GEOSPATIAL TECHNOLOGY FOR3D CITY AND URBAN MODELLING

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***Abstract**: Geospatial Technology, known as geomatics, refers to technology used for visualization, measurement, and analysis of features or phenomena that occur on the Earth.*
*Geospatial technology includes three different technologies that are all related to mapping features on the surface of the Earth. These are: **GPS** (**G**lobal **P**ositioning **S**ystems), **GIS** (**G**eographical **I**nformation **S**ystems), and **RS** (**R**emote **S**ensing). The consequence of the sustainable development implementation is a necessity of spatial system designing. Geographic Information System (GIS) can be such a tool. It gives quick access of updating and analyzing spatial database.*
Nowadays, there is an increasing interest in 3D technology which can be seen also by major cities developing 3- dimensional models, and global technology companies developing solutions to capture, display and manipulate this type of data.

***Keywords:** geospatial, GPS, GIS, database, spatial, urban modelling*

1. Aims and Background

GIS as modern technology of analysis and graphical-textual database processing method is a very important element in urban modelling and also in environment resources management. This is a basic purpose in case of multifunctional spatial system. The problem of urban modelling represents a very important activity regarding interdisciplinary interest for technical, economical and social development improvement; it can provide accurate and efficient solutions in order to cover basic needs of land administrative information and decision making for the Local Authorities.

The process of urbanization and metropolitan growth in the 20th century was a consequence of rapid technological evolution, rising living standards, as well as general well being. Compact city policies has resulted in an increasing demand for land within city . As for Romania, the problem has particular features caused by general economic, financial and technical, physical, geographic and other peculiarities.

The first problem is the lack of digital cartographic base resulting from a weak material and technical basis. The second problem is creation of different resources of the digital thematic geo-information on a unified digital cartographic base. Most of the existing sources of initial data are characterized by information isolation, incompleteness, contradictoriness, and duplication for their distribution. It is recommended to create a unified territorial system including all information on natural, material, technical and human resources.

The third problem concerns the construction of a special-purpose GIS for governmental bodies of different levels. It is solving requires development of modern GIS-environment; hardware and software for data protection, confidentiality, access delimitation to data bases and facilities; also software for general functions of executive power.

2. Problem Formulation

The increased availability of high-resolution satellite images and aerial photography in support of detailed terrain surface elevation models assists urban planners and municipal managers to create a model and visualize the urban space in three dimensions.

3D visualization have a variety of applications in geography and urban studies. Accurate cartographic feature extraction, map updating, digital city models and 3D city models in urban areas are essential for many applications, such as mapping of buildings and their heights, simulation of new buildings, military operations, disaster management, updating and keeping cadastral databases current, and virtual reality. While they are generally used to simply visualize the built environment, there are early signs of them being used as 3D interfaces to more sophisticated simulation models.

With today's high-resolution Satellite sensors available at the <0.6m resolution it becomes more practical and economical to use Stereo Satellite Image data to generate <3m Digital Surface Models (DSMs) for areas located around the world without any requirements for Aerial Mapping permits, licenses or mapping in restrictive airspace.

Satellite imagery can greatly enhance a Geographical Information System mapping project. Imagery is a powerful visual aid and serves as a source of derivative information such as planimetrics and classification schemes. 3D models can be used as a user-friendly interface for querying the urban environment as a Geographical Information System(GIS) for Web-based information, for visualizing model results, and for accessing functional simulation models.

A general classification of 3D city models [5], based on their operational purposes, might be organized around four main types: 3D CAD (computer aided design) models of cities; Static 3D GIS (geographic information systems) models of cities; Navigable 3D GIS models of cities; 3D urban simulation model.

- **3D CAD models of cities**

  3D CAD models of cities are by far the most common example of 3D urban model, with several applications applied to many cities around the world.

Generally, these models depict cities or scenes from the built environment in three dimensions with varying degrees of attention to detail and artistic rendering. The models can be developed using standard CAD software packages such as 3D Studio Max, or programming languages such as C++ and VRML (virtual reality modelling language). *3D CAD* models are often delivered as animations, static screenshots, and navigable VRML environments. Models may be navigated by the user or may be static. The applications to which these models are used are diverse, ranging from advertising and promotion to design review and public outreach.

- **Static 3D GIS models of cities**

3D GIS models are identical, in many cases, to the CAD models. In many cases they are generated using the same software and delivered via the same media. The difference is in functionality.

