THE USE OF GIS TECHNOLOGIES FOR CREATING TOURIST REFERENCE SYSTEMS

Oleksandr Dorozhynskyy, Ihor Kolb, Ali Fargal

Lviv Polytechnik National University Stepan Bandera St. 12, Lviv – 13, Ukraine, 79013 (adorozhynskyy@hotmail.com)

The purpose of this research is to show how to apply GIS technologies to creating information reference systems. The software product “Jordan GIS Tourism” is presented as a model. This stand-alone system requires Windows 95 or Windows NT and functions without basic instrumental GIS. The proposed GIS includes the following items: Map (options: vector maps, structure of image layers, scaling, printout, selecting single objects or a group of objects by certain characteristics, visualizing the information); Jordan viewed from space (a collection of satellite images); The History of Hashemite Kingdom of Jordan (a document in html format); Jordan today (the information on political, economic and social systems, natural resources, working hours of state and commercial establishments, traditions); References (database of mail addresses of state establishments, embassies, telephone directory, transport system); About GIS (how to use the program). The detailed description of GIS functioning is exemplified with the pictures of operational windows.

1. GIS BASED TOURIST INFORMATION REFERENCE SYSTEMS: BASIC APPROACHES

Owing to the ever-increasing capacity, speed and flexibility GIS technologies are nowadays embedded in various fields of human activity. The prospects of GIS can also be successfully extended by the use of Geoinformatic principles for creating computer-aided information reference systems (hereinafter – CAIRS) [1].

In order to develop CAIRS for wide groups of users with different level of Geography and Informatics knowledge it is necessary to elaborate techniques for creating GIS based CAIRS and methods for processing data used in the CAIRS. A special regard should be paid to the thematic perspectives of CAIRS. To enhance the adequate utilization of CAIRS information potential it is important to fix criteria for metric characteristics, content and visualization abilities of the maps. Another significant objective of the CAIRS is to create and effectively use the “object–description” and “object–illustrations” connections. One of the main needs is to effectively use the data of aerospace survey which although being still underused, make an extensive source of metric, descriptive and illustrative information about the objects.

The development of a CAIRS conception is presented in this article and was realized within “Tourist GIS”-project for Hashemite Kingdom of Jordan.

Though geographic electronic maps are an important information source for many users they are often of low quality and their informational potentials are not fully used. It is possible to improve the multimedia maps by use of GIS technologies that implement diverse methods and algorithms of information processing used in various fields. GIS can also integrate the cartographic DB records with the non-cartographic information specified by CAIRS theme.

Nowadays the modern GIS based CAIRS are presented in the following varieties:

- The computer-net oriented systems presented in a standard data format with the access through the standard protocol.
- Stand-alone libraries of programs arranged as RDBMS providing accesses to cartographic and non-cartographic information.
- CAIRS based on instrumental GIS.
- Systems created for mobile devices with GPS.
The CAIRS of the first type are mostly created as WEB-pages. The cartographic information is presented in the raster format which limits the capability of selection of the objects on a map. The map is relatively “interactive” owing to “active areas” located around most important objects. “Active areas” facilitate selecting the object on the map and searching for the characteristics of the object in the database. The illustrations and description published on a WEB-page are not linked to the map objects therefore such systems are meant for different user groups without special training in Geography and Geoinformatics.

The second type CAIRS views the map as the basic informative element of the system. The maps in both raster and vector format can be used. RDBMS provides diverse strategies of searching, selecting, sorting and representation of data. But the maps are often made inefficiently and cannot be changed by a user.

