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GEOGRAPHIC INFORMATION SYSTEM: AN OVERVIEW

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Abstract

This report deals with the Geographic information system (GIS) to provide general idea about GIS. Basically it is a system for storing, managing, and displaying geospatial data by conducting image processing.

The study comprises of literature review regarding the subject matter to get an idea about it. The seminar is a review of different books and research papers published in journals. An effort is made to segregate the information regarding GIS and its application in Civil Engineering and also in other fields. The paper discusses some of the features of a GIS, the general trends in the field and the technology behind it. It also describes the advantages of using multimedia to implement a GIS by extending its capabilities of presenting geographic and other information. The ability of GIS to manage geospatial data establishes GIS as an important tool for a wide variety of applications, since the 1970s GIS has been important in the management of natural resources and also the key areas where the GIS system could be very useful.

Keywords: GIS, geospatial data.

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1. INTRODUCTION

Geographical information system (GIS) is a computer based system that enable user to collect, store, process (manage), analyse and present spatial data. as of February 2006, geospatial technology is listed by U. S. Department of Labor as one of the three emerging industries, along with nanotechnology and biotechnology. Geospatial technology covers a number of fields, including remote sensing, cartography, surveying, and photogrammetry. To integrate data from these different fields in geospatial technology, we rely on geographic information system.

Today many of us use GIS technology on a daily basis even though we may not be aware of it. We go online, type in the name of restaurant, and download a map and direction to go to the restaurant. At google Maps or Yahoo Maps, we locate a reference map, superimpose our own content and make a professional looking map for a project. And some of us, we use an in-vehicle navigation system to get the shortest route and driving direction to reach our destination. All of these activities involve GIS technology that can handle and process location and attribute data of spatial features.

The ability of GIS to manage geospatial data establishes GIS as an important tool for a wide variety of applications. Since the 1970s GIS has been important in the management of natural resources. Most recently GIS has been used for crime analysis, emergency of planning, land records management, market analysis, and transportation planning. And the integration of GIS with other geospatial technologies such as global positioning system (GPS), remote sensing, and mobile devices has found applications in location-based services, in teractive mapping, in vehicle navigation system and precision farming. As of early 2006, geospatial technology is listed by U. S. Department of Labor as one of the three emerging fields, along with nanotechnology and biotechnology. GIS is no longer for specialist. Powerful and affordable computer hardware and software, the graphical user interface, and public digital data have brought GIS mainstream use. But the popularity of GIS has also created situation in which misuse of misinterpretation of data and results can easily happen. Therefore to use GIS properly, we must be familiar with the technology as well as the basic concept that drive the technology. [Kang-tsung Chang, 2008]

2. LITERATURE SURVEY

2.1 History of GIS:

Geographic Information System is not new. Since the late 1960s computers have been used to store and process geospatial data. Early example of GIS-related work from the late 1960s and 1970s include the following:

- Computer mapping at the University of Edinburgh, the Havard Laboratory for Computer Graphics, and

the Experimental Cartography Unit (Coppock 1988; Chrisman 1988; Rahid 1988).

- Canada Land Inventory and the subsequent development of the Canada Geographic Information System (Tomlison 1948).
- Publication of Ian McHarg's Design with Nature and its inclusion of the map overlay method for suitability analysis (McHarg 1969)
- Introduction of an urban street network with topology in the U.S. Census Bureau's DIME (Dual Independent Map Encoding) system (Broome and Maixler 1990)

For many years, though, GIS has been considered to be too difficult, expensive, and proprietary. The advent of the graphical user interface (GUI), powerful and affordable hardware and software, and public digital data broadened the range of GIS application and brought GIS to mainstream use in the 1990s. Table 1 shows a list of GIS software producers and their main products.

Table 1: GIS software producers and their main products.

Sr.no	Product	Producers
1	Autodesk Inc.(http://www3.autodesk.com/)	Autodesk map
2	Baylor University, Taxes (http://grass.baylor.edu/)	GRASS
3	Bantley System , Inc. (http://www2.bentley.com/)	Microstation
4	Calliper corporation .(http://www.caliper.com/)	TransCAD, Maptitude
5	Clark Labs. (http://www.clarklabs.org/)	IDRISI
6	Environmental System Research Institute (ESRI), Inc. (http://www.esri.com/)	ArcGIS, ArcView 3.x
7	Intergraph Corporation. (http://www.intergraph.com/)	MGE, GeoMedia
8	International Institute for Aerospace Survey and Earth Science, The Netherlands (http://www.itc.nl/ilwis/)	ILWIS
9	Keigan System (http://www.keigansystem.com/)	MFworks, Keigan Grid
10	Manifold.net (http://www.manifold.net/)	Manifold System
11	MapInfo Corporation (http://www.mapinfo.com/)	MapInfo
12	PCI Geomatics (http://www.pcigeomatics.com/)	Geometica

Google and Yahoo, two search engine companies, have recently developed software system that let users search and view spatial data at different levels of detail and even make their own maps by combining their data with data sources that are available online alog with the proliferation of GIS activities, numerous GIS textbook have been published, and several journals and trade magazines are now devoted to GIS and GIS applications.

