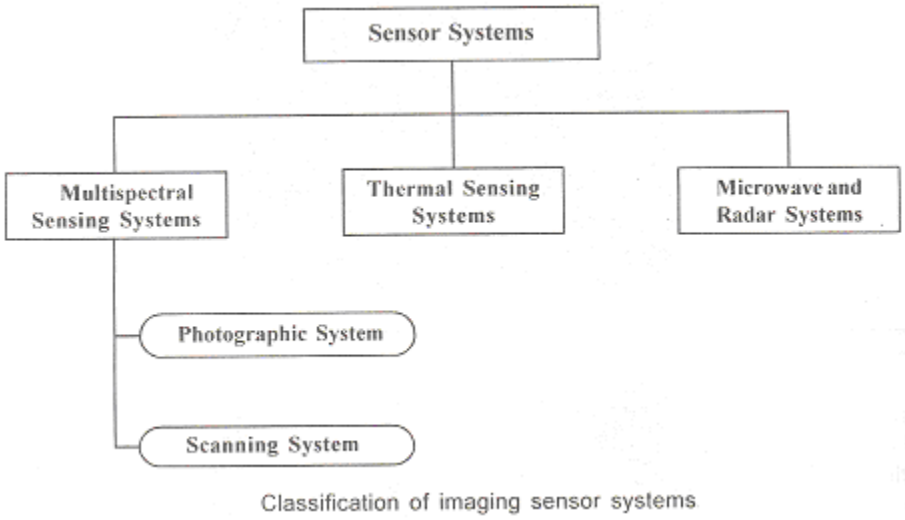
is given. Practical information for the implementation of the wavelet transform, the multi resolution analysis, and the ARSIS concept by practitioners is given with particular relevance to SPOT and Landsat imagery.

7. a. Classify and describe the imaging sensor systems.
b. Write the characteristics of Landsat satellites and their sensors. (8+8)

Answer:
(a): Various components of sensor systems operating in the visible, infrared, thermal and microwave regions of the electro magnetic spectrum are described in this section. Although analogue photographic imagery has many advantages, this book is mainly concerned with image data collected by scanning systems that ultimately generate digital image products. It is apparent that the useful wavebands are mostly in the visible and the infrared for passive remote sensing detectors and in the radar and microwave region for active type of sensors. Accordingly the imaging sensor systems in remote sensing are classified as shown in fig.



Classification of imaging sensor systems

Broadly, all the imaging sensor systems are classified based on technical components of the system and the capability of the detection by which the energy reflected by the terrain features is recorded.

The classification scheme is
(a) Multi spectral imaging sensor systems
(b) Thermal remote sensing systems, and
(c) Microwave radar sensing systems.

The multi spectral or multi band imaging systems may use conventional type cameras or a combination of them, along with filters for the various bands in the visible part in the scanning system of multi band imaging. This way electromagnetic energy can be recorded by scanning the ground bit by bit. In some instances, both photographic and

scanning systems like Return Beam Vidicon sensor of Landsat which is almost similar to an ordinary TV camera are used.

(b): Characteristics of Land Sat satellites and their sensors:

Satellite Capabilities:		
Particulars	Landsat- 1 to 3	Landsat – 4 & 5
Altitude	919 Km	705 Km
Orbit	Near-Polar Sun-synchronous	Near-Polar Sun-Synchronous
Inclination	99.09 degree	98.2 Degrees
Period	103 minutes	99 minutes
Equatorial crossing time	0930 Hours	0945 Hours
Repeat Cycle	18 Days	18 Days
Swath Width	185 km	185 Km
Data rate	15.06 Mbps	84.9 mbps

Sensor Capabilities:

Sensor	**Mission**	**Channel**	**Spectral Spatial Resolution (Microns)**	**Spatial Resolution**	**Radiometric Resolution**
RBV	Landsat 1 to 3	1 2 3 4	0.475-0575 0.580-0.680 0.690-0.830 0.505-0.750	80 m 80 m 80 m 80 m	6 bits (127 levels)
MSS	Landsat 1 to 5	1 2 3 4 5	0.5-0.6 0.6-0.7 0.7-0.8 0.8-1.1 10.4-12.6	79/82 m* 79/82 m* 79/82 m* 79/82 m* 240 m	6 bits (127 levels)
TM	Landsat 4 & 5	1 2 3 4 5 6 7	0.45-0.52 0.52-0.60 0.63-0.69 0.76-0.90 1.55-1.75 2.08-2.35 10.4-12.5	30 m 30 m 30 m 30 m 30 m 30 m 120 m	8 bits (255 levels)

*The Spatial Resolution is 79 m for Landsat-1, 2 &3. It is 82 m for Landsat 4 & 5.

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UNIT-IV

1. List various image enhancement techniques and explain each in detail.

Answer:
Two main concerns for any document imaging exercise are the image quality and the file size. Anyone will need to get the best possible image quality while keeping the file size to a minimum for obvious reasons. Thus image enhancement has become an essential step in a well defined capture workflow. The purpose of image enhancement (image cleanup / image processing) is to make the images more readable, and also to remove unwanted noise reducing the storage requirements. This is especially important for forms processing / OCR applications in order to improve character recognition. There are number of image enhancement techniques available today. Described below are 8 such image processing techniques.

1. Deskewing:
In a production scanning set up, document pre-processing is the most time consuming step. One objective of this step is to arrange the documents correctly by rotating (incorrectly filed documents) and aligning them together. The De-skew facility in production capture applications helps to reduce this effort by automatically de-skewing misaligned images. The De-skew process can straighten pages which were misaligned during the document feeding process, within a specified range of degrees.

A more advanced feature is available with Kofax VRS called content based rotation. VRS can analyze the content of the image and correct the orientation accordingly.

Here is a nice illustration called “The Effects of Deskewing a Document” in ScanHelp.com

2. Black border cropping & removing:
Cropping refers to the removal of the outer parts of an image. In document scanning, black border cropping is one technique that is used to remove the unnecessary black colour borders from an image. Border cropping removes black borders from the image completely also resulting in the reduction of image height and width. However this does not reduce the resolution of the image. (This is an Illustration of border cropping).

The other technique is to replace the black coloured pixels in the borders with white colour pixels which is called black border removal. Unlike cropping this does not reduce the image size.

3. De-speckling / Noise reduction:

When scanning old documents we usually get unwanted dots (speckles) in the background. This could be in two forms; black speckles in a white background as well as white speckles in a black background. This is also known as Salt and pepper noise. (This is an example for an image with salt and pepper noise)

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Whatever the form, this affects the image compression and increases the file size. De-speckling (also known as noise reduction) is the process of removing such unwanted speckles from the image background. (Illustration : noise removal)

4. Colour drop out:
Colour dropout is a proven useful technique for forms processing applications such as census projects. The idea is to discard the text boxes and lines of a scanned image. This will increase the recognition rate of OCR. Earlier scanners used specific colored lamps to achieve this. (eg : Blue Imaging Color Drop-Out Element for Kodak 9520/9500). Now this has been improved and is achieved by software.

Colour drop out accuracy directly depends on the printing quality of the forms. Only selected colors (shades of red, blue and green) can be dropped, which depends from scanner to scanner. Therefore it is essential to use the recommended color pantone (e.g. : Fujitsu PANTONE Dropout Confirmation Listing) for printing the forms.

This is a very informative article on color drop-out by the Document Doctor.

