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Multi-layer computer system of GIS type for needs of local government units of urban areas

Wielowarstwowy system informatyczny typu GIS dla potrzeb jednostek samorządowych aglomeracji miejskich

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Abstract
In the article authors present the structure of recourses management system in local government on example of one of the Varsovian district. Recourses are understanding as building and land (cadastral) data enriched by different accessible materials. The methodology of system construction, range of data as well as functions realized by the system were introduced. The architecture of a system is (with some modifications) the classical solution characteristic for systems of GIS type. Such a system is designed to support of economic, social and administrative decision making as well as is a ground to bring cadastral system into effect.

Słowa kluczowe: GIS, system zarządzania zasobami, dane rastrowe, wielowarstwowa baza danych

Abstrakt
W artykule autorzy prezentują strukturę systemu zarządzania zasobami w jednostkach samorządowych na przykładzie jednej z dzielnic warszawskich. Zasoby rozumiane są jako dane ewidencyjne gruntów i budynków wzbogacone o inne dostępne materiały. Przedstawiono metodykę budowy systemu, zakres danych, jaki on obejmuje oraz funkcje, jakie spełnia dla użytkowników. Architektura systemu stanowi (z pewnymi modyfikacjami) klasyczne rozwiązanie charakterystyczne dla systemów typu GIS. System ten przeznaczony jest do wspomagania decyzji gospodarczych, społecznych i administracyjnych oraz stanowi podstawę do wprowadzenia katastru.

Topic description

The efficient management in local government requires the acquaintance of data about resources what this units administers. To the most often used information about terrain belong data about possessional state accumulated in cadastral databases. The connection of these data with (possibly) current data about land development, aerial and satellite photographs, is the perfect material to creating information systems which are satisfying needs of economy, public administration systems as well as self-government units.

The current computer systems operate on large sets of information. Data very often project real objects in definite time and space. Such data are characterizing by very large variety of structures about many interrelationships. These data contain information about location, graphic interpretation as well as some descriptive, qualitative and quantitative features of real objects. Systems the most often consist of workstation sets operating on common data in the same time. To the such category of systems, among others, the Geographic Information System (GIS) should be classified [1].

The data simultaneous access in such systems should be assured with many worksites in order to realization editorial, project and presentative work. Regarding this fact, it is profitable to storage data in distracted or uniform but functional central database, to assure suitable synchronization mechanisms of data access for individual workstations of

the system [2, 3]. Similarly solutions were presented many times by authors on thematic, scientifically-technical conferences. The originality of presented researches concerns among author's solution of a communication problems between individual departments relating to real property status changing. Moreover, in article the methodology of filing (archiving) of editorial work was introduced. The storage in central database results of editorial work are unfavorable with the necessity of realization big quantity database transactions and network transmissions. It can cause to long time access (in many workstation systems type, strong time-critical conditioned) to database as well as to rise the state of lack cohesion data in a system. The complete results of editorial working realized in local workstations are usually connected with long--lasting data transmissions to central database of a system, which from different causes can be broken or end mistakenly. From this point of view, it should be secure before loosing, keeping simultaneously the cohesion of data in central database of the system.

The necessity of quick data access, procure of reliable information as well as technical progress, extort to keep real property record in computer system, in which the basis is outright the computer database.

Departments functioning in communes and working on geodesic data and administer huge quantity of information in both descriptive and graphic type, which in the majority of cases is keeping and actualizing using traditional methods. They influence on this state, have hitherto exist procedures, currently in force regulations and also necessary costs to adapt these data to numeric mould. The effort made on computer tools using and development seems to be necessary, if we want to catch up current needs.

The example of such a management system is the Recourses Management System put into practice in one of quarter of Warsaw [4]. Researches into system guided under prof. Sanecki management and continued under prof. Klewski management, was begun witch analysis of needs and data inventory control. The detailed work expected for realization of presented task included:

- identification of potential users of the system as well as analysis of their informative needs;
- performance of organizational, economical and technical general assumptions;
- proposing ways of managing of the system (creating, actualizing and making information available);
- assurance of compatibility of proposed solutions with different systems functioning at local government;
- proposing of data gaining, processing and analyzing methods;
- characterizing of computer standards;
- determination of directions of extension and farther development (of the system).

