UNIT 2 RECENT TRENDS IN GEOINFORMATICS

Structure

2.1 INTRODUCTION

You have been introduced to the concepts of geoinformatics and its components in Unit 1. Now, you have got an idea of its diverse applications and potential. Though geoinformatics has been in use since long in the areas of forestry, agriculture, utilities, urban planning, mining, etc., it was restricted to selected government departments, space research centres and universities.

Geoinformatics technology is now beginning to pervade all aspects of our daily life, and there is a perceptible change in the way we look at the technology as we are beginning to come to terms with it and understand its vast potential. Its value and potential is now being appreciated even by every person. Technology is gaining ground because of the huge benefits it offers, particularly, in terms of time and cost effectiveness. However, with the spread of the technology in a variety of application areas, the related technologies are constantly evolving and a variety of developments are taking place.

In this unit, you will study about recent trends and developments taking place in various fields of geoinformatics at the global level.

Objectives

After studying this unit, you should be able to:

- discuss about developments in the fields of remote sensing;
- list out the advancements in the field of photogrammetry;
- point out recent developments and trends in the field of GIS;
- list out the recent developments and trends in the field of GPS; and
- elaborate upon the recent trends in geoinformatics education.

2.2 TRENDS IN REMOTE SENSING

In this section, you will be introduced to the developments and recent trends in the field of remote sensing. Remote sensing methods had been in use in some form or other since long but with the launch of Sputnik in 1957 by Russia, research and development activities in the field got a boost. Since then, there have been a number of significant developments in this field.

Remote sensing data are the main source of geospatial data and input to Geographic Information System. Recent developments in remote sensing technology have enhanced our data acquisition capability in several aspects. Some of the notable developments are as following:

- enhanced capability to acquire information of smaller objects (i.e. spatial resolution)
- enhanced capability to acquire information in different wavelengths and in many number of bands (spectral resolution)
- increased capability to acquire data for a variety of parameters and spheres of the Earth system such as atmosphere, hydrosphere and lithosphere
- enhanced capability to extract information more accurately from variety of remote sensing data using automated or semi-automated methods.
- increased capability to apply the derived information for a variety of applications for the biosphere
- from multipurpose satellite mission to application specific sensors and satellites.

Developments in remote sensing can broadly be categorised into technology and application domains. The technological developments can again be classified into the areas of data acquisition and data interpretation techniques. One good example is the acquisition of remote sensing data from space shuttles. USA based Johnson Space Centre maintains a database of large amount of data acquired during the manned space shuttle flights. Because of the developments in data acquisition technologies, remote sensing data are now available in volumes larger than what is actually being analyzed by data analysts.

Developments in computing technologies have enabled data accessibility and availability to a large number of researchers and users. This has also resulted in development of algorithms which are able to derive information from a variety of remote sensing data acquired from different data acquisition platforms without much human interaction and intervention. This information is also becoming more accurate. Increased number of parameters, which we can derive from remote sensing data has also enabled us to apply it in a variety of application areas.

In the initial years, there were satellites, the data from which were used for land, coastal areas and ocean. In the recent times, application specific missions are being launched. One of the examples is the GRACE (Gravity Recovery and Climate Experiment) gravity gradient sensor mission that measures minute changes in Earth's gravity field to pinpoint localised variations in the planet's density. The GRACE mission is being executed by NASA (National Aeronautics and Space Agency) of USA in collaboration with Germany. Another example is the Jason mission by NASA in partnership with France, which employs a radar altimeter to measure sea surface height to a global average of within 5 cm of its actual value.

You have read in Unit 1 (subsection 1.3.5) that remote sensors are classified as optical microwave sensors because their detection mechanisms are quite different. These are further subdivided into passive or active types. These are further subdivided into optical and microwave sensors. The active or passive sensors could be categorised as either imaging, like the camera, or non-imaging, like the radiometer. Examples of optical sensors are photographic cameras, Multi-Spectral Scanners (MSS), Linear Imaging Self Scanning (LISS) sensors, etc., in passive category and LIDAR (Light Detecting and Ranging) in active category. Active microwave sensors are Synthetic Aperture Radar (SAR), Side Looking Airborne Radar (SLAR), Radar Altimeter, etc., and the passive instruments are called Microwave Radiometers.

LIDAR is an optical remote sensing technology that can measure a distance to or other properties of a target by illuminating the target with light often uses pulses from a laser.

Infrared (IR) light is electromagnetic radiation with a wavelength longer than that of visible light, measured from 0.74 µm, and extending upto to 300 µm.

Developments in remote sensing technologies have resulted in different kinds of data acquisition methodologies which are known as panchromatic remote sensing, multispectral remote sensing, hyperspectral remote sensing, etc. In the following sub-sections, we will discuss about the kinds of remote sensing and their related developments.

Shortwave refers to upper medium frequency and the entire high frequency portion of the radio spectrum, between 1,800–30,000 kHz.

2.2.1 Optical Remote Sensing

Let us now look at the different types of remote sensing in more detail!

Optical remote sensing makes use of visible, near infrared and short-wave infrared sensors to form images of the Earth's surface by detecting the solar radiation reflected from targets on the ground. Optical remote sensing systems are classified into the following types, depending on the number of spectral bands used in the imaging process.

Spectral band is the finite segment of wavelengths in electromagnetic spectrum.

You will study about many of the satellites and sensors mentioned in the text in Unit 6 *Major Space Programmes* of MGY-002 *Remote Sensing and Image Interpretation.*

Panchromatic imaging systems: This sensor is a single channel detector sensitive to radiation within a broad wavelength range resulting into a black and white image (Fig. 2.1). The physical quantity being measured is the apparent brightness of the targets. The spectral information of the target is lost.

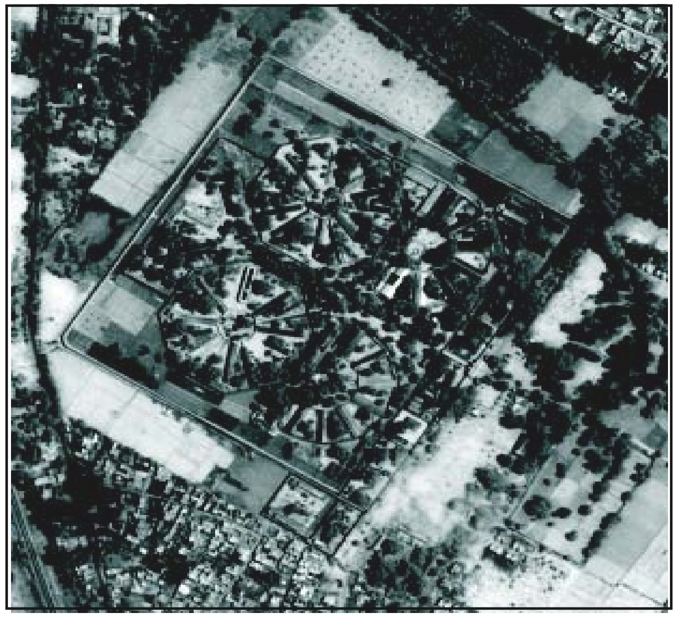


Fig. 2.1: A panchromatic image of a part of Allahabad acquired by Cartosat 2B PAN sensor (source: www.nrsc.gov.in/imagegallery.html)

Examples of satellites carrying panchromatic imaging systems are as follows:

- Cartosat
- QuickBird
- WorldView
- GeoEye

Multi-spectral imaging systems: This kind of sensor is a multi-channel detector with a more than one spectral band and generally 3 to 7 bands. The resulting image is a multi-layer image which contains both the brightness and spectral information of the targets observed (Fig. 2.2). Examples of multi-spectral systems are:

- QuickBird MSS
- GeoEye MSS
- IKONOS MSS

Fig. 2.2: A multispectral image of part of Riyadh as acquired by Quick bird satellite (source: www.satimageingcorp.com)

Superspectral imaging systems: Superspectral imaging sensor has many more spectral channels (typically >10) than a multi-spectral sensor. The bands have narrower bandwidths, enabling the finer spectral characteristics of the targets to be captured by the sensor (Fig. 2.3). Examples of superspectral systems are:

- MODIS
- MERIS

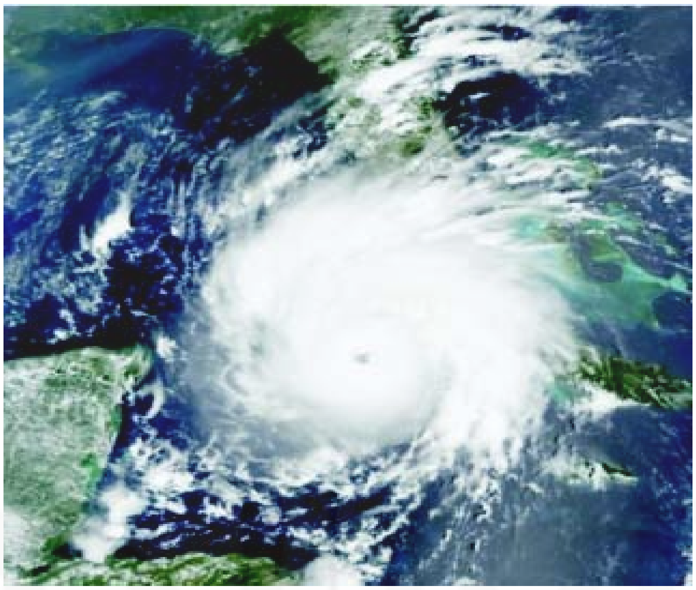


Fig. 2.3: Image of hurricane from a super-spectral imaging system (source: http://disc.sci. gsfc.nasa.gov/hurricane/additional/image-gallery/archive/2008/Hurr_Gustav_ 2008-08-31-MODIS.gif)

Hyperspectral imaging systems: A hyperspectral imaging system is also known as an "***imaging spectrometer***". It acquires images in about a hundred or more contiguous spectral bands (Fig. 2.4). The precise spectral information contained in a hyperspectral image enables better characterisation and identification of targets. Hyperspectral images have potential applications in fields such as precision agriculture (e.g. monitoring the types, health, moisture status and maturity of crops), coastal management (e.g. monitoring of phytoplanktons, pollution, bathymetry changes).

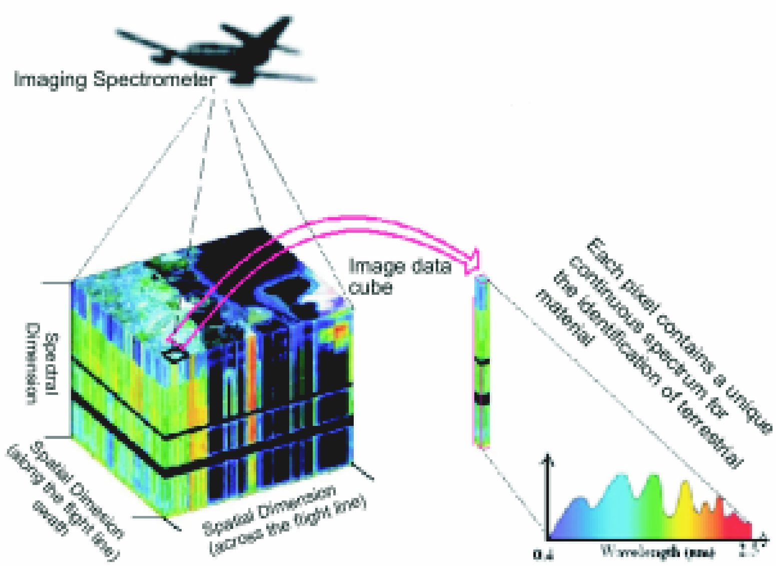


Fig. 2.4: Concept of hyperspectral remote sensing

Hyperspectral remote sensing, also known as ***imaging spectroscopy***, is relatively a new technology that is currently being investigated by researchers and scientists with regard to the detection and identification of minerals, terrestrial vegetation, and man-made materials and backgrounds.

Imaging spectroscopy has been used in the laboratory by physicists and chemists for over 100 years for identification of materials and their composition. Recently, with advancing technology, imaging spectroscopy has begun to focus on the Earth. The concept of hyperspectral remote sensing began in mid eighties and since then it has been used most widely by geologists for the mapping of minerals. Hyperspectral remote sensing combines imaging and spectroscopy in a single system which often includes large data sets and requires new processing methods (Fig. 2.5).

There are many applications which can take advantage of increased spectral information provided by hyperspectral remote sensing.

- **Atmosphere:** water vapor, cloud properties, aerosols
- **Ecology:** chlorophyll, leaf water, cellulose, pigments, lignin
- **Geology:** mineral and soil types
- **Coastal Waters:** chlorophyll, phytoplankton, dissolved organic materials, suspended sediments
- **Snow/Ice:** snow cover fraction, grain size, melting
- **Biomass Burning:** sub pixel temperatures, smoke
- **Commercial:** mineral exploration, agriculture and forest production.

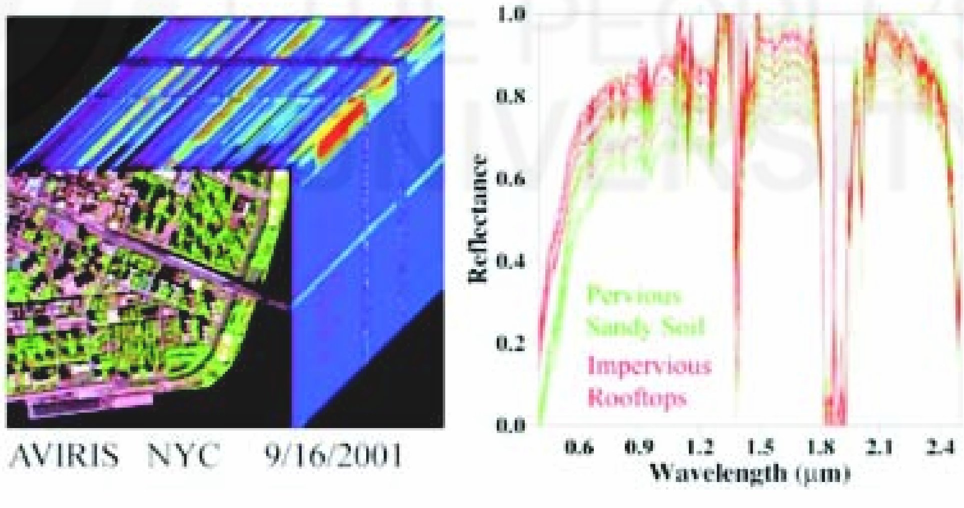


Fig. 2.5: Image data cube and spectral response pattern of different materials as obtained from a hyperspectral remote sensing image (source: www.ldeo.columbia.edu/~small/Urban/UrbanHyperspectral.htm)

Microwave radiometer is such a device, which responds to the extremely low levels of microwave energy emitted and/or reflected from ambient sources (such as the sun) by terrain features.