5. Thresholding:
Thresholding is a technique used when scanning grayscale images and saving as Black & white. A grayscale image will have 16 bits per pixel (representing 65,536 shades of gray) and a black & white image will have 1 bit per pixel (representing either black or white). When converting from grayscale to black & white (example: scanning a photograph in black & white mode), each pixel having a different shade of gray should be converted in to either black or white. This point of separation is called the threshold. By changing the threshold value the output image quality will change

As shown in the above illustration this is a fixed thresholding, which is ideal for separating solid colors (e.g.: text) from background. However for images with various shades of gray a advanced version of thresholding called adaptive thresholding is used. In adaptive thresholding the threshold value is calculated independently from pixel to pixel based on the contrast. Different scanner manufacturers and capture applications have come up with many different technologies and algorithms on this such as Kodak ithresholding developed on Adaptive Threshold Processing - ATP)

6. Line Removal:
Line removal is a very useful feature especially for OCR applications. This feature is used to remove unwanted lines from scanned images. These lines could be either actual content or noise. Most application forms such as credit cards, account opening etc.. consist of text boxes. Although such lines are actual content of the document, they interfere in the character recognition process hence are unwanted. Also when scanning documents that are folded or when scanning fax copies, there is a high possibility of getting unwanted horizontal lines in the scanned image. These lines, especially vertical ones can interfere in the OCR process. Also if there are any texts that intersect with

these lines, they appear as broken in the scanned image resulting in incorrect text recognition.

When line removal is used, these unwanted lines will not be included in the scanned image resulting in a clean image optimized for character recognition. Also characters that are broken due to horizontal lines will be corrected. Further line removal will also reduce the image size.

7. Punch Hole filling:
When filed documents having punched holes are scanned, most of the images will show these holes as black spots. In addition to the distracted appearance of the image, this results in two main problems. First is If the file contains large number of documents and the left margin is not adequate, these black spots could interfere with the actual content of the document. The second issue is that having such black spots in blank pages could interfere with the automatic blank page deletion, since they could be recognized as actual content. Earlier these black marks were removed manually which required lot of time and effort. With the advancement of image processing applications such as Kofax VRS, this can be now automated. This feature will change the color of such black spots with the surrounding image color. Most such applications take in to consideration the dimensions and locations of such black spots and compare with the different manufacturer specifications and standards.

8. Blank Page Deletion

Blank page deletion is useful when scanning in duplex mode where some documents contain information in both sides of the document as it requires the scanner operator to manually delete the blank pages. Automatic blank page deletion will delete the pages based on a threshold value (in bytes) specified. When a page size is less than the threshold value specified, it is considered as a blank page and will be automatically deleted. Selecting this value depends on the document type and the scanner being used and usually done after some testing with few experimental values. For blank page removal to be effective, it is essential to use some of the features described above such as black border removal, de-speckling, line removal and punch hole filling.

A common issue faced when using blank page deletion is the bleed-through effect, where content in one side of the paper appearing in the other side of the page, especially in very thin papers. Because of this the blank page is mistakenly recognized as having actual content. Advanced capture applications such as Kofax VRS, tries to address this by differentiating actual content and bleed through.

2. a. Write the various definitions of GIS.
b. Write short notes on applications areas for GIS. (8+8)

Answer:
(a): Various definitions of GIS given by various organizations are as follows:

→ A geographic information system, commonly referred to as a GIS, is an integrated set of hardware and software tools used for the manipulation and management of digital special (geographic) and related attribute data.

→ A geographic information system (GIS) is computer-based tool for mapping and analyzing things that exist and events that happen on earth. GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps.

→ GIS is an integrated system of computer hardware, software, and trained personnel linking topographic, demographic, utility, facility, image and other resources data that is geographically referenced.

→ A geographic information system (GIS) is a computer-based information system that enables capture, modelling, manipulation retrieval, analysis and presentation of geographically referenced data.

(b): Application areas for GIS: Major areas of GIS application can be grouped into five categories as follows.

Facilities Management:
Large scale and precise maps and network analysis are used mainly for utility management. AM/FM is frequently used in this area.

Environment and Natural Resources Management:
Medium or small scale maps and overlay techniques in combination with aerial photographs and satellite images are used for management of natural resources and environmental impact analysis.

Street Network:
Large or medium scale maps and spatial analysis are used for vehicle routing, locating house and streets etc.

Planning and Engineering:
Large or medium scale maps and engineering models are used mainly in civil engineering.

Land Information System:
Large scale cadastre maps or land parcel maps and spatial analysis are used for cadastre administration, taxation etc.