The CAIRS of the third type has the highest potential for making, representing and analyzing geoinformation. Powerful GIS toolkit provides abilities to create cartographic data banks, organize geographically-oriented information, arrange maps in layers with the choice of symbols for the map legend, realize various functions of data analysis and representation. By utilizing means of developing GIS-application it is also possible to create interfaces to be easily used by the “average” user, get access to metric and semantic characteristics of objects, program solutions to the tasks typical of certain CAIRS. The disadvantages and advantages of these systems are defined by the use of GIS technologies. The users need to operate with basic instrumental GIS. This demand suggests high requirements for hardware, certain level of special training and rather large financial expenses. Consequently, such systems are oriented toward the institutions and establishments that can purchase GIS and have adequate hardware and qualified personnel for its successful functioning.

The extensive development of PDA on the market propelled designing GIS software for mobile electronic devices.

Software products are divided into three groups – comparatively simple CAIRS (map browsing and searching procedures are realized according address, semantic or spatial attribute); advanced GIS with the function of network analysis providing on-line data correction by service provider; instrument combination “PDA-GPS receiver” that allows tracing the location of the user and displaying it on the map. This type of GIS suits the best the requirements of the wide range of users.

All aforementioned products utilize GIS either “directly” that requires knowing the geoinformatic technologies, or “indirectly” (“transparently”) that allows users to operate with specific notions without having geoinformatic knowledge.

To create CAIRS available to all users it is necessary to combine different methods and instruments of their realization simultaneously avoiding their disadvantages and preserving their advantages. The main requirements for CAIRS might be as follows:

- electronic map in vector format is a main information source for the spatial data users;
- it is necessary to utilize geoinformatic technologies to provide high quality connection “selecting object – displaying its characteristics – solving spatial task”;
- user interface should not allow operating procedures requiring special knowledge and training;
- It is necessary to utilize visual programming methods, means of GIS-application development to design CAIRS as a software module. Standard data exchange formats are used to save data;
- When developing software and data structures it is necessary to make provision for the system functioning on the basis of mobile electronic devices and data export import capabilities.

The prospective CAIRS consist of three units: the unit of electronic mapping, the unit of spatial data analysis and modeling, the unit of visualization of non-cartographic information.

The unit of electronic mapping provides creating cartographic base, data classification, input and editing cartographic database, management of electronic map viewing. The CAIRS for general purposes does not require maps with high degree of accuracy and is usually based on small-scale maps. Consequently, the cartographic capabilities of desk-top GIS are often quite sufficient.

The unit of spatial data analysis and modeling makes provision for solving a wide range of tasks defined by the theme of the CAIRS. Let us assume that city is represented with a point on a map, then the location of the city is described with a couple of coordinates XY and its name, population and administrative significance will make its probable semantic attribute. These data is enough to find the distance between the city and other objects, to find the nearest object of a certain type, to create a buffer zone, etc. Specific database are needed to solve more complicated tasks connected with the use of topologic structures. The results can be depicted as numerical characteristics, diagrams and
lists on the map. If standard GIS is insufficient for solving certain tasks stipulated by CAIRS themes, it should be programmed manually in high level programming languages.

GIS meant for the “average” user may effectively integrate traditional maps and other types of geographic images based on cartographic data bank.

There are following widely acknowledged ways to model geographic images [2]:
- map – 3D-model – animation – virtual model;
- map and photograph – ortophotomap - 3D-model - virtual model;

The unit of visualization of non-cartographic information serves to visualize DB, images and texts either in response to the request for electronic map object, or independently. One of the ways to arrange this type of visualization consists in saving the name of resource containing the non-cartographic information (file, DB record, cash buffer, etc.)as an attribute of cartographic object. Visualization of non-cartographic information is performed with standard methods of OS.

Thus CAIRS architecture may be presented as follows (Fig.1)

Graphical interface integrates the unit of electronic mapping and the unit of visualization of non-cartographic information to select the information requested by user and to send the data and requests to the unit of analysis and modeling. The unit of electronic mapping utilizes the library of GIS functions. Standard methods of OS WINDOWS provide data interchange in computer networks.