2.2.2 Microwave Remote Sensing

You have already read that microwave portion of the spectrum i.e. 1cm to 1 m in wavelength is used to acquire the remote sensing information. Longer wavelength microwave radiation can penetrate through cloud cover, haze, dust, etc. This property allows detection of microwave energy under almost all weather and environmental conditions so that data can be collected at any time.

Passive microwave sensing is similar in concept to ***thermal remote sensing***. A passive microwave sensor detects the naturally emitted microwave energy within its field of view. Applications of passive microwave remote sensing are used in the fields of meteorology, hydrology, and oceanography.

Active microwave sensors provide their own source of microwave radiation to illuminate the target. Active microwave sensors are generally divided into two distinct categories: imaging and non-imaging. The most common form of imaging active microwave sensors is RADAR. RADAR is an acronym for Radio Detection And Ranging, which essentially characterizes the function and operation of a radar sensor (Fig. 2.6). This image shows RADARSAT's ability to distinguish different types of bedrock. The light shades on this image (C) represent areas of limestone, while the darker regions (B) are composed of sedimentary siltstone. The very dark area marked A is Bracebridge Inlet which joins the Arctic Ocean.

You will study about many of the satellites and sensors mentioned in the text in Unit 6 *Major Space Programmes* of MGY-002 *Remote Sensing and Image Interpretation.*

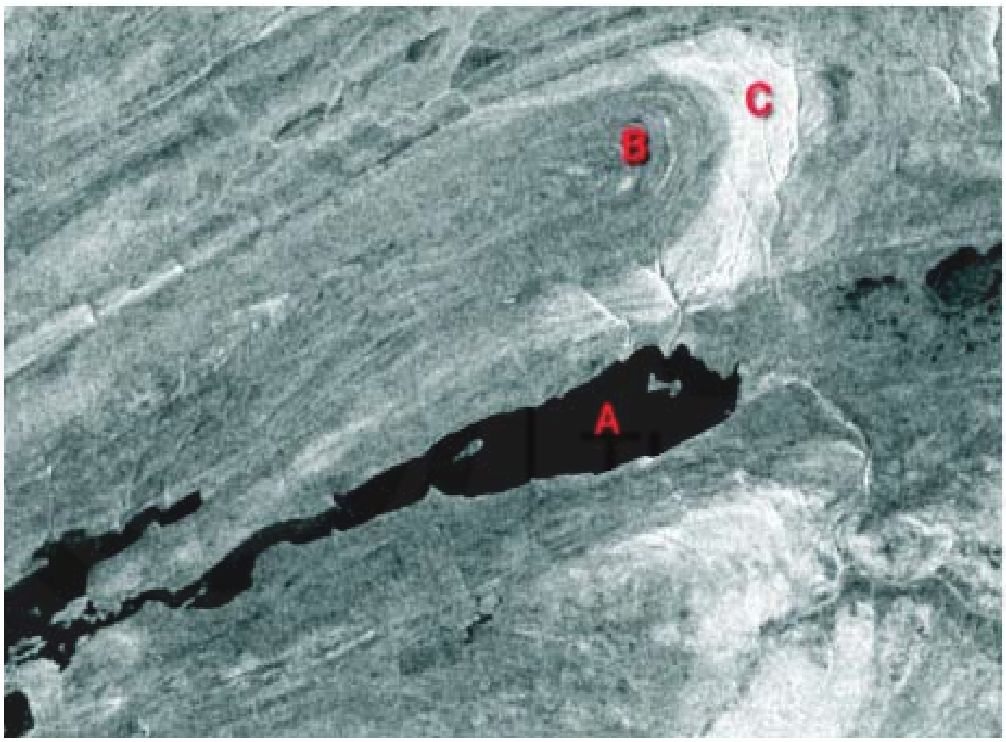
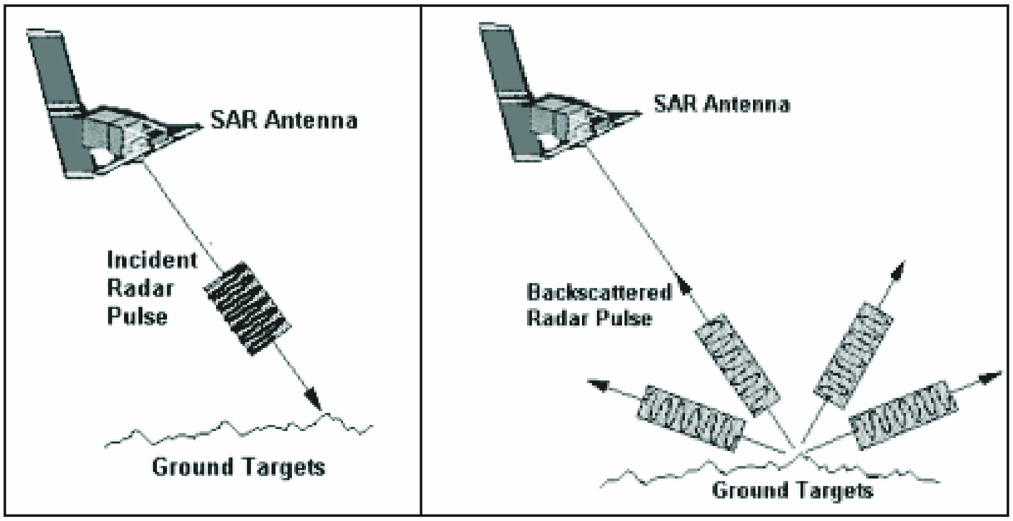


Fig. 2.6: Radarsat image acquired on March 21, 1996, over Bathurst Island in Nunavut, Canada (source: www.racurs.ru/?page=151)

Non-imaging microwave sensors include altimeters and scatterometers. Generally, altimeters look straight down at nadir below the platform, and thus measure height or elevation. Scatterometers are used to make precise quantitative measurements of the amount of energy backscattered from targets. Seasat-1, ERS-1, ERS-2, ENVISAT-1, JERS-1, RADARSAT-1, etc. are the examples of satellites carrying microwave sensors.

Nadir is the direction pointing directly below a particular location

Another development is the Synthetic Aperture Radar (SAR) imaging, in which microwave pulses are transmitted by an antenna towards the Earth surface. The microwave energy scattered back to the spacecraft is measured (Fig. 2.7). The SAR makes use of the radar principle to form an image by utilising the time delay of the backscattered signals.



(a) (b)

Fig. 2.7: Illustration showing the concept of SAR imaging; a) A radar pulse is transmitted from the antenna to the ground, b) The radar pulse is scattered by the ground targets back to the antenna

2.2.3 Thermal Remote Sensing

Thermal remote sensing is the branch of remote sensing that deals with the acquisition, processing and interpretation of data acquired primarily in the thermal infrared (TIR) region of the electromagnetic (EM) spectrum. In thermal remote sensing, we measure the radiations 'emitted' from the surface of the target, as opposed to optical remote sensing where we measure the radiations 'reflected' by the target under consideration. Thermal remote sensing, in principle, is different from remote sensing in the optical and microwave region. In practice, thermal data prove to be complementary to other remote sensing data. It is unique in helping to identify surface materials and features, such as rock types, soil moisture, geothermal anomalies, etc. The ability to record variations in infrared radiation has advantage in extending our observation of many types of phenomena in which minor temperature variations may be significant in understanding our environment.

There are limitations of thermal imagery. It can be very expensive to acquire and process thermal data as most thermal imaging systems have strict operational/technical parameters, such as detector materials. Thermal infrared imaging systems are difficult to calibrate because temperature differences can be very subtle and interactions with atmospheric moisture are unpredictable. Thermal images of water measure only the very top layer of the water surface because those wavelengths are attenuated/absorbed very rapidly, especially in water.