On that basic came into existence the conception of the system which based on following assumptions:

- *openness*, it is the possibility of a system extension basis on appearing of new needs and readiness of co-operation with different systems;
- *scaling*, it is the possibility of system components adaptation to different level of information details, stage of the user's requirements, enlarging the range of using of the system;
- *elasticity*, it is the ability of adaptation to possible changes of organizational structures or range of competence.

The first stage of system building was collection of all numerous data of geodesical inventory of city district. Accessible turned out:

- lists of co-ordinates of plot record and computational,
- plan of spatial management,
- data bases from ISEG-M system,
- various data in descriptive mould.

On that basics such an architecture of the system was designed which made possible to use different data which create thematic multi-layered numeric map.

Architecture of the system

In this publication description of Distracted Database was introduced. Using this database eliminates appearing of data incoherent as well as makes possible:

- storage complicated and mutually related object--oriented structures of descriptive and graphic data, using the typical related databases;
- realizing of editorial workings on storage data;
- making topology analyses on storage data;
- providing many versions of data (useful in projecting processes and for choice the best version or the possible take back of changes purposes).

Tasks above-mentioned are realizing by functions (accumulated in dynamically added to application library), which also entirely automatically manage database schemes (creating them, modifying and removing).

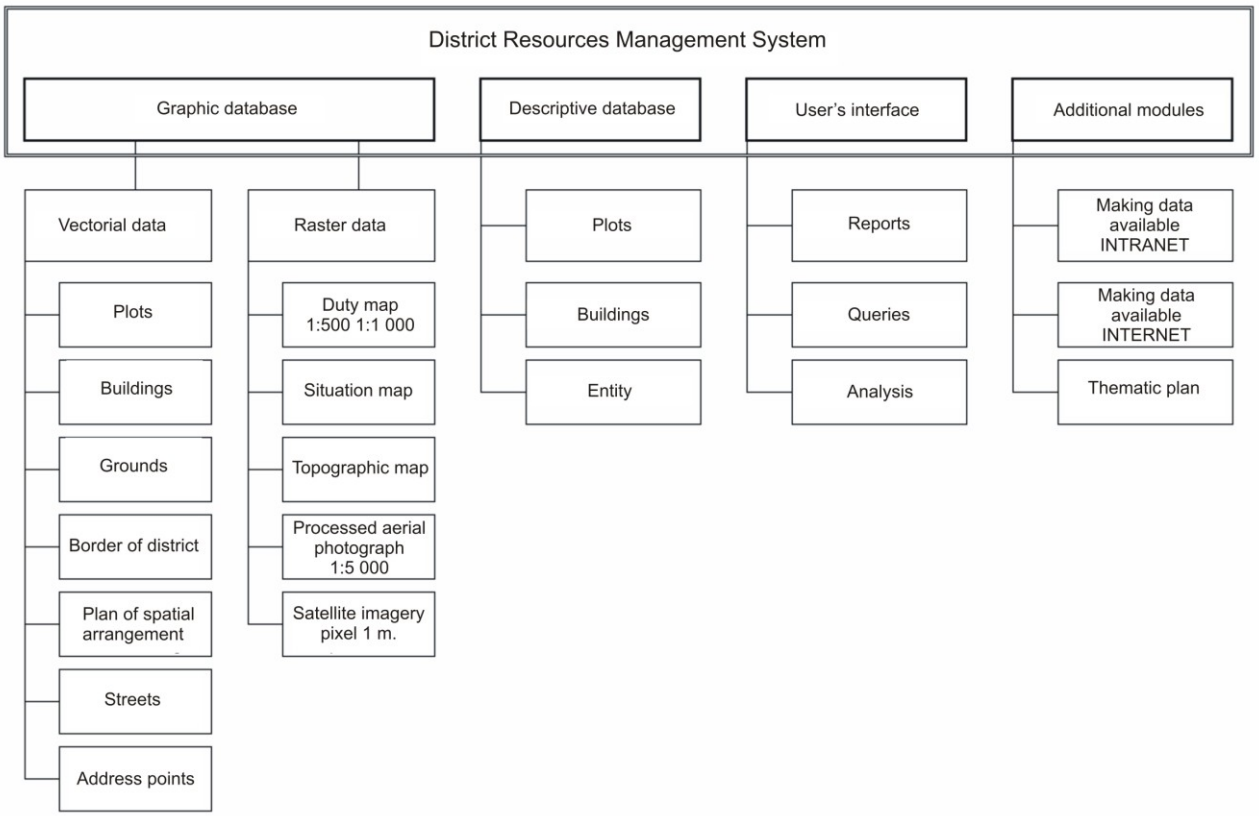

Fig. 1. Functional diagram of resources system
Rys. 1. Schemat funkcjonalny zasobów systemu

It is assumed, that data structures of a system are defined across edited models of data, on basis which schemes of databases are generated.

The architecture of the system was based on land and buildings record located in Department of Geodesy of one of Varsovian districts. For needs of modernized land and buildings record Oracle Related Database Management System was accepted. Except of basic database the system works supported with distracted databases functioning at department (in majority cases created in MS Access). The data exchange is holding through intranet network.