2. CAIRS FOR TOURISM: PROJECT AND REALIZATION

Tourism is a very important and dynamic economic issue. Under condition of rapid development of infrastructure, growing amount of tourist service offer, huge number of potential clients and continual changes of legal foundation it is necessary to provide effective dataware for tourism. GIS technology suggests a solution to the problem. The main objective of the GIS-project is to capture, accumulate, model, analyze and present spatial and descriptive data directly or indirectly connected with tourism.

The electronic map makes a basic element of the Tourist GIS. The map functions in dialog mode providing access to non-cartographic DB accumulating reference, descriptive, statistic information connected with the object on the map. Non-cartographic data are visualized as tables, diagrams, graphs, images (including satellite images).

Electronic map is created in the instrumental GIS environment. Various sources like geographic maps, atlases, geographic descriptions, statistic and reference information, materials of local surveying compose the information basis for the electronic map. It is necessary to code the information and to create build the map in accordance with the classification and coding system adopted in the basic instrumental GIS.

The non-cartographic information must be coded in standard data exchange formats of OS. This allows the user to independently correct the DB.
Tourist GIS for Hashemite Kingdom of Jordan and territories of bordering states cover the area of about 400 km x 400 km. The basic map scale of 1:2000000 (with possible image magnification 1:10000) is suitable for 17” display. It is highly recommended to choose geographic projection with the distortion of angles, lengths and areas less than 7%. The distortion exceeding 7% leads to incorrect visual representation of the territory [3].

To professionally use GIS in public administration and in various establishments and institutions that allow a user to complete various tasks like calculating and displaying the parameters of activity and prospects of region or/and state development [4-5].

The interface of the tourist GIS provides the following operations:
- visualizing cartographic and reference information (with further capability to change the scale, style of dialog and printout);
- shaping images; managing the electronic map layers;
- interactive selecting map according to the type and attributes;
- Solving the specific problems like selecting and optimizing the tourist route with calculating distance and identifying the nearest to the route objects (hotels, service centers, etc.)
- accessing to the Internet to search for the data with the preliminarily indicated addresses.

The interface should be designed taking into account the demands and abilities of the wide range of users.

Considering everything aforesaid the GIS for Hashemite Kingdom of Jordan includes following main items:
- Map (options: vector maps, structure of image layers, scaling, printout, selecting single objects or a group of objects by certain characteristics, visualizing the information);
- Jordan viewed from space (a collection of satellite images);
- The History of Hashemite Kingdom of Jordan (a document in HTML format);
- Jordan today (the information on political, economic and social systems, natural resources, working hours of state and commercial establishments, traditions);
- References (database of mail addresses of state establishments, embassies, telephone directory, transport system);
- About GIS (how to use the program).

3. “TOURIST GIS”-PROJECT FOR HASHEMITE KINGDOM OF JORDAN: IMPLEMENTATION

The aforementioned theory and methodology were implemented in the software product “Jordan GIS Tourism”. It is a stand-alone software program requiring Windows 95 or Windows NT. The program may function without basic instrumental GIS.

The source code of the system is created in the rapid application development (RAD) environment “Delphi” with the use of GIS Tool KIT (a system for developing GIS-applications) used for instrumental GIS PANORAMA 2000 [6].

As Windows based application this System allows sharing data between different windows applications (RDBMS, electronic spreadsheets, text and graphics editors etc.) and electronic maps using OLE 2.0 protocol in client-server mode or cut and paste (clipboard) mode.

User environment supports multi document interface (MDI) and Drag and Drop feature. It permits using several types of data at the same time.

The Main Form of the system provides access to the items “Map”, “Jordan viewed from space”, “The history of Hashemite Kingdom of Jordan”, “Jordan today”, “References”, “About GIS”.