Spend 5 mins

Check Your Progress I

1) Optical remote sensing systems are classified on the basis of the number of .... used in the imaging process.

2) What are the different types of optical remote sensing systems?

....

....

3) Microwave remote sensing has been divided into .... and .... remote sensing.

2.3 TRENDS IN PHOTOGRAMMETRY

We introduced the term *photogrammetry* in Unit 1, which is a technique of making measurements, such as coordinates, distance, area or volume, etc. with the help of photographs. In some cases, photogrammetric techniques are the only possible way of such measurements. Photogrammetry has proved to be a cost-effective and better method for mapping a large area than surveying on the ground. It enables the users to capture elevation information from stereo-pairs of aerial photographs/ satellite images and generate orthophotos/images (vertical photographs/ images) and thematic maps.

You will read about orthophotos in detail in Unit 6 *Remote Sensing Data and Formats* of MGY-001

Photogrammetry is connected with photography, aviation and computers. Advancements in high precision optics and mechanics, usage of large film format, to receive a good ground resolution in the photos, availability of high end computer systems, etc. have resulted in the development of photogrammetry.

We can summarise some of the notable developments in the field of photogrammetry as given below:

- development from analogue technique to digital techniques
- recording, acquisition and analysis of data digitally as a result of transition from glass or film to digital cameras due to change from opto-mechanical equipments to digital systems
- availability of high-end computers with peripherals including storage devices, monitors, faster data transfer, and compression/decompression techniques
- coming up of new fields of applications, such as stereo photogrammetry using high resolution satellite images
- digital cameras have now become available at lower prices than earlier enabling wider use in close-range applications
- ease in handling as it has now became easier to handle and use for non-photogrammetrists
- integration of digital photogrammetry applications into GIS databases has now become offered new possibilities for the end-users
- development and availability of digital photogrammetry workstations has made the work flow fully digital having the capability to provide stereoscopic viewing and enabling precise 3D measurements and editing of 3D data.

One of the examples of 3D data is the Shuttle Radar Topography Mission (SRTM), a joint project of National Geospatial-Intelligence Agency (NGA) and National Aeronautics and Space Administration (NASA) of USA, which has produced topographic maps for 80 per cent of the Earth's land surface through the development of DEM from the stereo-pairs of satellite images.

SRTM refers to Shuttle Radar Topography Mission. You can get more information about it from the website www2.jpl.nasa.gov/srtm/mission.htm and also in Unit 5 *Data Types and Sources* of MGY-001 *Introduction to Geoinformatics*.

2.4 TRENDS IN GIS

In the 1960s, computer based GIS concepts began to be explored in North America and today numerous and considerable technological and methodological developments have taken place in the field of GIS. The main advancements are a result of the use of computing techniques and this would continue to affect the future advancements also.

Some of the important developments in GIS methodology are listed below:

- GIS has evolved from the earlier use in mainframe computers to personal computers to now in mobile devices, facilitating the growth of GIS usage and research
- application of computer based technology to handle numerical census data for deriving useful information
- introduction of topological data structures to store and analyse map data
- relational database technology becoming standard and integral part of GIS for handling spatial/aspatial data with the development of spatial database management systems (SDBMS)
- standardisation of data quality norms and accuracy standards
- developments in the field of object orientation in system and database design
- advent of internet and subsequent developments of GIS tools in World Wide Web leading to development of new internet protocols, easy to use interfaces (browsers), tools and programming languages, Web GIS, OPEN GIS, etc
- evolution of GIS from a mere powerful spatial technological tool to a spatial science
- it was earlier required to have all the parts at one place for any GIS implementation; whereas its now possible to access data and software remotely and implement
- its applications have expanded from mapping and resource management to utilities, market analysis, location based service and data browsing
- use of GIS has now opened up for general public from the earlier restricted use in only government sectors
- focus has changed from earlier system centric approach to service oriented approach

DBMS, which refers to Database Management Systems, is a software package which is capable of creating, maintaining and use of a database i.e. records of data. DBMS allows concurrent access to data and can perform queries on large datasets such as listing out the names of all schools. GIS uses SDBMS to store, search, query and share large spatial data sets. SDBMS is capable of performing spatial queries such as listing out the names of all schools within 5 kms of IGNOU campus.

As you have studied in the previous section about recent trends in the field of remote sensing, there are many developments taking place in the field of GIS. We will now study about recent trends and developments in GIS in the following subsections.

2.4.1 3D GIS

The land surface has been the object of mapping for hundreds of years and the terrain with its undulating, continuous land surface is a familiar phenomenon to GIS users. Mapmakers have introduced various techniques for displaying 3-dimensional Earth into 2-dimensional maps and GIS outputs which has made it easier to incorporate terrain mapping and analysis into applications ranging from wildlife habitat analysis to hydrologic modelling. Use of 3D in GIS began around a decade back. Now most of the GIS software has the capability to create 3D visualisation complete with landscape objects such as buildings, trees, etc. Fig. 2.8 displays the capability of 3D GIS in visualisation of features. At present, the 3D research area is concerned with issues of 3D structuring and 3D topology.