The following table summarizes the major areas of GIS applications

Major areas of GIS applications:

Areas	GIS Applications
Facilities Management	locating underground pipes & cables planning

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	facility maintenance telecommunication network services energy use tracking & planning
Environment and Natural Resources Management	Suitable study for agricultural cropping management of forests, agricultural lands water resources, wetlands etc. Environmental impact analysis disaster management and mitigation waste facility site location.
Steel Network	Car navigation (route & scheduling) locating houses and streets site selection ambulance services transportation planning
Planning and Engineering	Urban planning Regional planning Route location of high ways
Land information System	Cadastre administration Taxation Zoning of land use Land acquisition

3. a. Write the advantages and benefits of GIS.
b. What are the basic requirements for GIS. (8+8)

Answer:
(a): In theory, all GIS processes can be undertaken manually. Before GIS, analysis procedures would have been manually undertaken using transparent overlays or run through very slow and cumbersome machines with far less power than the machines of today. The essential advantage of modern GIS, however, is that all the functionality for working with multiple sets of geographic information are grouped and automated within one piece of software. In addition it benefits from modern computer efficiency and speed.

Overall, the use of modern GIS offers many advantages over paper maps**:**

1. Can cope with larger amounts of data.

2. Can cover large study areas (the whole world if necessary).

3. Can conveniently select any sub-study area.

4. Can cope with unlimited and frequent edits and changes.

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5. More robust and resistant to damage.

6. Faster and more efficient.

7. Requires less person time and money.

(b): Basic requirements of GIS: The architecture of distributed GIS a dramatic departure from the web mapping applications. In interactive web mapping, although client-side applications such as Java applets and Achive X controls offer much interactivity between the user and the graphic user interface, the variations of CGI or different CGI extensions at the server side are simply Band-Aid solutions for distributed GIS. From a technical perspective, the middle ware with CGI and its extensions between the web client and the map server cannot provide a truly distributed GIS. To quality as true distributed GIS, a system has to have the following characteristics:

1. It is composed of distributed components; each component has its own functions. For example, a buffer is a component, a “point in polygon” overlay is another component, and so on.

2. The component is distributed. That is, the components could reside in different computers or GIS nodes but interact directly with each other computers on demand.

3. The components is mobile. Although components reside in different computers, they can be retrieved and downloaded into other computers on demand.

4. The components are open and interoperable. Once the components migrate to other computers, they can be assembled and interoperated with other components that may be downloaded from yet another computer. To be interoperable, the components have to be constructed according to standards.

5. The components are searchable and mechanisms are available to purchase and use the components from service providers. A service catalog is needed to advertise the availability and functions of all components.

6. Data are distributed. Distributed GIS can access any data repository is provided to connect distributed GIS data on the Internet.

7. Data are interchangeable. This means that data from different sources can be interchanged. Mechanisms are needed to integrate data with different special reference systems, different semantics, and different formats.

4. a. Explain the components of GIS.
b. Write the important terminology of GIS. (8+8)

Answer:

