Images, GPS and GIS for Spatial Data Infrastructure

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1. INTRODUCTION

Geospatial information, including maps and images, are vital to support decision making at various level and implementation of action plans. With the availability of space borne imagery, Global Positioning System (GPS) data and Geographic Information System (GIS) technology, users are now able to process maps -both individually and along with tabular data and crunch them together to provide a new perception- the spatial visualization of information.

Space based images has the characteristic to cover vast areas and have larger information quality as well as multi-spectral and repeat observations ability, thus, it is suitable for regional and global environment monitoring. The application of satellite images not only used for mapping but also to monitor temporal changes in the environment.

Global positioning system is one of the recent and important advances positioning technique. Its effectiveness and high positioning accuracy, the system has been widely applied in many different fields.

Geographic information system now has become a tool to integrate different sources to help users to manage earth's resources and environment. It assists decision makers to formulate the best policy for the development and the use of earth's resources. Vast amount of geographical information that was originally scattered in different organizations like maps, photos, statistics, detailed list etc could be integrated in GIS environment.

The science of surveying and mapping encompasses a broad range of disciplines including Surveying & Mapping, Remote Sensing (RS), GIS and GPS. The technology of digital image processing, the global positioning system and GIS are being used to integrate, processed and analyzed the spatial data for sustainable development of the natural resources. The digital data (e.g. High resolution images, scanned aerial photographs, scanned maps and digital orthophotos) are currently available for this purpose. GIS is powerful system for decision-making tool is now in the hand of cartographers. Beginning with a computerized topographic map as its base, a GIS overlays and integrate graphic and textual information from separate databases. The end result is a customized and reliable tool that can support decision making and problem solving and provides almost instantaneous answers to complex questions.

In view of the present day requirement, Survey of India (SOI) plans to provide digital topographical databases for entire country on 1:50,000 scale initially, in a years time. Topographical data/maps in digital and analogue form on WGS 84 (World Geodetic System 84) is made available for general public without any restriction (existing topographical maps of SOI are on Everest datum). The department uses the state-of-the- art technology in glossarial data acquisition, management and dissemination. Airborne Laser Terrain Mapping (ALTM), GPS, Electronic Distance Measuring (EDM) instruments, digital photogrammetry, modern printing technology and computer hardware! software are being used in map-making process. High-resolution satellite imagery viz. SPOT, IKONOS data etc being used for updating of topographical maps. All these data sets would be useful in developing Spatial Data Infrastructure that will better facilitate the availability and access to spatial data for all level including Government sectors, Commercial sectors, Academia and citizens in general.

2. GPS, IMAGES & GIS

The technology of the geoinformatics is now becoming user friendly. The sophistication of new data gathering technologies and geographic information system (GIS) technologies is increasing in developing spatial data applications. In the present scenario, we may identify various technologies where its products and services are directly representing its application in sustainable development. These are like navigation and positioning, high resolution sensing, image analysis, GIS, data visualization, database management, geospatial data and its infrastructure and user application and solutions.

2.1 GPS Positioning

The principal navigation and positioning technologies in use today are the GPS, Inertial Navigation Systems (INS), radio-navigation systems such as differential GPS, beacons, satellite wide-area systems and local radio links.

Recent developments in GPS technologies include the incorporation of the Russian Global Navigation Satellite System (GLONASS) and the networks of low Earth orbit satellites.

Applications of navigation and positioning technologies are extensive, involving almost anything that requires positioning infonnation. Application areas include:

- Surveying: geographic location and data analysis including high-resolution asset location mapping
- GIS: geographic location, data analysis and presentation for asset management
- Vehicle navigation: installed in anything from commercial passenger cars to tanks

- Emergency location systems: typically installed in cars, in call-911 and in telecommunications devices made to pass on precise location data
- Airborne crop spraying: field positioning devices
- Marine navigation systems: from commercial fish finders to redundant systems on oil tankers

- Marine docking systems: centimeter level, short range systems for ferries and cargo vessels
- Aircraft navigation systems: from simple, en route systems in light aircraft to full landing systems
- Aircraft CFIT (controlled flight into terrain) avoidance systems: which match aircraft position to three-dimensional maps and warn crews of dangerous approaches to terrain
- Aerial survey systems: measuring and recording data from the air
- Hand-held personal navigators: from recreational use to search-and-rescue operations
- Wide area navigation systems: land-based, fixed data gathering and analysis systems to improve accuracy and integrity of the basic GPS system
- Robotic vehicles: mining ore extractors, helicopter surveillance, dangerous area surveillance, security surveillance
- Weapons training pods: attack aircraft weapons training systems

2.2 High Resolution Images

Airborne remote sensing has been characterized extremely flexible and broad range of high-resolution data enabling mapping at scales of better than 1:1000; black-and-white and color photography, mono and stereo; high-resolution multi-spectral and radar digital imagery. Alternatively, satellite remote sensing has exhibited resolutions typically 10 m or better, enabling mapping of up to 1:50000 scale. ALTM technology is being used for preparing large-scale maps. SOI has recently acquired digital data through ALTM technology and prepared a line map.

2.3 Image Analysis

Image analysis technologies are undergoing a number of changes. The major trend will be to see the expansion of image analysis technology from the exclusive domain of the highly educated remote sensing professional to the desktop of significant numbers of new professional and other users, as a result of a number of contributing factors. First, the continued drop in the price of PC hardware combined with a substantial increase in power, memory, storage capabilities and graphics speed makes sophisticated image analysis feasible for the first time on the desktop. Also, the planned launch *of* high- resolution commercial satellites will bring image analysis technology into many new markets including infrastructure, property management, health and insurance.

2.4 Geographic Information Systems

Geographic information systems deal with the storage, management, retrieval, conversion, analysis, modeling and display *of* spatially related data in a systematic way.