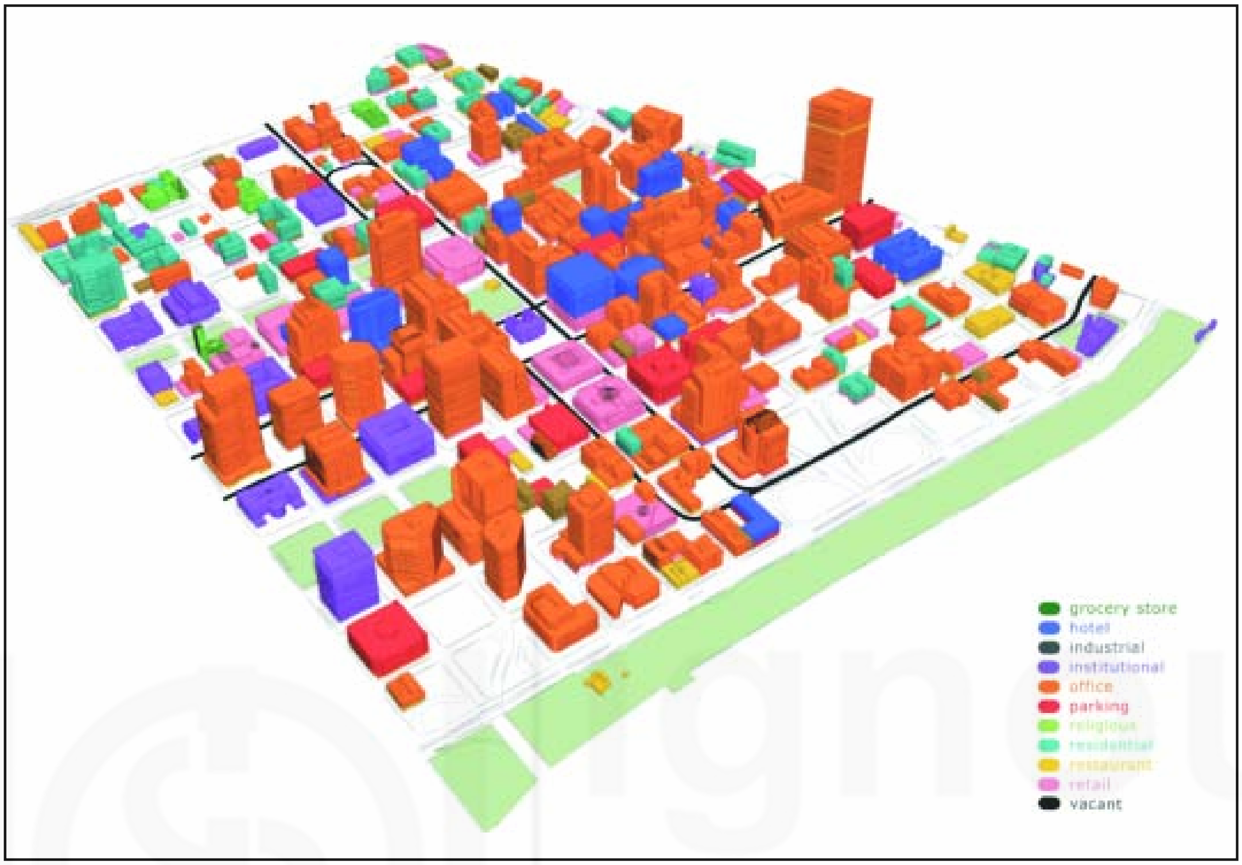


Fig. 2.8: 3D GIS showing realistic landscape objects (source: www.esri.com/ mapmuseum/mapbook_gallery/volume24/engineering1.html)

2.4.2 Web GIS

You have been introduced to Web GIS in Unit 1. The advent of web mapping can be regarded as a major new trend. Earlier, cartography was restricted as it required expensive and complex hardware and software, as well as skilled cartographers and geoinformatics engineers. With web mapping, freely available mapping technologies and geodata potentially allow every skilled person to produce web maps.

Web mapping is the process of designing, implementing, generating and delivering maps on the World Wide Web and its products. While web mapping primarily deals with technological issues, web cartography additionally includes theoretic aspects: the use of web maps, the evaluation and optimisation of techniques and workflows, the usability of web maps, social aspects, and more. Web GIS is similar to web mapping but with an emphasis on analysis, processing of project specific geodata and exploratory aspects (Fig. 2.9).

Often the terms web GIS and web mapping are used synonymously, even if they don't mean exactly the same. In fact, the border between web maps and web GIS is blurry. Web maps are often a presentation media in web GIS and web maps are increasingly gaining analytical capabilities. A special case of web maps are mobile maps, displayed on mobile computing devices, such as

PDA refers to Personal Digital Assistant which came into existence in 1968. It is an electronic devise which assist us in information management. It is also known as palmtop computer or personal data assistant. Some of the PDAs can be used as mobile phone, media player and can also connect to Internet.

mobile phones, smart phones, PDAs, GPS and other devices. If the maps on these devices are displayed by a mobile web browser or web user agent, they can be regarded as mobile web maps.

Fig. 2.9: Concept of WebGIS (source: www.esri.com/news/arcnews/winter0809 articles/ gis-geography-in-action.html)

There are various types of web maps, such as analytic, animated, collaborative, customised, distributed, hyper maps, interactive maps, etc. Out of which collaborative web map projects appear to be more popular, such as Google Map Maker, OpenStreetMap, WikiMapia, etc.

There are several advantages of web maps. We will mention here about some of them:

- *easy delivery of up to date information*- when the maps are generated automatically from databases, they can display information in almost real-time for example, a map displaying the traffic situation near real-time by using traffic data collected by sensor networks or a map showing locations of vehicles
- availability of software and hardware infrastructure at low cost
- easy distribution of product updates
- webmaps work across browsers and operating systems
- capability to combine distributed data sources
- web maps allow for personalisation
- web maps enable collaborative mapping
- web maps support hyperlinking to other information on the web
- easy to integrate multimedia with web maps.

The first consumer LBS-capable mobile web device was the Palm VII, released in 1999. Two of the in-the-box applications made use of the ZIP code-level positioning information and share the title for first consumer LBS application: the Weather.com app from The Weather Channel, and the TrafficTouch app from Sony-Etak / Metro Traffic.

2.4.3 Location Based Services (LBS)

Convergence of different technologies, such as wireless networks, internet, GIS and GPS have introduced a new type of information technology, called ***Location Based Services*** (LBS). It is developing rapidly in the mobile and IT fields. Advancement of LBS is governed by increased demand and interest in utilising geospatial information through wireless networks. ***LBS*** is an information or entertainment service, accessible with mobile devices through the mobile network utilising the ability to make use of the geographical position of the mobile device (Fig. 2.10). LBS can be used in a variety of contexts, such as health, indoor object search, entertainment, work, personal life, etc.

LBS include services to identify a location of a person or object, such as discovering the nearest banking cash machine or the whereabouts of a friend or employee. LBS include parcel tracking and vehicle tracking services. LBS can include mobile commerce when taking the form of coupons or advertising directed at customers based on their current location. They include personalised weather services and even location-based games. They are an example of telecommunication convergence. LBS applications are useful for the following tasks:

- recommending social events in a city
- requesting the nearest business or service, such as an ATM or restaurant
- turn by turn navigation to any address
- locating people on a map displayed on the mobile phone
- receiving alerts, such as notification of a sale on gas or warning of a traffic jam
- location-based mobile advertising
- games where your location is part of the game play, for example your movements during your day make your avatar move in the game or your position unlocks content.
- real-time questions and answers revolving around restaurants, services, and other venues.

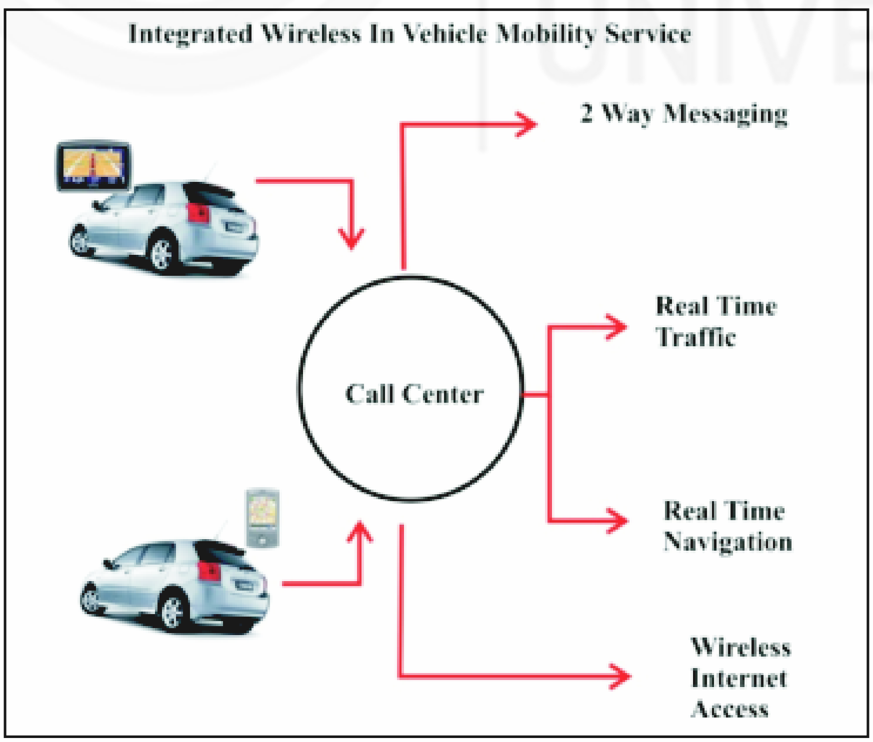


Fig. 2.10: An illustration of the concept of LBS (source:www.bsmart-solutions.com/services-inV-whatis.asp)

Mobile messaging plays an essential role in LBS. Messaging, especially SMS, has been used in combination with various LBS applications, such as location-based mobile advertising. SMS is still the main technology carrying mobile advertising/marketing campaigns to mobile phones. A classic example of LBS applications using SMS is the delivery of mobile coupons or discounts to mobile subscribers who are near advertising restaurants, cafes, movie theatres. The Singaporean mobile operator MobileOne carried out such an initiative in 2007 that involved many local marketers, which was reported to be a huge success in terms of subscriber acceptance.

