).

iii. Used as floor guide for evacuation routes.

Que 5.14. **What are the difference between Geostationary and sun-synchronous satellites ?** **AKTU 2014-15, Marks 05**

Answer

S. No.	Geostationary Satellites	Sun-synchronous Satellites
1.	It is an earth orbiting satellite, placed at an altitude of approximately 35,800 km directly over the equator.	It is a satellite that moving around the earth and always gets its power from the sun.
2.	It remains in geosynchronous orbit, where the object orbits once per day.	It remains in sun-synchronous orbit where the movement of satellite always looks the same when viewed from the sun.
3.	They rotate from west to east.	They rotate from the north pole to south pole and cross all latitudes at the same time.

PART-5

Digital Image Processing : Introduction, Image Rectification, and Restoration.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 5.15. **What do you mean by digital image processing ?**

Answer

Digital Image Processing :

1. The digital image processing is the task of processing and analyzing the digital data using some image processing algorithm.
2. The analysis relies solely upon multispectral characteristic of the feature represented in the form of tone and colour.

Purpose : Digital image processing is done to obtain images close to original geometry of the earth and the brightness values close to radiance from the respective feature.

Operations : The digital image processing has the following broad operations :

1. Image rectification and restoration.
2. Image enhancement.
3. Image classification.
4. Data merging and GIS integration.

Que 5.16. **What is image rectification ? Explain the various types of image rectifications.** **AKTU 2017-18, Marks 07**

OR

Describe the image rectification and restoration.

OR

Describe in brief the radiometric and geometric corrections which are required for rectification of satellite image.

AKTU 2014-15, Marks 10

Answer

A. Image Rectification : It is a transformation process used to project images onto a common image plane. This process has several degrees of freedom and there are many strategies for transforming images to the common plane.

Uses :

1. It is used in computer stereo vision to simplify the problem of finding matching points between images (*i.e.*, the correspondence problem).
2. It is used in geographic information systems to merge images taken from multiple perspectives into a common map coordinate system.

Types : Following are the types of image rectification :

1. Plane Rectification :

i. Rectification requires a projective transformation or homograph of the image plane.

ii. This homograph is associated with the circular points, a pair of Euclidean invariant points imaged on the vanishing line of the plane.

iii. It can be computed from scene constraints. Specifically, we use parallel lines, lines at known orientations, pairs of unknown orientations and known ratios of line lengths

2. Cylindrical Rectification :

i. It is guarantees that the rectified images are bounded for all possible camera motions and minimizes the loss of pixel information along epipolar line.

ii. The processes (e.g., stereo matching, etc.) subsequently applied to the rectified images are thus more accurate and general since they can accommodate any camera geometry.

3. Polar Rectification :

i. It presents a simple algorithm for rectification which can deal with all possible camera geometries. Only the oriented fundamental matrix is required. All transformations are done in the images.

ii. The image size is as small as can be achieved without compressing parts of the images.

iii. This is achieved by preserving the length of the epipolar lines and by determining the width independently for every half epipolar line.

B. Image Restoration :

1. It is the operation of taking a corrupt/noisy image and estimating the clean, original image. Corruption may come in many forms such as motion blur, noise and camera miss-focus.
2. Image restoration is performed by reversing the process that blurred the image and such is performed by imaging a point source and use the point source image, which is called the Point Spread Function (PSF) to restore the image information lost to the blurring process.

C. Radiometric Corrections :

1. Radiometric corrections may be due to variations in scene illumination and viewing geometry, atmospheric conditions, and sensor noise and response.
2. Each of these will vary depending on the types of sensor and platform used to acquire the data, and the environmental conditions during data acquisition.
3. Sometimes, it may be desirable to convert and/or calibrate the data to known (absolute) radiation or reflectance units to facilitate comparison between different dates.

D. Geometric Corrections : All remote sensing imageries are inherently subject to geometric distortions. These distortions may be due to several factors such as :

1. The perspective of the sensor optics.
2. The motion of the scanning system.
3. The motion of the platform.
4. The platform altitude, attitude, and velocity.
5. The terrain relief.
6. The curvature and rotation of the earth.

Que 5.17. What is a satellite image ? Write short note on characteristics and formats of satellite image.

AKTU 2016-17, Marks 05

OR

Enumerate and explain the various digital image data formats.