GIS software is potentially applicable in nearly any situation that calls for decisions involving a spatial component. m other words, GIS can be a useful tool in situations as diverse as area to determining the environmental impact. It is impossible to list all the possible applications of GIS, as they are practically limitless. As computer power grows, enabling the use of more complex models and the more efficient incorporation of a time component in analysis, the more this will be true.

Advances in computer software and hardware, increased familiarity with the power and applicability of GIS and its related technologies, and a greater breadth of accessible data have driven the growth in demand for GIS and will continue to do so in the future. Throughout the knowledge-based economy, both software and hardware have become much more powerful and simple to use while becoming less expensive. Clients in all markets are now comfortable with computers and have access to the necessary equipment to run even complex GIS packages. Furthermore, not only has a greater range of geospatial data become more readily available but also non-traditional data such as those found in the social sciences.

2.5 Data Visualization

Geospatial-related data visualization technologies are tools that facilitate the understanding of complex data sets, models and issues that have a spatial component. They include everything from their simplest form -- paper maps -- to a wide range of computer hardware and software. While these represent a broad spectrum of complexity, these media are linked by their purpose of presenting geospatial data from different perspectives. Recently, however, data visualization has been driven by advances in modem computer and display technology.

As geographic information systems become more flexible, powerful and sophisticated and more closely integrated with modeling software, the interface between the GIS and the user needs to become more interactive and complex. There is also a push for the broader application of data visualization technologies in non-traditional areas.

2.6 Database Management

Data Base Management System (DBMS) are specialized pieces of software that provide functionality for storing, updating and retrieving information and generally provide mechanisms for maintaining the integrity of stored information, managing

security and user access, recovering information after the system fails, and accessing database functionality from within an application written in a third-generation language such as COBOL, C or JAVA.

Great advances have been made in the area of DBMS over the past decade. Early systems were hierarchical in nature, but relational systems have become the standard recently. With the emergence of object-oriented programming languages, object-oriented systems are becoming increasingly important to data storage. Constant developments in areas such as structured query languages, most recently SQL3, have been a driving force in these changes and are fuelling a shift away from purely relational systems.

2.7 Geospatial Data and its Infrastructure

The characteristics of the geospatial data set are changing. First and foremost, in order to meet users demands effectively, the capacity for the real-time collection, synthesis and access must exist; data currency is essential. The data should be scale less, seamless, without artificial boundaries, and linked to a time component that has become critical to many applications, for example, traffic flow management, routing and delivery, and tidal and marine traffic. Moreover, as technologies become more advanced, geospatial information will be both more readily available and in greater demand.

There will also be a growing trend toward the collection and integration of non-traditional data using secondary reference systems like voting, culture and housing patterns, gender, sales and industry. Furthermore, as technologies and applications become more globally used, geospatial data will spread to and originate from non- traditional sources such as the voluntary sector, health councils, communities and peoples. However, regardless of what data are collected by whom, unless they are easily and readily accessible, their value diminishes; hence the importance of an exceptional geospatial data infrastructure.

Furthermore, a well-developed national information infrastructure, enabling the dissemination and sharing of valuable, geographically referenced information, and with an ever-increasing audience of businesses, entrepreneurs, students and researchers, and communities, is widely accepted as an essential asset for any country to maintain and to, advance its social and economic well being. As such, geospatial data and the infrastructure in which they are organized can be considered to be a technology in its own right within the rubric of this Technology.

2.8 User Applications and Solutions

While technologies such as GPS and GIS have matured during the 1990s, increasing attention has been focused on the development of user applications and solutions. This technology segment can be defined as software/hardware

solution bundles developed specifically to solve a geospatial information user's problem. The critical challenge in this area is for the technology supplier to gain an in-depth understanding of the user's business environment so that the solution is optimized to address the user's key business issues. Built on top of the core technologies, user applications/solutions are developed using combinations of database management, object-oriented programming and systems integration tools and techniques. Clearly, geospatial data and GIS were considered to be extremely important technologies for addressing solutions in a number of applications.

India, over the years, has generated a rich base of information through systematic data collection in the form of topographical surveys, geological surveys, soil surveys, cadastral surveys, various national resource innovative programmes and the use of remote sensing images. Further with the availability of digital topographic databases, high- resolution imageries and sophisticated techniques of data collection using GPS and tidal station, the accuracy of information content of these spatial data sets or map is very high.

With the growing awareness for Information Technology among users, an initiative was taken by Department of Science & Technology in the form of National Spatial Data Infrastructure (NSDI). NSDI is the mechanism through which need for access to reliable, timely and spatial data are met. It is a first step in the direction of bringing together data providing agencies and to obtain commitment from them to make special data available and accessible to the user community, which Conforms to accepted standards, The NSDI framework aims at decentralized approach to achieve the following objectives:

- Develop and maintain standard of collection of spatial data.
- Develop common solution for discovery, access and use of spatial data in response to the needs of diverse and new user groups.
- Relationship among participant's organizations to support the continuing development of NSDI
- Increase the awareness of the vision, concepts and benefits of the NSDI.

This framework when fully implemented will be utilized for various developmental activities including preparedness, response and recovery purposes during disasters. The availability and use of spatial data shall have impacts on every aspect of society and will be made available to people who need them, when they need them and in the format at they can make decision with minimal pre processing.

3. CONCLUSION

Images, GPS and GIS were considered to be extremely important technologies for addressing solutions of various users. The technology of surveying and mapping is knowledge-based and having no bounds or limits at this time and

having the possibility to evolve in numerous directions. The technology advancement will determine the direction and strength of this evolution over the next few years. As such, it is very difficult to describe how the technology will look at any time in the future with any degree of certainty.

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