The item “Map” (Fig.2) allows the user to select electronic map, manage map representation and inquire for information about the map objects.
The electronic map of the Hashemite Kingdom of Jordan is created in the environment GIS Panorama and includes the following cartographic layers:

- mathematical base;
- relief;
- hydrography;
- road network and road constructions;
- inhabited locality;
- administrative division;
- tourist objects;

The image of map can be sent to various external devices. It allows getting high quality hard copies of electronic maps with the situation inserted by users and copies of raster images and documents.

Some fragments of electronic map can be saved as Windows metafiles and used as illustrations in various applications. Multi-layer map representation on the display is achieved by combining the layers and objects of different types.

Map manipulation functions are realized through a set of dynamic libraries GIS PANORAMA 2000 which permit embedding call, representation and management functions into the task.

The relief or administrative division may serve as raster background for the map.

The Main Form enables realizing additional tasks of the network analysis, namely making optimal routes with calculating distance on map and using known algorithm on graphs [7]. To save the data on road network graph, the topologic structure is used. The data on nodes, intermediate points describing the axis of roads, type of paving, notes on the conditions of the road section are saved for each edge of the graph owing to the elaborated structure of data file on road network of Hashemite Kingdom of Jordan. This structure permits shaping a new graph of the road network for each separate “search session”, visualizing and processing routes as cartographic objects. All in all, the data file includes 6000 records for saving information on 620 edges of the road network graph. The route-making "session" suggests different variants of implementation:

The first variant:
- to make route as a polyline passing through specified points on the map;
to search for optimal length of the route passing along the roads of selected types (motorway, highway, earth road) and connecting points selected on the map.

The second variant:
- to make a road network graph according to specified parameters;
- to indicate the initial point of the route on the map and to search for the nearest intermediate point of the road network graph and the graph node nearest to that point;
- to indicate the end point of the route and to search for the nearest intermediate point of the road network graph and the graph node nearest to that point;
- to compose the tree of the shortest route;
- to make and visualize the route as a cartographic object; to represent the path length.

The samples are shown in Fig. 3.

Figure 3. Making route of optimal length.

The items “The history of Hashemite Kingdom of Jordan” and “Jordan today” allows visualizing and editing relevant information saved in html or doc files. Standard browser uses WINDOWS tools to organize the work in the Internet, to edit and manage the document (Fig.4).

The item “Jordan viewed from space” includes a collection of satellite images and a navigator to select the image (Fig. 5)

IN SUMMARY

The main principles of the use of GIS technologies for creating multimedia information reference systems were elaborated. These systems are oriented toward public administration, education, economy and can also be used by individual user. Based on the theoretical approaches of geoinformatic cartography, the tourist GIS for Hashemite Kingdom of Jordan exemplifies strong positive influence of GIS technologies on various branches of human activity, particularly on development of tourism.
Figure 4. “Jordan today”

Figure 5. “Jordan viewed from space”
REFERENCES
5. Захарцев А.Ф., Семенов А.В., Федотов А.В. Географические информационные системы в управлении регионом на примере развития инфраструктуры туризма.: http://www.gisa.ru/3227.html

OLEKSANDR DOROZHYNSKYY (UKRAINE)
born Feb.4, 1941)
Professor. Doctor of Science.
Field of research: Analytic Photogrammetry and GIS Technologies.
1962 – graduated from Lviv Polytechnic National University (specialty Photogrammetry).
Since 1963 he has held a position of lecturer at Lviv Polytechnic National University, Docent (1973 – 1989), Professor and Chairperson of the Department of Photogrammetry and Geoinformatics (1989 – till now).
Oleksandr Dorozhynsky presented his Candidate thesis in 1972 and his Doctoral thesis in 1988. In 1989 he was awarded the Golden Medal of the Academy of Science for application of Analytic Photogrammetry methods to Geologic mapping, Hydrogeology and Geophysics. The number of his publication has amounted to 145 articles, 2 monographs and 5 textbooks. He was a scientific supervisor of 6 Candidate and 1 Doctoral thesis.
1995 – elected as President of Ukrainian Society for Photogrammetry and Remote Sensing.