2.4.4 Mobile GIS

GIS is rapidly extending into the mobile environment also which is now known as ***Mobile GIS***. Mobile GIS is the use of geographic data in the field on mobile devices. It integrates three essential components; Global Navigation Satellite Systems (GNSS), rugged handheld computers, and GIS software. Bringing these three technologies together make the enterprise database directly accessible to field personnel whenever and wherever it is required.

Mobile GIS has an advantage over LBS. Location based systems require either you or at least your phone to be there to get location but it is difficult in some cases. Mobile GIS is useful in such cases.

Mobile GIS is a mapping technology for resource managers and other field workers to visualise and improve their field-based management and research tasks. With mobile GIS, field workers may capture spatial data directly in the field and, with access to a wireless communication network; the data can then be remotely transferred in real time to the central database back at the company office. Mobile GIS is especially important in emergency situations and natural disasters when emergency workers, such as fire-fighters (Fig. 2.11), need to have access to the most current and accurate information in order to make decisions about people's lives and the health of the environment.

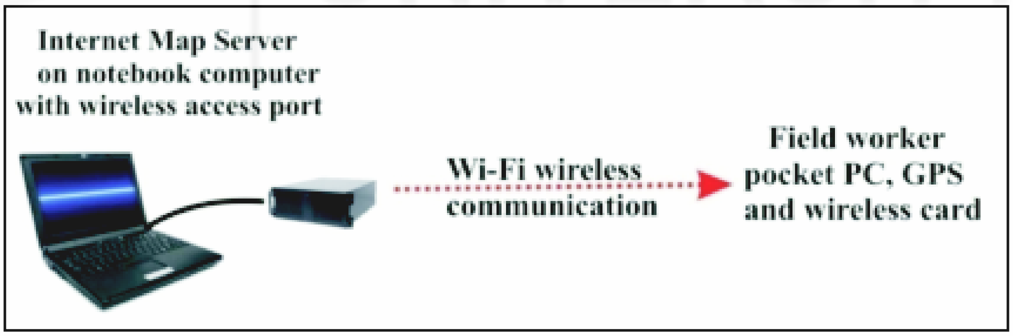


Fig. 2.11: Illustration of the concept of Mobile GIS (source: www.map.sdsu.edu/fireweb/mobileGIS.htm)

2.4.5 Enterprise GIS

Enterprise GIS is a geographic information system that is integrated through an entire organisation so that a large number of users can manage, share, and use spatial data and related information to address a variety of needs, including data creation, modification, visualisation, analysis, and dissemination. Concept and capabilities of Enterprise GIS is shown in Fig. 2.12.

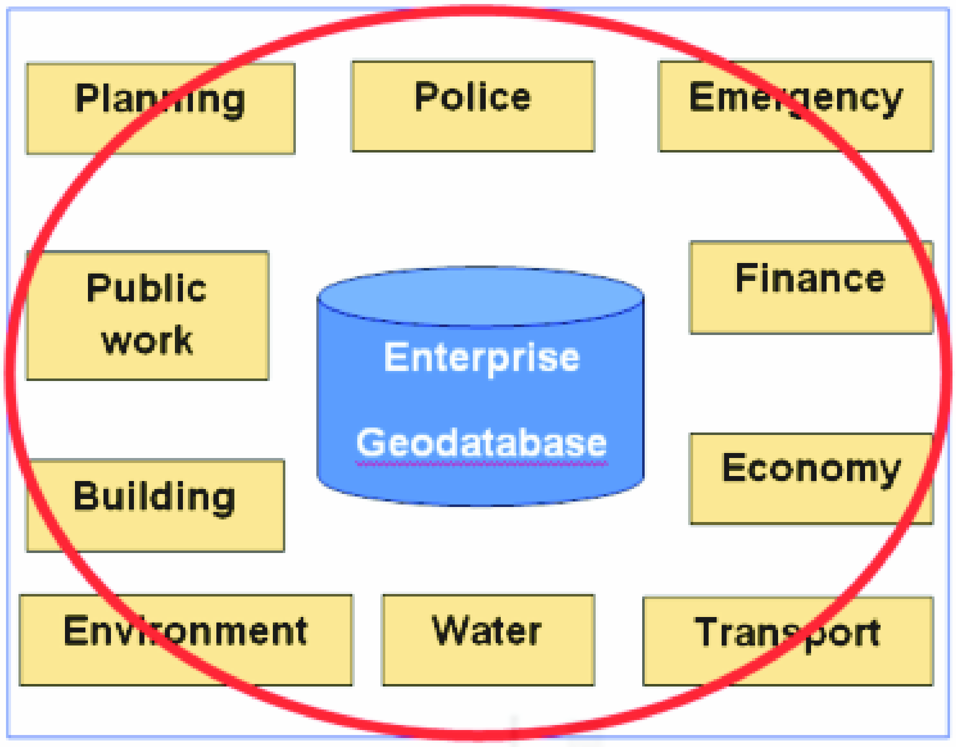


Fig. 2.12: Capabilities of Enterprise Geodatabase

Enterprise GIS has evolved over a period of time and especially during last five-six years. Most of the leading GIS vendors have had components that constitute an Enterprise GIS for long time but the efforts to have them all packaged together and provide an end-to-end solution picked up fast pace in the recent times. To put it in simpler terms, an Enterprise GIS should be capable of:

- supporting huge number of simultaneous transactions
- integrating with other Enterprise Systems (such as SAP, Billing Systems)
- comply with Open Geospatial Consortiums (OGC) Standards to enable easier integration with other systems
- displaying data in the same way (styles/symbols) for Desktop, Web and Mobile users
- preferred reusable functionality across Desktop, Web and Mobile platforms.

Some of the applications of Enterprise GIS are the following as shown in Fig. 2.13:

- increased communication and encouragement of collaboration among various organisational departments in support of better decision making
- lower cost of software ownership and increased return on investments through single, focused GIS applications (such as Web applications) that scale to support many users
- integration of GIS functionality with other enterprise systems in an effort to better manage resources and assets.