2.2 Defining GIS

A GIS is an information system designed to work with data referenced by spatial/geographical x-, y-coordinate system. In other words, GIS is both a database system with specific capabilities for spatially referenced data as well as a set of operations for working with the data. It may also be considered as a higher order map. GIS technology integrates common database operations such as query and statistical analysis with the distinctive visualization and geographic analysis remuneration offered by maps. These abilities distinguish GIS from other information systems and make it valuable to a wide range of public and private enterprises for explaining events, predicting outcomes, and planning strategies. A typical GIS can be understood by the help of various definitions given below:

- A geographic information system (GIS) is a computer-based tool for mapping and analyzing things that exist and events that happen on Earth
- Burrough in 1986 defined GIS as, "Set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes"

Hence GIS is looked upon as a tool to assist in decision-making and administration of attributes that needs to be analyzed spatially.

2.3 Data types and models of GIS

Geospatial Data: Geospatial data separate GIS from other information systems. Therefore, before discussing GIS operations, we must understand the nature of geospatial data. Take the example of roads. to describe a road, we refer to its location (i.e., where it is) and its characteristics (e.g., length, name, speed limit, and direction), as shown in figure 1. The location also called geometry or shape, represents spatial data, whereas the characteristics are attribute data. thus a road, like any geospatial data, has the two components of spatial data and attribute data.[Kang-tsung Chang, 2008]

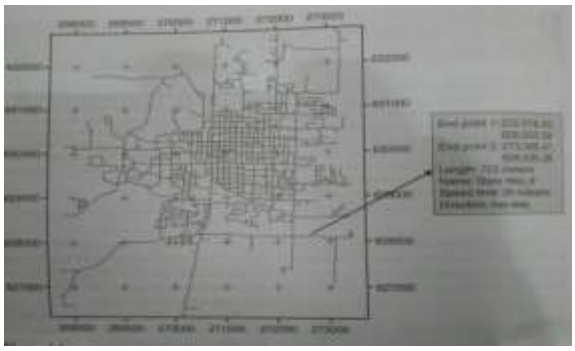

Figure 1. Geospatial Data

An example of geospatial data. The street network is based on a plane coordinate system. The box on the right lists the x-, y-coordinates of the end points and other attributes of the street segment.

Spatial Data: Spatial data describes the locations of spatial features, which may be 'discrete features' are individually distinguishable features that do not exist between observations. Discrete features include points (e.g., wells), lines (e.g., roads), and areas (e.g., land use type) 'Continuous features' are features that exist spatially between observations. Example of continuous features are elevation and precipitation. A GIS represents these spatial features on the Earth's surface as map features on a plane surface. This transformation involves two main issues: the spatial reference system and the data model.

The location of spatial features on the earth's surface are based on a geographic coordinate system with longitude and latitude values, whereas the locations of map features are based on a plane coordinate system with x-, y-coordinates. 'Projection is the process that can transform the earth's spherical surface and bridge the two spatial reference system.

The data model defines how spatial features are represented in GIS figure 2. The 'Vector data model uses points and their x-, y-coordinates to construct spatial features of points, lines, and areas. The 'Raster data model uses a grid and grid cells to represent the spatial variation of feature. the two data model differ in concept: Vector data are ideal for representing discrete features; Raster data are better suited for representing continuous features. They also differ in data structure. The raster data model uses a simple data structure with rows and columns and fixed cell locations. The vector data model may be georelational or object based, may or may not involve topology, and may include the simple or composite features.[Kang-tsung Chang, 2008]