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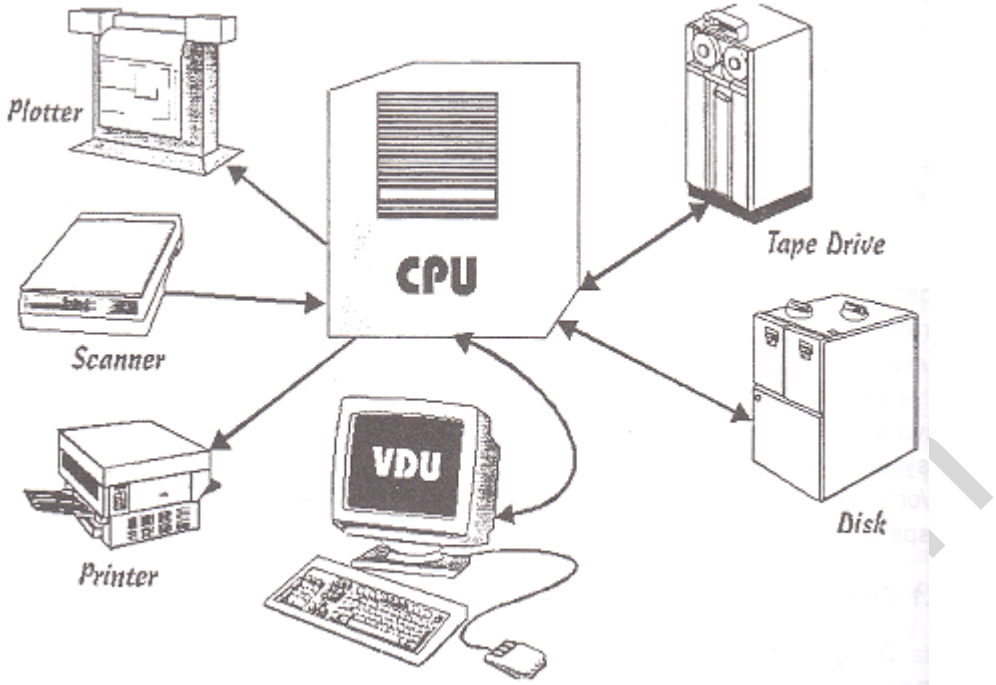
(a): Components of GIS:



Hard ware components of GIS

Geographical Information Systems have three important components, namely, computer hardware, sets of application software modules, and a proper organizational setup. These three components need to be in balance if the system is to function satisfactorily. GIS run on the whole spectrum of computer system ranges from portable personal computers to multi-user super computers, and are programmed in a wide variety of software packages. Systems are available that use dedicated and expensive work stations, with monitors and disitising tables built in. In all cases, there are a number of elements that are essential for effective GIS operations. These include

(i) the presence of a processor with sufficient power to run the software

(ii) sufficient memory for the storage of large volumes of data

(iii) a good quality, high resolution color graphics screen and

(iv) data input and output devices, like digitisers, scanners, keyboards, printers and plotters.

The general hardware components of a GIS include control processing unit which is linked to mass storage units, such as, hard disk drives and tape drives, peripherals such as digitizer or scanner, printer or plotter and Visual Display Unit (VDU). Fig shows the major components of GIS.

(b): Terminology of GIS: GIS are decision support computer based systems for collecting, storing, presenting and analyzing geographical special information. These systems are spatially referenced databases giving users the potentiality to control queries over space, and usually through time. GIS is much more advanced than Computer Aided Design (CAD) or any other special data system. The basic output of GIS or special data analysis system is a map. The need to analyze maps to compare and contrast patterns of earth relates phenomena, is confirmed by the long standing tradition of doing so with traditional maps.

Many geographical phenomena are best described scientifically as fields. Good examples are topographic elevations, air temperatures, and soil moisture content. A 2-D field may be defined as any single valued function of location in a 2-D space and discrete fields, with nominal dependent variables. It appears that any geographical phenomenon can be represented either as a field or as a collection of digital objects. For example, a set of states or revenue or administrative units like mandals with in a country would commonly be represented in a GIS as a set of area objects or a set of linear objects that from their boundaries. Fields can be digitally represented by vector approaches, but are often represented by data structures.

5. a. Write the architecture and work flow of GIS.
b. Write the four M's concept of GIS. (12+4)

Answer:
(a): GIS Architecture: According to the definition proposed by Marble and Peuquet (1983), GIS deals with space-time data, and often but not necessarily, employs computer hardware and software. GIS can be understood as the subsystem nature within the framework of a main system. According to these investigators, GIS has the following generic subsystems:

(i) A data input subsystem which is also called data capture subsystem

(ii) A data storage and retrieval subsystem

(iii) A data manipulation and analysis subsystem

(iv) A reporting subsystem.