AKTU 2017-18, Marks 05

Answer

A. Satellite Image :

1. A satellite image is an image of the whole or part of the earth taken using artificial satellites.
2. These images have a variety of uses, including cartography, military intelligence and meteorology.
3. Satellite images can either be visible light images, water vapour images or infrared images.

B. Characteristics : Following are the satellite image characteristics :

1. Spatial Resolution :

i. It is the size of a pixel in ground dimensions.

ii. A 30 m size represents a square ground dimension of 30 m × 30 m.

iii. It also means number of pixel per inch length of the image.

2. Spectral Bands :

i. Bands mean which wavelengths (colours) images have been captured and bandwidth means the "range of colours" imaged.

ii. Number of bands determines how many colours are imaged. Two most likely colour modes are RGB (Red, green and blue) colour for colour images and grey scale for black and white (B/W) images.

3. Radiometric Resolution :

i. The number of shades of one colour in which the data has been imaged.

ii. A bit is a single binary digit and represents only one of the two numbers.

iii. A one bit image can show only two shades.

4. File Format : There are several file formats in which the data can be stored. These are :

TIFF : Tagged Image File Format.

JPEG : Joint Photographic Expects Group.

GIF : Graphic Interchange Format.

PDF : Portable Document File.

EPS : Encapsulated Post Script.

5. File Size :

i. It depends upon number of pixels in the image, spectral bands, radiometric resolution and the file formats and is measured in bytes (8 bits), kilobytes (1024 bytes), mega bytes (1024 kilo bytes).

ii. File size of a 1200 × 1500 pixel image in 8 bits or 1 byte would be 18,00,000 bytes.

C. Formats : Digital remotely sensed data of a multispectral image is organized in following three data file interleaving formats :

1. Band Interleaved by Pixel (BIP) :

i. In this format, the data for same one pixel is organized one after the other for different spectral bands in the same line.

ii. The data is written for first pixel band 1, first pixel band 2, first pixel band 3 and so on, in one line as adjacent numbers followed by second pixel for all bands in the same pattern, second pixel for all bands and so on.

iii. This format provides information how the reflectance of the same pixel varies in different spectral bands.

2. Band Interleaved by Line (BIL) :

i. In this format, data of different pixels in sequence for the spectral band is arranged in one row, for the same pixels for another spectral band in second row, for the third band in third row and so on.

ii. This form facilitates observance of difference between radiance properties of adjacent pixels in different bands.

3. Band Sequential (BS) :

i. Data for each pixel sequentially for first spectral band is arranged together in different lines one after the other. Then for second band below it for each pixel in same sequence and so on.

ii. This format provides information how a scene looks like in a particular spectral band and can be used to generate colour image output bandwise.

iii. Fig. 5.17.1 is shows the data acquired for nine pixels in multi (four) bands along with how this data will be arranged under different formats.

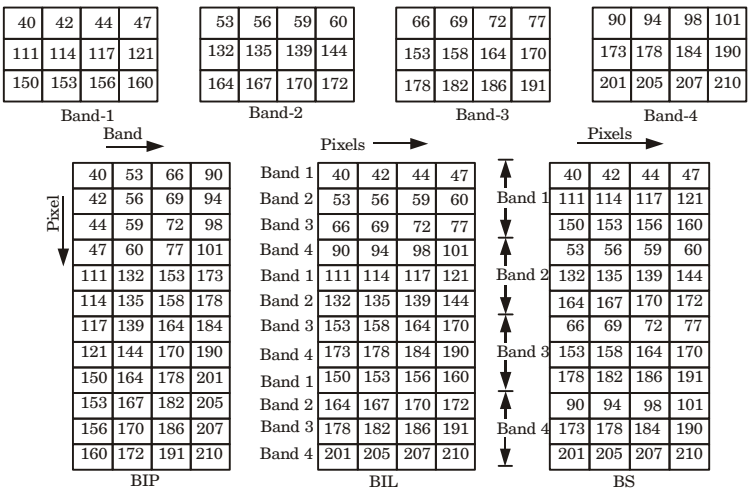


Fig. 5.17.1.

4. Other popular formats are Geo TIFF (Geo Tag Image File Format), Hierarchical Data Formats (HDF) which is used to store digital images and formats.

Que 5.18. Elaborate the relative advantages of using aerial photos and satellite images over products of conventional survey.