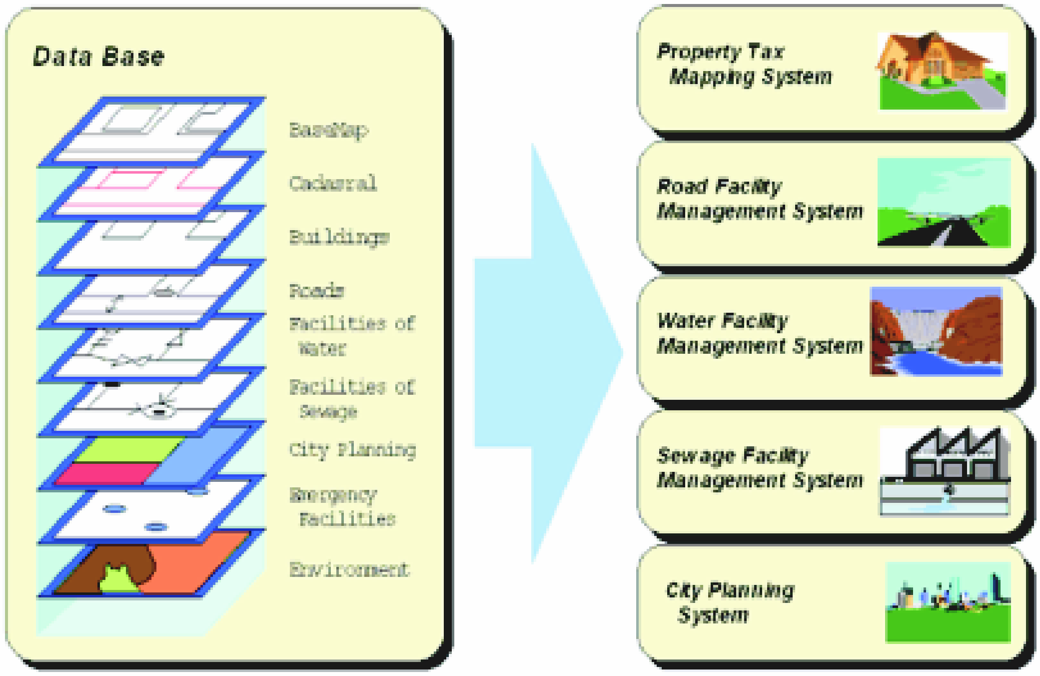


Fig. 2.13: Applications of Enterprise GIS (source: www.proceedings.esri.com/library/userconf/proc98/proceed/TO400/PAP363/P363.HTM)

2.4.6 GIS Customisation and Software Automation

With the advent of web applications/client server concept, several organisation are opting for software customisation to make it more user friendly for their clients/customers. Client/customer would be more happy to get the results or output at the click of the button rather than bother about the long and tedious back end process. In the current scenario, GIS customisation has got numerous benefits as mentioned below:

- it reduces the cycle time of certain project processes
- manual intervention could be greatly minimised
- human induced errors are significantly reduced as the process is automated
- with little modification of the custom built application, the same tool or scripts could be reused in other applications as well.

Most of the customisation is being carried out to create Spatial Decision Support Systems (SDSS), which use inherent capabilities of GIS and provides better analytic capabilities and visualisation in the form of tailor-made maps. This facilitates decision making to a great extent (Fig. 2.14). In a typical SDSS for forest management, the vision/need comes from the forestry experts, which ultimately gets transformed into a database. The efficient use of this dataset through GIS and IT can be extremely helpful in deriving the most meaningful information necessary for better governance. Another important benefit of SDSS is that it can even be used by the people who do not have any specific background related to GIS and IT. SDSS named ***'Aranya'*** has been developed by Centre for Development of Advanced Computing (C-DAC) for forest department, 'Bodoland Territorial Areas District' (BTAD), Assam, under the Government of India initiative for promoting IT-based services in Northeast

India. ***Aranya*** has been developed using open source tools including Quantum GIS (QGIS), Python, PyQt, C and C++ to ensure its wider dissemination.

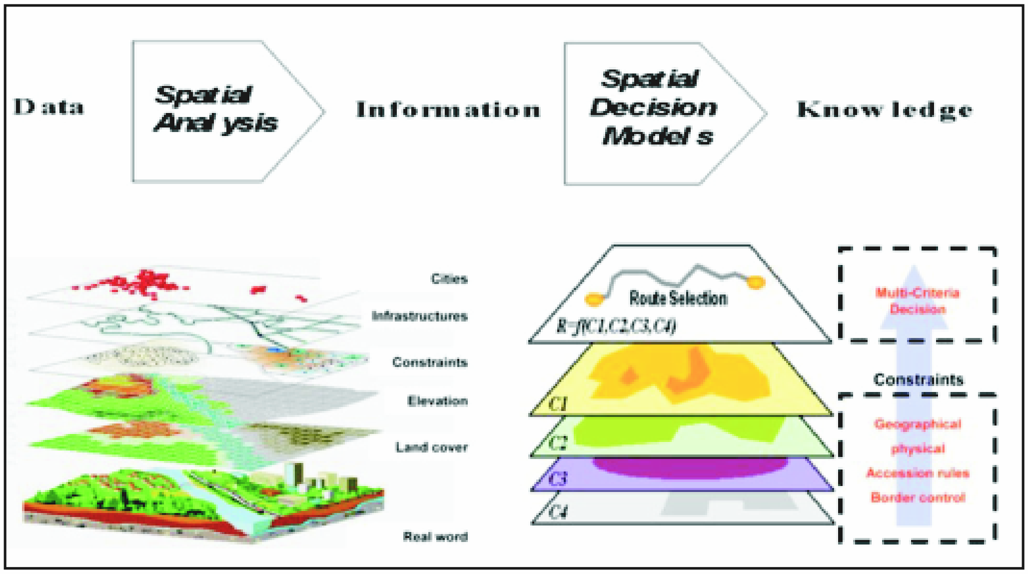


Fig. 2.14: Illustration showing function of SDSS (source: http://isferea.jrc.ec.europa.eu / Activities/Technologies/Pages/Spatial DecisionSupportSystems.aspx)

QGIS is a GIS package having compatibility with GRASS (a comprehensive open source image processing and GIS software) and can be customised using Python language. Python is an easy to use and robust scripting language, and can be integrated with C, C++, Fortran and Java. Further, QGIS works in plug-in mode which provides the flexibility to invoke or revoke a particular module. Plug-ins are programs (dynamically linked libraries) responsible to carry out specific tasks, and can be called in QGIS in runtime environment; even different modules of GRASS can be called as plug-ins. Further, Python can effectively be used with both grid (raster) and vector formats. PyQT is a Python binding for Nokia's QT application framework and runs on the windows.

Aranya is aimed at providing the flexibility to forest managers and planners to do various analyses in GIS. It has different modules relevant to forest departments in India. These include territorial forestry, joint forest management, and wildlife, working plan and research and development.

Check Your Progress II

Spend 5 mins

1) What is digital photogrammetry?

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2) List some of the latest developments of GIS tools in World Wide Web.,

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3) Define LBS.

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2.5 TRENDS IN GPS

Cellular telephony enables time transfer, which is critical for synchronising its spreading codes with other base stations to facilitate inter-cell handoff and support hybrid GPS/ cellular position detection for mobile emergency calls and other applications.

Geofencing refers to locating vehicles, person or pet, when GPS devices are attached to them. The application provides continuous tracking and mobile or internet updates if the target leaves a designated area.

Geotagging refers to applying location coordinates to digital objects such as photographs and other documents for purposes such as creating map overlays.

You have learnt in the first unit that Global Positioning System provides reliable positioning and navigation services on a worldwide basis at any point of time. GPS, which was earlier used exclusively by military, has made impacts into the lives of common man. It is a revolutionary tool, which provides unequalled accuracy and flexibility of positioning for navigation, surveying and Geographic Information System data capture. Growing use in automotive and consumer applications is propelling the market for mobile location technologies. Although standalone products are quite popular, the most common applications are built around Portable Navigation Devices (PNDs), mobile phones, or car navigation systems. As per World GPS Market Forecast, the technology is fast gaining acceptance worldwide, as it is penetrating into previously untapped areas.