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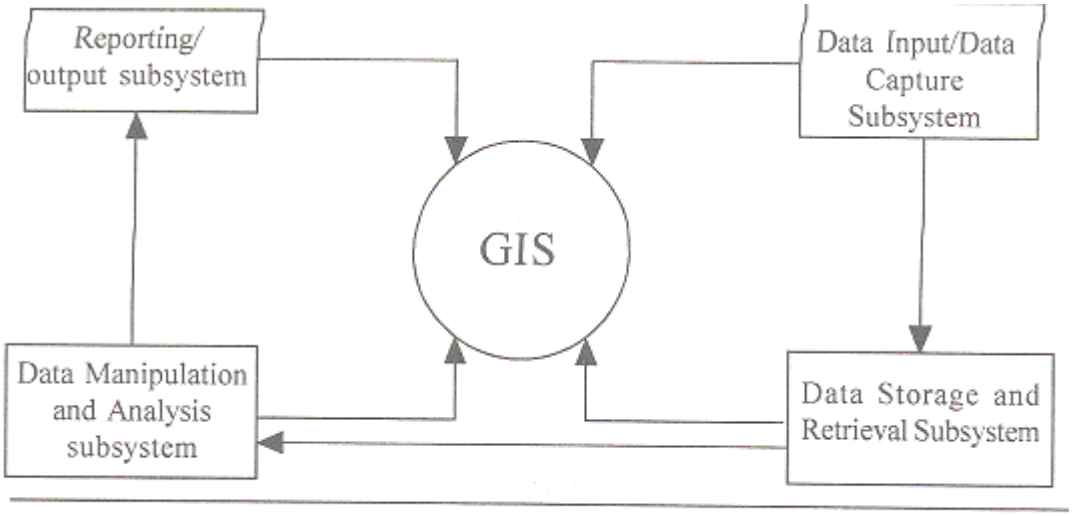
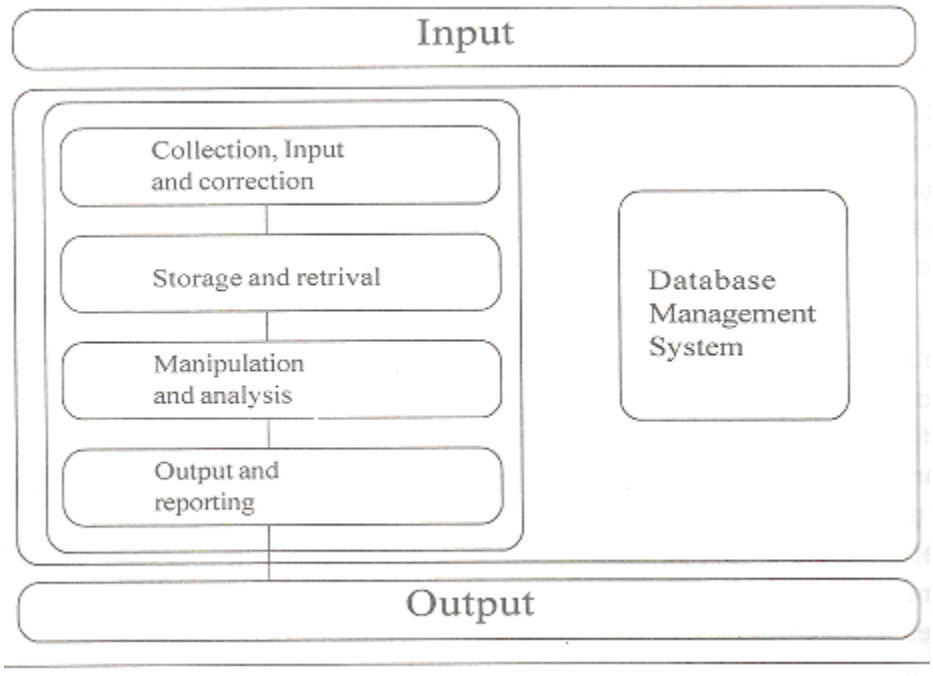


Subsystem nature of GIS (structural prespective).