AKTU 2015-16, Marks 10

Answer

A. Advantages of Aerial Photos :

1. Aerial photos provide a current pictorial view of the ground that a map cannot.
2. It is more readily obtained. The photograph may be in the hands of the user within a few hours after it is taken; a map may take months to prepare.
3. It may be made for places that are inaccessible to ground soldiers.
4. It shows military features that do not appear on maps.
5. It can provide a day-to-day comparison of selected areas, permitting evaluations to be made of enemy activity.
6. It provides a permanent and objective record of the day-to-day changes with the area.

B. Advantages of Satellite Images :

1. Satellite images show the intensity, speed and direction of storms or more accurate details about the weather conditions in any given location.
2. By observing a satellite image, the forecaster can see what changes are taking place within the storm system over a period of time. If the storm is intensifying or breaking apart, changing directions, speeding up or slowing down, this will all become apparent in real time satellite images.
3. A satellite image can also help forecasters to determine the severity of the approaching storm. They can forecast heavy showers or snow storms, or light rain or flurries.

PART-6

Image Enhancement, Image Transformation, Image Classification.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 5.19. What do you understand by image enhancement ? List any four changing operations. Describe linear contrast enhancement process. **AKTU 2016-17, Marks 05**

OR

An image from satellite is obtained which have the DN values in a narrow range. How would the quality of this image be enhanced ? Explain the methods.

Answer

A. Image Enhancement :

1. After geometric and radiometric corrections, the image is still not fit for visual interpretation.
2. Image enhancement is improving the appearance of the image to make its interpretation and easier understanding.
3. After restoration (geometric and radiometric corrections) the remotely sensed data is processed to enhance the features of special interest. For it the original digital values are changed.
4. The advantage of digital imagery is that it allows manipulating the digital values of a pixel in the image on a computer.

Methods : Following are the methods of contrast enhancement :

1. Linear contrast enhancement method—Min-max stretch.
2. Linear contrast enhancement method—Percentile stretching.
3. Non-linear contrast enhancement—Histogram equalization method.
4. Spatial filtering.

1. Linear Contrast Enhancement (Min-Max Stretch) :

i. In this method, lower value of the original histogram is assigned zero bright level and the upper value a brightness level of 255.

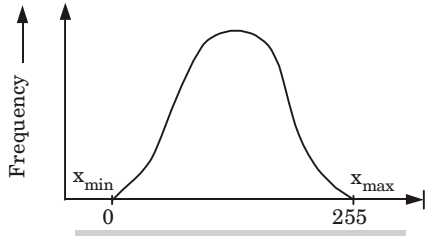


Fig. 5.19.1. Original histogram.

ii. Intermediate brightness levels are assigned new values by linear interpolation as under :

$$x_{new} = \frac{x_{in} - x_{min}}{x_{max} - x_{min}} \; x_r$$

Where, x_r = Range of brightness scale (0 – 255 for 8 bits data),
x_{in} = Original brightness value of the pixel, and
x_{min} and x_{max} = Minimum and maximum value of the original data.

iii. It produces a good contrast in the image but there is loss of contrast at the lowest and highest brightness values.

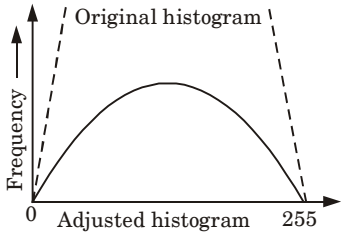


Fig. 5.19.2. Linear contrast enhancement—min-max stretch.

iv. The lower value areas become lighter and higher value areas become darker which leads to loss of information in these areas.

2. Linear Contrast Enhancement (Percentile Stretching) :

i. If the start and end of a histogram have very low frequency of the pixels as shown in Fig. 5.19.3, there is little improvement in the image under min-max stretching.

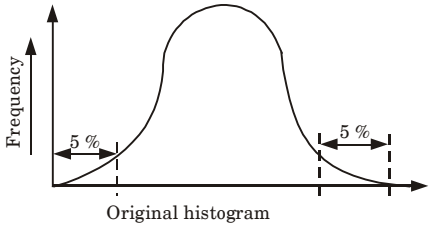


Fig. 5.19.3.

ii. Under such conditions 2 %, 5 %, ... of the data at the two ends of the histogram, where frequency of pixels is low, are curtailed and the remaining portion is stretched as min-max stretching.

iii. It decreases the slope of the histogram. It is not necessary that same percentage be curtailed at the two ends of the histogram.