While the CAD model offered no functionality to the user, the incorporation of a geographic information system (GIS) underpinning a CAD display model enables users to perform spatial queries of the buildings and built space depicted in the model environment. A GIS, essentially, acts as a spatial database with a graphical interface for performing queries, operations, and manipulations on data in a spatial plane. *3D GIS* models introduce that functionality (if available data permits) to the CAD model. Users can query the built environment and have the results displayed visually and interactively in three dimensions on the screen. For example, a user might wish to find out where available office space fitting several price, situation, and structural characteristics lies within a downtown district of a major city.

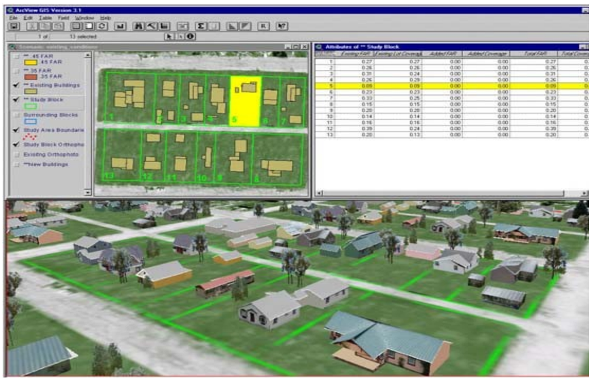

Fig.1 Static 3D GIS models of cities

- **Navigable 3D GIS models of cities**

3D city models are increasingly considered as important resources for municipal planning and decision-making.

An important aspect of cities is the navigable space within them. There is a need for 3D city models to incorporate topologically connected navigable spaces, in which space internal to buildings is topologically connected to space outside buildings and in which the terrain is part of this navigable space rather than a simple surface upon which buildings are placed.

Navigable space in cities can be considered to be a set of topologically-connected discrete spaces, juxtaposed in three-dimensional space. Access to these spaces is governed mostly by the geometry of these spaces.

Such navigable details of space in cities are difficult to obtain, but some of the general-purpose semantically-rich 3D city models may provide opportunities for obtaining this information.

Fig.2 Navigable *3D GIS* model, Bucuresti-Romania [13]

- **3D urban simulation models**

In recent years, significant advances have been made in the development of intelligent 3D models of the built environment. Our days technology enables us to render visually stunning and richly detailed simulations of urban environments in a manner that renders an ease of interaction and understanding that is not currently present in many simulation models.

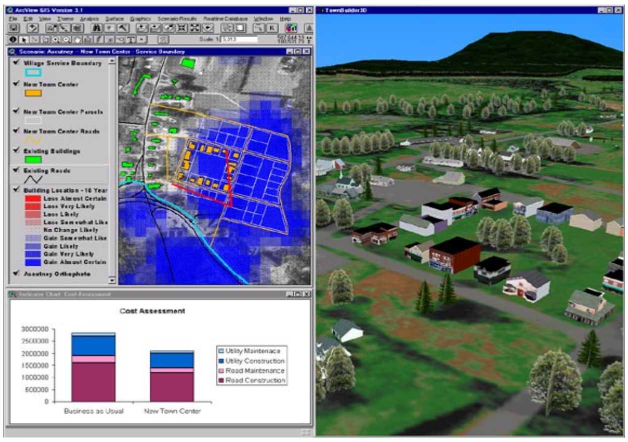

Fig.3 Simulation model

3. Problem Solution

„Geospatial technology includes three different technologies that are all related to mapping features on the surface of the Earth. These are: **GPS** (**G**lobal **P**ositioning **S**ystems), **GIS** (**G**eographical **I**nformation **S**ystems), and **RS** (**R**emote **S**ensing).

Satellite Positioning Systems-GPS

Lately, positional science has been adding space-based telemetry techniques to obtain ground coordinates. These new passive and active space-based measurement systems are changing the very nature of positional science to one that can give precise coordinates very quickly for any ground position. Satellite positioning systems have one thing in common – receiver hard-ware has to be taken to every field location to be mapped. There are currently three operational satellite positioning systems available for land management coordinate determination activities:

- ✓ ARGOS Data Collection and Location System, which has been used to identify and locate some natural resource phenomena.
- ✓ TRANSIT Satellite Positioning System, which was developed for the U.S.Navy Navigation Satellite System. Is a passive system requiring a ground receiver for the user, the TRANSIT satellite, satellite tracking and control facilities.
- ✓ GLOBAL POSITIONING SYSTEM (GPS), designed to provide worldwide, all weather, 24 hours/day instantaneous geographic positioning and time information.