As environment of work was accepted Geomedia system in stand (basic) and professional version. This computer program has wide sets of tools which give abilities to process complicated geometry of plots as well as other resources, and it supports own macros programming which automating individual activities.

Data stored in a system were divided on several categories. Vectorial data gain from other systems and created on the way of scanning and direct measurements, together with raster data made up the graphic part of a system. It is connected with descriptive part among relationships, which came into being on the way of import from existing systems as well as putting data from documents which are stored in a district in varied moulds.

For efficient moving in a system as well as executing series of editorial and updating operations, function of searching etc. the interfaces were created for users on different levels. This users are employees of department working in a GIS working group.

The data are available across intranet network with keeping protections according to requirements of Act of Personal Data Protecting.

Multi-layer of database

Except graphic data in vectorial form, which create multi-layered map onself, system was equipped in tool to generating thematic layers of multi-layered map on a basis of contained in database descriptive information. Moreover, the system was equipped in module to raster basic map projection in thematic layers form. Overlays S+E and U+R were loaded. It makes possible to project any number of overlays across indication of interesting section and starting suitable function. Individual scanned sheets of basic map were exposed calibration and filtration, suitable colours were attributed, and next it was loaded to the system. In this way

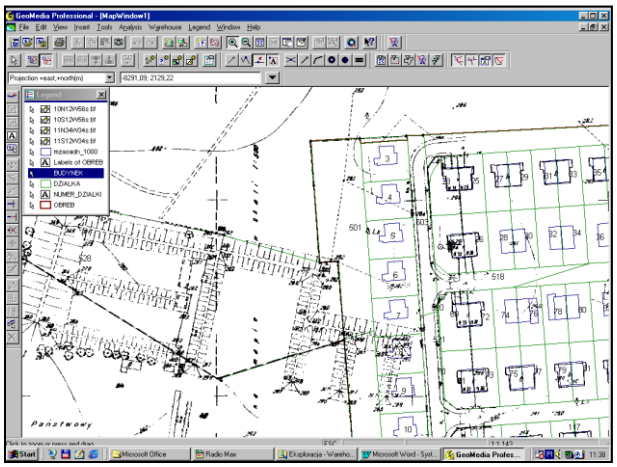

Fig. 2 The part of multi-layered map witch vectorial map projected on the background of raster map (overlay S – in black colour)
Rys. 2. Fragment mapy wielowarstwowej z wyświetloną mapą wektorową na podkładzie rastrowym (nakładka S – kolor czarny)

it is possible to projection of any vectorial layers on the basic map background. It helps also in actualization and loading data about buildings and plots to the system.

Within the confines of the system building was created the category called spatial planning (arrangement) which has base on the Architecture Department. It contains among other things plan of spatial arrangements (implements), strategic areas important for a commune. Thematic layers of this category include the whole administrative unit within chosen neighbouring areas. Thanks to connection of these data with layers of lands record and buildings as well as with the course of streets, user receives many valuable information.