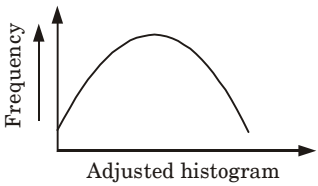


Fig. 5.19.4. Linear contrast enhancement-percentile stretching.

Que 5.20. Differentiate between restoration and enhancement of remote sensing image. **AKTU 2014-15, Marks 05**

Answer

S. No.	Restoration	Enhancement
1.	It is an objective process.	It is a subjective analysis.
2.	It involves the process to manipulate the image in order to take the psychophysical advantage of human being.	It involves modeling of degradation in image and applies some mechanism to get image back.
3.	Removing of blurring from an image by applying deblurring filter is an image restoration process.	Contrast stretching is an image enhancement technique.

Que 5.21. Describe image transformation.

Answer

1. Image transformation generates new images from two or more sources which tend to highlight particular features or properties of interest, better than the original input images.
2. Basic image transformations use simple arithmetic operations such as addition, subtraction, division and multiplication to the image data.
3. In image subtraction, two geometrically registered images acquired at two different dates are subtracted pixel by pixel to yield a new image called as the difference image.
4. In these new images, areas where there has been little or no change are represented in mid-grey tones, while those areas where significant change has taken place, and are shown brighter or darker tones depending on the direction of change in reflectance between the two images.
5. This type of image transformation can be useful for mapping growth of cities, deforestation, crop acreage, etc. Hence image subtraction is also known as change detection.
6. Image addition is basically an averaging operation, in order to reduce the overall effect of noise. It is very commonly used in spatial filtering to enhance features the overall effect of noise. It is very commonly used in spatial filtering to enhance features.
7. Image multiplication of two real images is rarely performed in remote sensing.

8. Image division or spectral ratioing is one of the most common transforms applied to image data.
9. It serves to highlight subtle variations in the spectral responses of various surface covers. By ratioing the data from two different spectral bands, yields useful information regarding the objects.
10. Healthy and green vegetation reflects strongly in the near-infrared portion of the spectrum while absorbs strongly in the visible red. Other types of surface, such as soil and water, show near equal reflectance in both the near-infrared and red portions.

Que 5.22. Explain in detail land use/land cover classification system. **AKTU 2014-15, Marks 10**

OR

What do you understand by Land use/Land Cover classification ? Explain. **AKTU 2016-17, Marks 07**

Answer

Land Cover :

1. This is the physical condition of ground surface – forest, grassland, water bodies, mountains, rocks, barren land, ice, snow, tundra etc.
2. These features may be natural, manmade or combination of the two. These are directly observable by remote sensing.

Land Use :

1. This is the human employment of land e.g., industrial area, residential area, agricultural fields, commercial, recreation, rural, urban, oil extraction or a combination of many activities.
2. Inferences about land use can often be made from land cover on the basis of ancillary (auxiliary) data and prior knowledge.

Land Cover/Land Use Classification System :

1. It is important to identify land use/land cover as per a classification scheme such as USGS (United States Geological Survey).
2. Anderson's classification is one of the best and most widely applied systems.
3. The classification system is in three levels. Level I divide total land use and land cover types into nine types. Level II divides level I division into its sup-types. Level II is further divided into its types at level III. Each level is assigned a number.
4. The nine level-I divisions are as under :

i. Urban or built-up (100) e.g., villages, towns, cities, highways and similar structures.

ii. Agriculture (200) e.g., crops, orchards, pastures.

iii. Range lands (300) *i.e.*, land covered by natural grasses, shrubs and forbs (non-woody plants such as weeds and flowers). These support native or domesticated grazing animals.

iv. Forest lands (400) : Forest produce timber and other wood products. These are also essential for balanced environmental conditions.

v. Water (500) : This includes natural and manmade water bodies which support aquatic life.

vi. Wet lands (600) : Wet lands are areas where water table is at near or above the land surface for a significant part of the year e.g. marshes, tidal flats, mud flats.

vii. Barren land (700) : These are surface with thin soil, sand or rock.

viii. Tundra (800) : These are treeless regions due to presence of permafrost and subfreezing temperatures most of the year.

ix. Perennial snow or ice (900) : There are the areas where snow and ice persists throughout the year e.g., snow fields and glaciers.