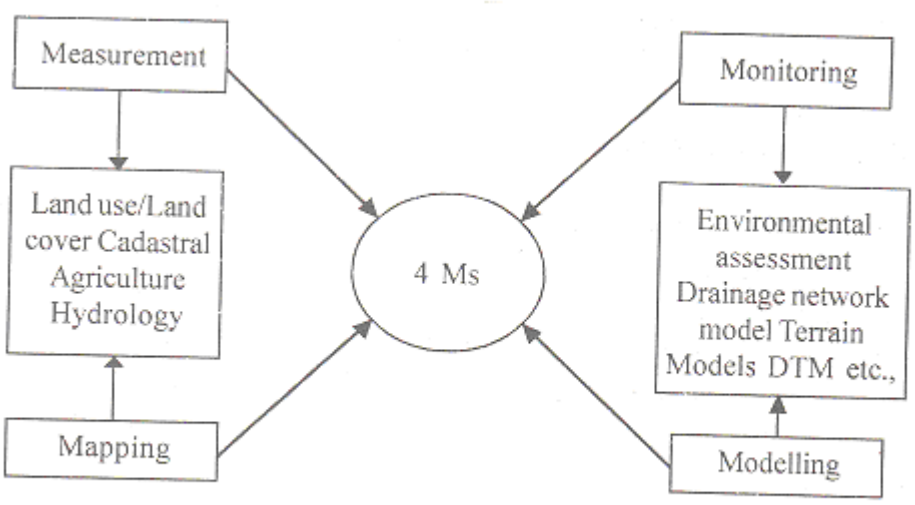
Each of the subsystems has been described in terms of functions that the respective subsystem performs. The data input/capture subsystem provides operational functions for acquiring data. The data management or data storage and retrieval subsystem stores and retrieves the data elements, The manipulation and analysis subsystem handles the transformation of data from one form to another derivation of information from the data. The fourth subsystem output/reporting subsystem provides away for the user to see the data in the form of diagrams, maps, and or tables. Fig shows the architecture of all subsystems of GIS from a structural perspective.

Work flow of GIS:



Workflow process of GIS (Procedural perspective)

(b):



Schernatic representation of Four Ms: Measurment, Mapping, Monitoring and Modelling.

There are mainly four key activities that any urban planners or scientists or resource managers and others use geographic information for. They observe and measure environmental parameters and develop maps which portray characteristic of the earth. They monitor changes in our surroundings in space and time. In addition, they model alternatives of actions and process operation in the environment. These, four activities are Measurement, Mapping, Monitoring and Modeling termed as key activities which can be enhanced by the using information systems technologies through GIS. Fig explains those four Ms.

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1. (a) Explain spatial data and non spatial data with suitable example

(b) List out some of the major international GIS vendors.

Answer:

(a): Spatial Data: A spatial characteristic rule is a general description of a set of spatial related data. For example, the description of general weather patterns in geographic regions is a spatial characteristic rule. A spatial discriminant rule is the general description of contrasting or discriminating features of a class of spatial related data from other classes. For example, the comparison of the weather patterns in two geographic regions is a spatial discriminant rule.

Lu, Han and Ooi (1993) first developed a generalization-based method to discover the characteristic and discriminant rules from the spatial data. The method extracts the general knowledge in two different ways: non-spatial data dominated generalisation and spatial data dominant generalization.

Non Spatial Data: The non-spatial data dominated generalization algorithm creates maps consisting of regions that share the same high-level nun-spatial descriptions. It realizes this by merging the neighboring areas with the same generalized non-spatial attributes. In contrast, a spatial data dominant generalization algorithm focuses first on the spatial data. It partitions the regions and merges them based on the hierarchy of spatial data attributes. In the end, it creates maps consisting of areas that share the same spatial descriptions.

Although the generalization-based approach could find some interesting patterns from the spatial databases, the discovery process depends very much on the availability of the hierarchies of the data. Further, the quality and the interesting-ness of the discovered patterns ore also influenced greatly by the fineness and

appropriateness of the given hierarchies of data.

(b): No answer.

2. Explain the following advanced tools of GIS analysis along with suitable examples

(a) Proximity analysis

(b) Spatial operation

(c) Terrain analysis

(d) Network analysis

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