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Prominence of Spatial Database in Geographical Information Systems

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***Abstract*—Spatial Database is a collection of spatially referenced data that acts as a model of reality. Geographical Information System includes spatial data which is either in raster or vector form and data derived from remote sensors are increasingly utilized as source for GIS. Spatial data is the core part of the Geographical Information System. Data mining techniques are studied to discover knowledge from GIS database and remote sensing image data in order to improve land use or land cover classification. Remote sensing (RS) technologies was utilized to extract some of the important spatially variable parameters, such as land cover and land use (LCLU), from satellite images. Land Use Land Cover (LULC) classification from remotely sensed data is an important research and widely used in remote sensing application. The goal of this paper is to provide broad overview of Geographical information system and remote sensing data which includes spatial data.**

***Keywords*—Spatial data, Geographical Information System, Remote Sensing, Raster data.**

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I. INTRODUCTION

This Spatial data is core of the Geographic Information System (GIS). Spatial data management is an important part of the GIS, many present spatial data management systems are usually only attached importance to storing and managing graphical data and attribute data of GIS. The word 'Geographic' deals with spatial objects or features which can be referenced or related to a specific location on the earth surface .Similarly the word 'Information' deals with attributes of large volume of data about a particular object on the earth surface. The data includes a set of qualitative and quantitative attributes of the real world objects. The term 'System' is used to represent all the components collectively on the earth surface including its complex characteristics. In general GIS deals with complex environment consist of a large number of objects or features on the earth surface.GIS provides a mechanism for integrating various geo-information data sets and analyzing them in order to generate information relevant to planning needs in a context. Burrough (1986) defined GIS as a set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purpose[2].

II. COMPONENTS OF GIS

A geographic information system (GIS) is a computer-based tool for mapping and analysing geographic phenomenon that exist, and events that occur, 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. The components of GIS play a major role to the success of Information System. The five major components of GIS are shown in Fig 1.

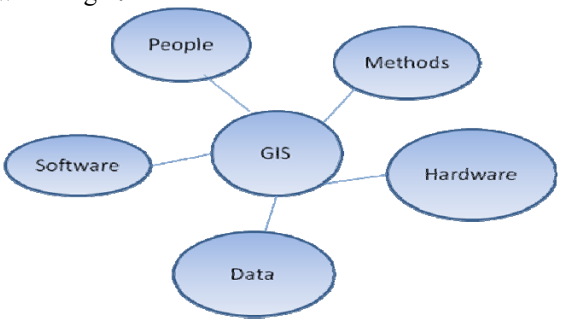

Fig 1: Components of GIS

A. Hardware

Hardware is the computer system on which a GIS operates. Today, GIS software runs on a wide range of hardware types, from centralized computer servers to desktop computers used in stand-alone or networked configurations.

B. Software

GIS software provides the functions and tools needed to store, analyse, and display geographic information. A review of the key GIS software subsystems is provided above.

C. Data

Geographic data and related tabular data can be collected in-house, compiled to custom specifications and requirements, or occasionally purchased from a commercial data provider. A GIS can integrate spatial data with other existing data resources, often stored in a corporate DBMS. The integration of spatial data (often proprietary to the GIS software), and tabular data stored in a DBMS is a key functionality afforded by GIS.

D. People

GIS technology is of limited value without the people who manage the system and develop plans for applying it to real world problems. GIS users include technical specialists who design and maintain the system to end users who use GIS to help them to perform their everyday work. The

identification of GIS specialists versus end users is often critical to the proper implementation of GIS technology.

E. Methods

A successful GIS operates according to a well-designed implementation plan and business rules, which are the models and operating practices unique to each organization. As in all organizations dealing with sophisticated technology, new tools can only be used effectively if they are properly integrated into the entire business strategy and operation.

III. DATA FOR GIS

A. Digitizing and scanning of maps

The Use the digitizer to transform the information from analog format, such as a paper map, to digital format, so that it can be stored and displayed with a computer . Or use scanner to convert the analog paper map to computer-readable form automatically.

B. Input image data

Image data includes satellite images, aerial photographs and other remotely sensed or scanned data, which are in the raster form. Remote sensing has become a more and more important data source for GIS system.

C. Direct data entry including Global Position System (GPS)

Surveying field data which measure the distance and angle to decide the location of other points could also be transferred into the GIS. GPS is a set of hardware and software designed to determine accurate locations on the earth using signals received from selected satellites. Location data and associated attribute data can be transferred to mapping and GIS.

D. Transfer data from existing sources

Data are obtained already in digital format from Government Agencies such as survey of India.