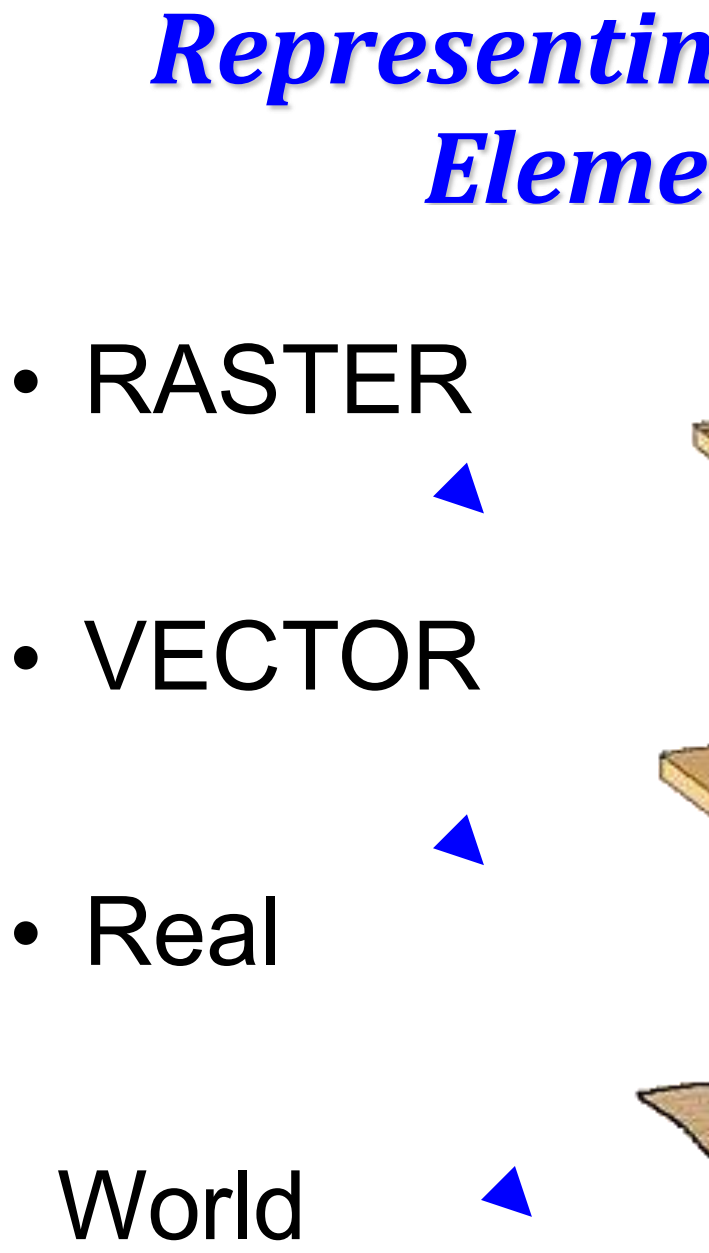

Figure 2. Data Model

Geo-Relational Data Model: All spatial data files will be geo-referenced. Geo-referencing refers to the location of a layer or coverage based on latitude longitude in space defined by the x-, y-coordinate referencing system. The geo relational approach involves abstracting geographic information into a series of independent layers or coverage's, each representing a selected set of closely associated geographic features (e.g., roads, land use, river, settlement, etc). Each layer has the theme of a geographic feature and the database is organized in the thematic layers. With this approach users can combine simple feature sets representing complex relationships in the

real world. This approach borrows heavily on the concepts of relational DBMS, and it is typically closely integrated with such systems. This is fundamental to database organization in GIS.

Topological Data Structure: Topology is the spatial relationship between connecting and adjacent coverage features (arc, nodes, polygons, and points). For instance, the topology of an arc includes from and to nodes and its left and right polygon. Topological relationships are built from simple element into complex elements: points, arcs, areas.Topological data structure adds intelligence to the GIS database.

Attribute data: Attribute data express the characteristics of spatial features. For raster data, each cell has its own value that corresponds to the attribute and spatial feature at that location depends upon the latitude longitude. A cell is tightly bound to its cell value. For vector data, a spatial feature data with attribute data vary significantly. A road segment may only have the attributes of length and speed limit, whereas a soil polygon may have dozens of properties, interpretations, and performance data. How to join spatial and attribute data is therefore importance in the case of vector data..[Kang-tsung Chang, 2008]

Relational Database Concepts & Model: The relational data model is conceived as a series of tables, with no hierarchy and any predefined relations. The relation between the various tables should be made by the user. This is done by identifying a common field in two tables, which is assigned as the flexibility than in the other two data models. However, accessing the database is slower than with the other two models. Due to its superior flexibility, the relational data model is used by almost all GIS systems.