5. Level - II classification for urban and built-up are : 110-Residential, 120-Commercial, 130-Industrial, 140-Transportation, 150-Communication and utilities, 160-Institutional, 170-Recreational, 180-Mixed, 190-Open land and other.

6. Level III classifications of 170-Recreational are : 171-Golf courses, 172-Parks and Zoos, 173-Marinas, 174-Stadiums, fairgrounds and race-tracks.

Necessity :

1. Land cover and land use monitoring is necessary to have a consistent view of the stock and state of our natural and built resources for their management, development, planning sustainable development protection of natural resources.

2. It also helps to get an idea of change in land use pattern, intensity of change, developing strategies to balance conservation.

Que 5.23. Write a note on image classification. Discuss supervised and unsupervised classification. **AKTU 2014-15, Marks 05**

OR

What do you understand by image classification ? Differentiate between supervised and unsupervised classification.

AKTU 2017-18, Marks 07

Answer

A. Image Classification :

1. The objective of image classification is to categorize all pixels in an image into land cover classes or themes.

2. Image classification is sorting pixel into finite number of individual classes based on their DN values in a spectral band.
3. Each homogeneous group belongs to a particular land cover type or feature e.g., water coniferous trees, deciduous forests, corn, wheat etc., and is essentially a thematic map of the original image.

B. Classification Procedures : Common classification procedures are :

1. Supervised Classification :

i. First the information class is specified on the image. The selection of information classes is based on the analyst familiarity with the geographical area and knowledge of the actual surface, cover types present in the image as if the analyst is supervising the categorization of a set of information classes.

ii. Information classes are termed as "training areas". The DN values of all spectral bands comprising the information class is used to train the computer to recognize spectrally similar areas for each class.

iii. The computer uses algorithms to determine the "class signatures" of each "training area".

iv. Now the computer compares each pixel in the image to these spectral signatures and labeled to the class it closely resembles digitally.

2. Unsupervised Classification :

i. Broadly speaking it reverses the supervised classification process. Spectral classes are grouped first based on DN values and then matched to information classes.

ii. In it the algorithm examines the pixels and aggregates them into number of spectral classes (clustering algorithm).

iii. Number of groups or clusters to be looked in the data is decided by the analyst.

iv. The analyst may also specify parameters related to the separation distance amongst the clusters and the variation within each cluster.

v. Finally the analyst may decide to combine some clusters or breakdown others.

vi. Unsupervised classification does not start with a predetermined set of classes as in supervised classification.

Que 5.24. What are temporal images ? Why these are used in remote sensing ? Explain with a suitable example, which cannot be carried out without the use of temporal images.

Answer

Temporal Image : Temporal means related to time. Therefore temporal images are images of the scene acquired at a particular time.

Uses of Temporal Images in Remote Sensing :

1. Remote sensing data provides essential information that helps in monitoring various applications such as image fusion, change detection and land cover classification.
2. Remote sensing is a key technique used to obtain information related to the earth's resources and environment. As we know temporal images are images of the scene acquired at a particular time. The time to take one image is dependent on the actual applications. If the application is to develop a soil map, the image should be taken in the off-growing season.
3. Similarly, mapping crop residue for conservation practices also uses imagery acquired in off-season. On the other hand, if the purpose is for crop monitoring, the remote sensing imagery should be obtained from the growing season. Hence temporal image is generally used in remote sensing for change detection.

Example :

1. For crop monitoring the remote sensing imagery should be obtained from the growing season. It is helpful for proper yield estimation and management if the temporal relationship between image and yield could be identified. Since the variation of crop spectral reflectance during the growing season can be used to relate to yield, it could help growers to estimate yield during the growing season.
2. Furthermore in-seasonal image data acquisition might need to occur many times to better understand the growth pattern and in-field variability.

Que 5.25. What are the essential differences between a raw, standard and geo-coded imagery ? Which are most suitable in terms of geometric quality ?

Answer

1. **Raw Data :** The data received from a sensor has certain flaws and discrepancies due to variation in sensor-earth geometry, platform altitude, altitude and velocity, earth curvature and rotation and atmospheric effects, is raw data.
2. **Standard Data :** When this data is corrected for distortions by establishing between image co-ordinates and map co-ordinates and by correcting the bright value of each pixel as close as possible to the original reflectance of the feature it becomes standard data.
3. **Geo-coded Data :** When the data is derived from conventional (non digital) map or image or the original data is in analog form and it is converted to digital form suitable for use by a computer is geo-coded data.