IV. DATA MODEL IN GIS

A GIS stores information about the world as a collection of thematic layers that can be linked together by geography. The thematic layer approach allows us to organize the complexity of the real world into a simple representation to help facilitate our understanding of natural relationships.GIS uses two basic data types. They are Spatial data and Attribute data.

Spatial Data describes the absolute and relative location of geographic features[1]. Attribute Data describes characteristics of the spatial features. These characteristics can be quantitative and/or qualitative in nature. Attribute data is often referred to as tabular data. The coordinate location of a forestry stand would be spatial data, while the characteristics of that forestry stand, e.g. cover group, dominant species, crown closure, height, etc., would be attribute data.

A. Spatial Data

The spatial data or real world features are very complex. So, spatial data is simplified before they are entered into the computer. The common way of doing this is to break down all geographic features into three basic entity types are points, lines and areas.

Points are 'one dimensional' objects, used to represent features that are very small ,for example a post box, an electric pole, a well or tube well etc. Only latitudinal and longitudinal values or a coordinate reference can be given to these features to explain their location.

Lines are two dimensional objects and are used to represent linear features, for example roads and rivers. Lines are also used to represent linear features that do not exist in reality, such as administrative boundaries and international boundaries.

Areas are three dimensional objects and are represented by closed set of lines and are used to define features such as agricultural fields, forest areas, administrative areas etc. Area entities are often referred to as polygons.

Points may be used to represent features such as electric poles, post boxes etc. Likewise lines and areas may be used to represent road networks and residential blocks respectively. So, the decision makers decide the 'entities' through which different features of real world would be represented.

B. Attribute Data

Attribute data tells the characteristics of different objects or features on the earth surface. These are descriptions, measurements or classification of geographic features. Attribute data can be both qualitative (like land use type, soil type, name of the city/river etc.) and quantitative (like elevation, temperature, pressure of a particular place, crop yield per acre etc.). So, the attribute can be both numeric and textual.

V. REMOTE SENSING IN GIS

Remote sensing is the art and science of making measurements of the earth using sensors on airplanes or satellites [3]. These sensors collect data in the form of images and provide specialized capabilities for manipulating, analyzing, and visualizing those images. Remote sensed imagery is integrated within a GIS. Images from space and the air are major source of geographical data. Remote sensing includes techniques for data acquisition and processing anywhere on the globe at low cost, consistent update potential. Many image analysis systems contain sophisticated analytical functions interpreted data from a remote sensing system can be merged with other data layers in a GIS.

Remote sensing is the technique of deriving information about objects on the surface of the earth without physically coming into contact with them. This process involves making observations using sensors mounted on platforms (aircraft and satellites), which are at a considerable height from the earth surface and recording the observations on a suitable medium (images on photographic films and videotapes or digital data on magnetic tapes).When

electromagnetic radiation falls upon a surface, some of its energy is absorbed, some is transmitted through the surface, and the rest is reflected. Surfaces also naturally emit radiation, mostly in the form of heat. It is that reflected and emitted radiation which is recorded either on the photographic film or digital sensor. Since the intensity and wavelengths of this radiation are a function of the surface in question, each surface is described as processing a characteristic ″Spectral Signature″. If an instrument can identify and distinguish between different spectral signatures, then it will be possible to map the extent of surfaces using remote sensing.

Sensors are devices used for making observations. They consist of mechanisms usually sophisticated lenses with filter coatings to focus the area observed onto a plane in which detectors are placed. These detectors are sensitive to a particular region in which the sensor is designed to operate and produce outputs, which are either representative of the observed area as in the case of the camera or produce electrical signals proportionate to radiation intensity.

A. Spatial Resolution

It is a measure of the smallest angular or linear separation between two objects that can be resolved by the sensor. The greater the sensor's resolution, the greater the data volume and smaller the area covered. In fact, the area coverage and resolution are inter-dependant and these factors determine the scale of the imagery.

B. Spectral Resolution

It refers to the dimension and number of specific wavelength intervals in the electromagnetic spectrum to which a sensor is sensitive. Narrow bandwidths in certain regions of the electromagnetic spectrum allow the discrimination of various features more easily.

C. Temporal Resolution

It refers to how often a given sensor obtains imagery of a particular area. Ideally, the sensor obtains data repetitively to capture unique discriminating characteristics of the phenomena of interest.