2.4 Components of GIS:

Hardware: It consists of the computer system on which the GIS software will run. The preference of hardware system range from 300MHz Personal Computers to Super Computers having potential in Tera FLOPS. The computer forms the backbone of the GIS hardware, which gets it's input through the Scanner or a digitizer board. Scanner converts a picture into a digital image for further dispensation.

Software: GIS software includes the program and the user interface for driving the hardware. Common user interface in GIS are menus, graphical icons, command lines, and scripts.

Data: Data consist of various kinds of inputs that the system takes to produce information.

People: GIS users range from technical specialists who design and maintain the system to those who use it to help them perform their everyday work.

Infrastructure: The infrastructure refers to the necessary physical, organizational, administrative, and cultural environments that support GIS operations. The infrastructures includes requisite skills, data standards, data clearing houses, and general organizational patterns. [Kang-tsung Chang, 2008]

2.5 Principal Functions of GIS

Data Capture: The collection of data involves different technologies such Remote-sensing satellite imagery and as Data used in GIS often come from many types, and are stored in different ways. A GIS provides tools and a method for the integration of different data into a format to be compared and analyzed. Data sources are mainly obtained from manual digitization and scanning of aerial photographs, paper maps, and existing digital data sets. Remote-sensing satellite imagery and GPS are capable data input sources for GIS.

Database Management and Update: After the collection and integration, the GIS must provide facilities, which can store and preserve data. Effective data management has many definitions but should include all of the following aspects: data security, data integrity, and data storage and recovery, and data protection abilities.

Geographic Analysis: The data integration and conversion are only a part of the input phase of GIS. What is required next is the ability to interpret and to analyze the collected information quantitatively and qualitatively. For example, satellite image can support an agricultural scientist to project crop yield per hectare for a particular area. For the same region, the scientist also has the rainfall data for the past six months collected through weather station interpretation. The scientists also have a map of the soils for the region which shows fertility and appropriateness for agriculture. These point data can be interpolated and what you obtain is a thematic map presentation isohyets or contour lines of rainfall.

Presenting Results: GIS technology is different from others because it presents information in different ways, In which the information can be presented once it has been processed by GIS. Conventional methods of tabulating and graphing data can be supplemented by maps and three dimensional images. Visual communication is one of the most enthralling aspects of GIS technology and is available in a different range of output options.

2.6 Applications of GIS

GIS in agriculture: GIS is used in a variety of agricultural applications such as, monitoring crop rotation techniques, managing crop yields, rainfall data, and projecting soil loss for individual farms or entire agricultural regions.

GIS in business: GIS is a tool for organization business information of any kind according to the location. You can keep track of where customers are, site businesses, target marketing campaigns, optimize sales territories, and model retail expenses patterns. A GIS gives you that extra benefit to make you and your company more competitive and successful.

GIS in the environment: Day by day GIS is very helpful to protect the environment. As an environmental professional, one can use GIS system to produce maps, catalog species,

measure environmental impact, or trace pollutants. The environmental applications for GIS are almost endless.

GIS in forestry: Today, administration forests is becoming a very hard task and demanding challenge. With GIS, foresters one can easily see the forest as an ecosystem and manage it conscientiously.

GIS in geology: GIS is used every day by geologist in a wide variety of applications. also can use GIS to study geologic features, analyze soils and strata, assess seismic information, or create 3-dimensional displays of geographic features.

GIS in hydrology: GIS can be used to study drainage systems, evaluate groundwater, and visualize watersheds, and in many other hydrologic applications.

GIS in land use planning: Now days GIS is very helpful to visualize and plan the land use needs of cities, regions, small towns, villages, or even national governments.

GIS in the military: cartographers and military uses GIS in a wide variety of applications such as creating base maps, assessing terrain, and aiding in tactical decisions.

GIS in Site Planning: All over the world people uses a GIS to help them locate sites for new facilities and also for to locate alternate sites for accessible facilities.

GIS in transportation: in transportation GIS is very helpful to manage transportation infrastructure or helpful to manage our logistical problems. Whether monitoring rail systems and road conditions or finding the best way to deliver your goods or services, GIS can help you.

GIS in the water and wastewater industry: One/Engineer can use GIS in water/wastewater industry for the planning, engineering, operations, maintenance, finance, and admin functions of their water and wastewater networks.

3. CONCLUSION

From the above study we have studied about the GIS system and get a general introduction about the data types, components, and applications of GIS system in different fields and also get how it is very useful in day to day works and by using this system how the braod work can be reduce to a less.

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