The Global Positioning System (GPS) is the only fully functional Global Navigation Satellite Systems (GNSS). Using a constellation of at least 32 Medium Earth Orbit satellites that transmit precise microwave signals, the system enables a GPS receiver to determine its location, speed, direction, and time. The technology collects and processes signals from GPS satellites in orbit around the earth to determine the location of points of interest on the ground.

The typical nominal accuracy for dual-frequency systems is 1 centimeter ± 2 parts-per-million (ppm) horizontally and 2 centimeters ± 2 ppm vertically.

Geographic Information System -GIS

Geographic Information System, or GIS is technology that offers a radically different way in which we produce and use the maps required to manage our communities and industries. GIS is a computer system capable of capturing, storing, analyzing, and displaying geographically referenced information; that is, data identified according to location. Specialists also define a GIS as including the procedures, operating personnel, and spatial data that go into the system. A GIS creates intelligent super maps through which sophisticated planning and analysis can be performed at the touch of a button.

Geographic information system technology can be used for scientific investigations, natural resource management and mining, government, environmental impact, urban planning, law enforcement, route planning, and natural hazards.

The key advantage to GIS is the ability to share maps. National and local agencies, along with utility companies, which create their own respective maps, can, for example, share maps with each other. This not only saves money, but provides the ability to create hundreds of new maps, many of which never existed before, for minimal cost.

Geographic Information System (GIS) is an assembly of people, equipment (hardware), programs (software), algorithms and procedures (methods) which ensure the processing, management, manipulation, analysis, modelling and visualization of spatial data in view of solving some complex problems regarding planning and territory management [1].

Transformation of the present informational system into database system supposes the organization of all information into separate files, which are closely, related one to another Designing a dynamic framework for planning and development, based on spatial information like Geographic Information System (GIS), can be created the master plan of any populated area.

The Master Plan is part of a larger process implying the use of Geographic Information Systems in order to develop an urban quarter. In this sense, the Master Plan is much more than a document for spatial development orientation; it is, above all, ***a strategic vision of the city*** based on directive principles that make a coherent combination of respect for natural balances, economic efficiency, market forces and social equity.

Remote Sensing

Satellite Imaging Technology (Remote Sensing) has led the way to the development of hyperspectral and multispectral sensors around the world, a tool that can be used to map specific materials by detecting specific chemical and material bonds from satellite and airborne sensors. Multispectral data acquired in space and by airborne sensors have been utilized extensively for the past many years in research projects dealing with such diverse problems as land cover and topographic mapping, physical and biological oceanography, and archaeology.

Research has expanded to include analysis of hyperspectral data acquired simultaneously in tens to hundreds of narrow channels. New algorithms have been developed both to exploit the spectral information of these sensors and to better deal with the computational demands of these enormous data sets. It is an excellent tool for environmental assesments, mineral mapping and land cover mapping, wildlife habitat monitoring and general land management studies.

Multispectral imaging often can include large data sets and require specialized processing methods. Hyperspectral data sets are generally composed of about 100 to 200 spectral bands of relatively narrow bandwidths (5-10 nm), whereas, multispectral data sets are usually composed of about 5 to 10 bands of relatively large bandwidths (70-400 nm).

At present, considerable development of GIS-technologies and GIS-complexes are carried out in Romania and there is a good basis to create own
standards for the Geographic Information System, especially for governmental and regional authorities.

4. Conclusions

Much of the information the decision-makers have to take into account has a dynamic quality; the information changes continuously in time and space.

In such a situation, the challenge is to maintain community services at a high level and stimulate change and development in spite of the difficulties. To be able to handle these challenges and problems in an efficient way, there is a need for improved planning and decision support systems.

At urban and out-of-urban high stocked areas the multifunctional exploitation rule of resources can concern nature resources (water, soil, etc.) and human resources (technical infrastructure, housing etc.). The sustainable development of specified spatial systems stands for economic-social and ecological equable development. It results in a creation of more and more complicated and effective systems, such as multifunctional systems, which have a high economic, social and ecological effectiveness.

The consequence of the sustainable development implementation is a necessity of spatial system designing. Geographical Information System (GIS) can be such a tool. It gives quick access of updating and analyzing of spatial database. A GIS is capable of integrating large amounts of geographic data from different sources and is able to respond to non-routine questions. As a result, it can be a most powerful instrument in the development of Environmental Information Management System.

5. Acknowledgment

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