Some of the notable trends and advancements in the field of GPS are listed below:

- introduction of GPS in civilian domain
- developments of methods and techniques to improve accuracy for civil applications, which has widened GPS applications in various land, water, air and space applications, including cellular telephony, geofencing, geotagging, etc.
- the first handsets with integrated GPS were launched in the late 1990s. Disaster relief/emergency services depend upon GPS for location and timing capabilities
- in military, the GPS technology is utilised from reconnaissance to target tracking to missile and projectile guidance purposes. GPS satellites which carry a set of nuclear detonation detectors form a major portion of the United States Nuclear Detonation Detection System
- enhancement in global coverage for GPS signals

- possibility of precise measurements with introduction of differential GPS
- availability of wide range of GPS receivers with varying capabilities and processing speeds
- availability of range of GPS receivers at reduced size and cost
- greater real time applications
- development and availability of improved user friendly software for GPS receivers.

2.6 TRENDS IN GEOINFORMATICS EDUCATION

You have studied in the previous sections of this unit about the recent trends and developments taking place in various components of the geoinformatics. The recent trends and developments have brought markable changes in structure and format of University curricula and also in delivery mechanisms of geoinformatics related educational programs. This revolution is necessary to keep pace with the latest technologies and to develop knowledgeable and skilled manpower in different employment sectors.

Some of the developments and trends observed currently at Indian and global levels are listed below:

- training and education in geoinformatics were earlier restricted to few selected disciplines and were later included in many other disciplines. It has now been realised that multidisciplinary education in information technologies, management, and space technology can increase employment opportunities
- earlier, there were only few institutes and universities, which were offering educational and training programmes related to geoinformatics. Now many universities and institutes are offering such programmes
- the range of programmes being offered vary from appreciation level (from few days to few weeks duration) to certificate levels (from few weeks to few months duration) to diploma (of few months) to masters (from ~one year to ~three years) to doctoral levels
- in comparison to the past, there are many choices one can make with regards to the level of programmes, depending upon the preference of learners with regard to location of institute, cost of programme, level and mode of programme, etc.
- focus has shifted from just developing professional and technical skills of learners to expose learners to modern tools and technologies and also to update their knowledge in specific application areas and domains
- education and training is now also being imparted by adopting other modes, such as open and distance learning including e-Learning with interactive lecture/education materials and hands on exercises along with the use of internet medium to conduct online test and examinations. The use of e-Learning enables enrollment of working professionals as their time and possibility of attending courses are limited
- due to the above efforts, geoinformatics technicians and professionals are comparatively more readily available in the market in comparison to the past.

2.7 FUTURE TRENDS AND CHALLENGES

You have studied in previous sections, about the trends and advancement in different components of geoinformatics viz. remote sensing, GIS, photogrammetry, GPS and geoinformatics education. The technologies utilised in geoinformatics are advancing at an extraordinary rate due to changes in user needs and advances in computing technologies, which is continuously increasing its potential to utilise it in different sectors. The advancement in technology and applications is further expected to grow and have a major impact on our daily lives.

Some of the important points related to future trends and developments in the field of geoinformatics are given below:

- launch of more sophisticated and specialised application specific sensors with reduced size, weight and cost
- improved methodologies and techniques for faster and more accurate geoinformation retrieval
- GIS is expected to be interoperable, fully web based and become more dynamic and maps to become interactive
- further improvement in availability, reliability, usability, accuracy and interoperability of GNSS
- development of receiver independent GPS software
- methods to improve usability of GNSS in situations such as indoor, underwater, inside tunnel, etc.
- improved new methodologies and techniques for faster and reliable geospatial data acquisition, storage, processing, transfer and retrieval, and also for remote sensing, GIS and GPS data integration
- development of innovative data fusion approaches to synthesise and analyse extensive and diverse data sets and to create new information products
- developments of new methods and approaches for much wider applications of geoinformatics to make it become part of daily life
- Open Geospatial Consortium (OGC) is expected to grow faster and richer, and with it the use of open source geoinformatics software
- newer or improved educational models for geoinformatics education to fulfill the demands of changing education, industry and market scenario
- greater role of geoinformatics to facilitate multidisciplinary research to enhance our understanding of the Earth system processes for its sustainable management.

However, the growth and trends may be affected by the many issues. Some of the issues are mentioned here:

- geospatial data, which were earlier either absent or lacking, are now available from numerous sources at larger volumes and faster rates however, at times the quality data is absent and if available, it is either in incompatible formats or there is ownership issue. It also requires regular updation and maintenance. Further, the available data is liable to be misused.

- many mainstream IT companies have now entered in the GIS related business bringing along with them overwhelming and excessive information about their products and capabilities resulting into creating confusion among the ordinary users.
- newer and improved methods for improving interoperability at different levels are required.

2.8 ACTIVITY

1) If you are living in a metro city then you know that traffic congestion is the biggest transportation issues facing cities. If you have won a project to use the high resolution satellite imagery and GIS to identify the bottleneck areas and come out with a comprehensive traffic management plan. Here, you have a task to prepare entire road network, bridges, median, traffic island, signals, pedestrian crossing, accident spots, bus terminal, bus stops, etc. How do you plan to do this?

2) Government is on a massive drive against encroachment of settlements on lakes and rivers. In this connection, they are planning a demolition drive based on the individual house level details overlaid on high resolution satellite imagery. Here, how would you differentiate the buildings which are legal and illegal? Apply your real world knowledge and demonstrate.

2.9 SUMMARY

In this unit, you have studied about the recent trends in different components of geoinformatics. Let us now summarise what we have studied:

Remote sensing sensors broadly cover optical, hyperspectral, microwave and thermal sensors. The data collected using the above mentioned sensors become an input for various GIS mapping and customisation. Every sensor is unique in its application where they are put in to best use to most of the Earth resource applications.

On the other hand, GIS in its advanced stage, and day-to-day utility, like 3D GIS, Web GIS, Mobile GIS, LBS, Enterprise GIS, and GIS customisation have been briefly elaborated to give the learner a flavour for the subject with some practical applications to try out as part of their on-going project.

Global Positioning System (GPS) provides reliable positioning and navigation services on a worldwide basis at any point of time. GPS has undergone many notable developments in this field. There are many issues and challenges in the field of geoinformatics.

It is high time that mankind should make use of sustainable space technologies to the very survival and to take it forward to our future generations. You have also learnt about potential applications of space technologies through integrated approach, such as GIS & RS in combination with GPS.

Spend 30 mins

2.10 UNIT END QUESTIONS

1) Discuss in brief some of the notable developments in remote sensing satellites.
2) What are the applications which can take advantage of hyperspectral remote sensing?
3) How Web Mapping is useful during natural disaster?
4) Discuss some of the notable trends and advancements in the field of GPS.

2.11 REFERENCES

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Data from above links was retrieved between 1st to 15th May 2011.

2.12 FURTHER / SUGGESTED READING

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- Yang, C., Wong, D., Miao, Q. and Yang. R. (2011), Advanced Geoinformation Science, CRC Press, 485 p.

2.13 ANSWERS

Check Your Progress I

1) Spectral bands
2) Panchromatic imaging systems, Multi-spectral imaging systems Superspectral Imaging Systems, Hyperspectral Imaging Systems.
3) Passive and active sensors.

Check Your Progress II

1) Digital photogrammetry is characterised with the use of digital images or scanned photographs as input data, correlation techniques, and availability of digital cameras, satellite imagery, and automation of some processes performed by operators.

2) Web GIS, Open GIS, 3D GIS.

3) Location Based Services (LBS) is an information or entertainment service, accessible with mobile devices through the mobile network utilising the ability to make use of the geographical position of the mobile device

Unit End Questions

1) Refer to section 2.2 for trends in remote sensing.
2) Elaborate on Atmosphere, Ecology, Geology, Coastal Waters, Snow/Ice, Biomass Burning and Commercial.
3) Refer to subsection 2.4.2 on Web GIS.
4) Refer to section 2.5 on GPS.