D. Radiometric Sensitivity

It is the capability to differentiate the spectral reflectance/ emittance from various targets. This depends on the number of quantization levels within the spectral band. In other words, the number of bits of digital data in the spectral band will decide the sensitivity of the sensor

VI. FUNCTIONS OF GIS

The use of GIS is needed to collect data, store, manage, analyse and produce useful information. In other words, the process of GIS is to input sets of raw data to produce useful output information the functions of GIS are given below

- Data Pre-processing and Manipulation
- Data Analysis
- Data Display
- Database Management

VII. APPLICATIONS OF GIS

The uses of GIS and RS technologies, either individually or in combination, span a broad range of applications and degrees of complexity. Simple applications might involve determining the location of sampling sites, plotting maps for use in the field, or examining the distribution of soil types in relation to yields and productivity. More complex applications take advantage of the analytical capabilities of GIS and RS software. These might include vegetation classification for predicting crop yield or environmental impacts, modeling of surface water drainage patterns, or tracking animal migration patterns.

In Land use/land cover classification system the present study, a very detailed classification system is being adopted for mapping using large scale aerial photographs and high resolution satellite data. In the present study the preliminary classification was conceptualized and design with the help of some secondary data. After that, the classification system was modified and designed the details of each class and their operational definition are described as below.

E. Residential Area

This includes land, which provides living space within and around buildings or houses to meet the daily needs of the families of different sizes and composition. This area is predominantly identified for the purpose of living accommodation. These areas are developed according to some plan or devoid of any plan. The following are two types of residential area.

Residential urban: Residential urban refers to those residences which are found mainly urban areas. These are homogeneous residential units mainly used for living purposes with a regular network of road pattern.

Residential other: Residential other refers to those residences which are found mainly fringe area. Compact cluster of dwelling units is found outside the main urban built-up area surrounded by agricultural land. These areas are generally unplanned and characterized by irregular layout.

F. Commercial

Commercial areas are those built-up land with non residential use and broadly classified in to some kind of business transaction. It includes wholesale market, retail trade, shopping complexes and other commercial activities but not related to the manufacturing industry. Commercial activities have inter relationships with storage functions.

G. Industrial

Industrial areas include a wide array of land uses from light manufacturing to heavy manufacturing plants.

H. Transportation

The land use included in the transportation, communications occurs to some degree within built up categories and actually can be found within many other categories. Roads, bus station, bus deports and workshops, railways, railway station and yard are covered in this category. The following are some classes of transport/communication.

National highway, Main roads, Railway

I. Recreational

Areas within urban environment generally used for active and passive recreation purposes are being considered to put under this category. These are generally parks, gardens, play grounds etc.

J. Agricultural land

Agricultural land may be defined broadly as land used primarily for production of food and fiber. It is the land primarily used for production of food and fiber. It includes crop land, agricultural form and fallow lands.

K. Residential Area

Forest lands have a tree-crown area density of 10 percentages or more are stocked with trees capable of producing timber or other wood products and extract an influence on the climate or water regime. The land under natural vegetation, tree cover with good canopy cover, it includes all agricultural plantation and forest plantation.

L. Vacant land

Vacant land is a non- built up land without any land use activity or land cover. These are mainly barren devoid of trees/bushes/scrub and may be found within or outside the urban built up area. Mainly two types of vacant lands are observed in the study area. First category is vacant land within development and second is vacant land under development.

M. Waste land

Wastelands are those lands which are presently not being used to their optimum potential due to some constraints.

N. Water bodies/Wet land

The delineation of water areas depends on the scale of data presentation and resolution characteristics of remote sensor data used for interpretation of land use and land cover. The land which covered with natural drainage system like rivers, streams as well as manmade features classified like tanks, ponds, canals, etc.

O. Public/semipublic/institution

This class generally includes built up land use constructed purposefully as working place for government, semi government, private sector offices, and educational institutions, the built-up land predominantly under public authority utilized for providing basic amenities and service.

VIII. ADVANTAGES OF GIS

Geographic Information System (GIS), is a group of processes that collect and analyse data. The resulting information forms the basis for making quality decisions related to land, the oceans, lakes and resources management, as well as transportation and retailing. GIS technology integrates spatial and administrative information into one system, bringing together scientific disciplines, such as geography, cartography, remote sensing, photogrammetry, surveying, geodesy and statistics.

- GIS gives a "high tech" feel to geographic information.
- GIS is an important tool in understanding and managing the environment.
- GIS is a convergence of technological fields and traditional disciplines.
- GIS has been called an "enabling technology" because of the potential it offers for the wide variety of disciplines which must deal with spatial data.

IX. CONCLUSIONS

In this paper, a brief review of geographical information system with its functions and real time benefits are presented. GIS has the capabilities of analysing a large amount of data within no time. These voluminous data would have become useless without the development of GIS. GIS would have no use without the development of Remote Sensing technology, which provides voluminous data. Thus converting data into knowledge is the key issue in remote sensing applications where GIS could be used.

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