Suitability : Standard data and geo-coded data are most suitable in terms of geometric quality.

PART-7

Application of Remote Sensing to Civil Engineering.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 5.26. Explain the various applications of remote sensing.

AKTU 2014-15, Marks 05

Answer

Following are the applications of remote sensing :

1. Agriculture :

i. Early season estimation of total cropped area.

ii. Monitoring crop condition using crop growth profile.

iii. Identification of crops and their coverage estimation in multi-cropped regions.

iv. Crop yield modeling.

v. Cropping system/crop rotation studies.

vi. Command area management.

vii. Detection of moisture stress in crops and quantification of its effect on crop yield.

2. Forestry :

i. Improved forest type mapping.

ii. Monitoring large scale deforestation, forest fire.

iii. Monitoring urban forestry.

iv. Forest stock mapping.

v. Wild life habitat assessment.

3. Land Use and Soils :

i. Mapping land use/cover (level III) at 1 : 25000 scale or better.

ii. Change detection.

iii. Identification of degraded lands/erosion prone areas.

iv. Soil categorization.

4. Geology :

i. Lithological and structural mapping.
ii. Geo morphological mapping.
iii. Ground water exploration.
iv. Drainage analysis.
v. Mineral exploration.
vi. Coal fire mapping.
vii. Oil field detection.

5. Urban Land use :

i. Urban land use level IV mapping.
ii. Updating of urban transport network.
iii. Identification of unauthorised structures.

6. Water Resources :

i. Monitoring surface water bodies frequently and estimation of their spatial extent.
ii. Snow-cloud discrimination leading to better delineation of snow area.

7. Coastal Environment :

i. More detailed inventory of coastal land use on 1:25000 scale.
ii. Discrimination of coastal vegetation types.
iii. Monitoring sediment dynamics.

8. Ocean Resources :

i. Wealth of oceans / explorations / productivity.
ii. Potential fishing zone.
iii. Coral reef mapping.

9. Environment :

i. Impact assessment on vegetation, water bodies.
ii. Loss of biological diversity / biosphere reserves / ecological hot spot areas / wet land environment.

10. Natural Resources Based Applications :

i. Management of wild and scenic rivers, recreation resources, flood plains, wet lands, agricultural lands, aquifers, forest, wild life etc.
ii. Environmental Impact Analysis (EIA).
iii. View shed analysis.
iv. Hazardous or toxic facility siting.
v. Ground water modeling and contamination tracking.
vi. Wild life analysis, migration routes planning.

11. Disasters :

i. Mapping flood inundated area, damage assessment.
ii. Disaster warning mitigation.

VERY IMPORTANT QUESTIONS

Following questions are very important. These questions may be asked in your SESSIONALS as well as UNIVERSITY EXAMINATION.

Q. 1. Write short notes on (*a*) Multi spectral scanner (*b*) Along and across track scanner.

Ans. Refer Q. 5.11, Unit-5.

Q. 2. Describe multi-concept in remote sensing. Explain how remote sensing helps in flood related studies.

Ans. Refer Q. 5.13, Unit-5.

Q. 3. What are the difference between Geostationary and sun-synchronous satellites ?

Ans. Refer Q. 5.14, Unit-5.

Q. 4. What is image rectification ? Explain the various types of image rectifications.

Ans. Refer Q. 5.16, Unit-5.

Q. 5. What is a satellite image ? Write short note on characteristics and formats of satellite image.

Ans. Refer Q. 5.17, Unit-5.

Q. 6. What do you understand by image enhancement ? List any four changing operations. Describe linear contrast enhancement process.

Ans. Refer Q. 5.19, Unit-5.

Q. 7. Differentiate between restoration and enhancement of remote sensing image.

Ans. Refer Q. 5.20, Unit-5.

Q. 8. Explain in detail land use/land cover classification system.

Ans. Refer Q. 5.22, Unit-5.

Q. 9. Write a note on image classification. Discuss supervised and unsupervised classification.

Ans. Refer Q. 5.23, Unit-5.

Q. 10. Explain the various applications of remote sensing.

Ans. Refer Q. 5.26, Unit-5.