In a system were implemented such layers as:

Aerial photographs 1:5 000

In result of realization of PHARE programme multispectral aerial photographs were executed in 1997. on the Warsaw–Bemowo District area, in scale 1:5000. This images were processed to the local co-ordinate system. In order to easier operating of processed images collection their mosaics process were executed. Owing to large sizes of whole mosaic, its division on 4 parts was executed: north-west (NW), north-east (NE), central (C) and south (S).

For assurance of optimum possibilities of using these images in dependence on purpose of processing and hardware, resolving power (resolution) was processed into three levels of details: GSD = 0.3 m, GSD = 1.2 m and GSD = 2.5 m, which will permit on using this layer as working background to optimal presentation (projection) of chosen thematic layers in different (best) scales. This layer, owing to archival character, can also serve as reference to analyses of terrain development changes.

Satellite imageries

For assurance of topicality of ground raster imagery, realization of the next photogrammetry flying would be very expensive. The purchase of satellite image from IKONOS turned out to be the better solution. The bought image were executed on the 30th of August 2006. Height of flight of the satellite is 681 km, and the zone of photographing is 11 km in nadir. Because the satellite has the possibility of making arrangements of sensors (deflections in relation to direction of a flight), and the photographed area was moved in relation to its

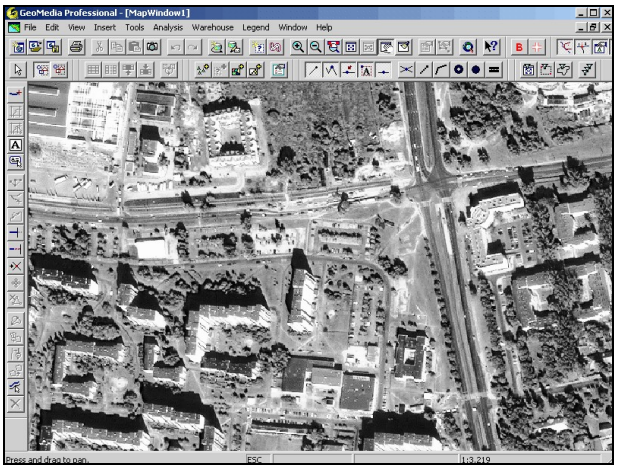

Fig. 3. The part of panchromatic imagery from IKONOS satellite
Rys. 3. Fragment zobrazowania panchromatycznego z satelity IKONOS

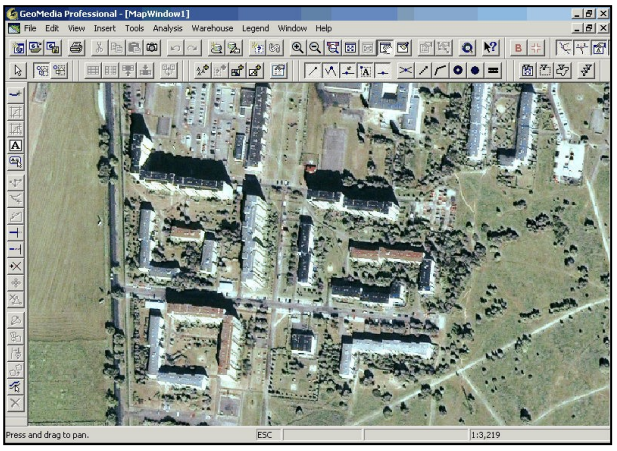

Fig. 4. The part of panchromatic imagery processed to 1 m resolution, as a result of joining resolution with 4 m resolution coloured imagery (pan-sharpened)
Rys. 4. Fragment zobrazowania panchromatycznego przetworzonego do rozdzielczości 1 m w wyniku łączenia rozdzielczości z 4-metrowym zobrazowaniem barwnym

orbit, the executed image has the character of oblique aerial photograph. To process such an aerial photograph to orthogonal figure it should undergo suitable geometrical transformations.

The resolution of a panchromatic imagery of IKONOS is 1 m and a multispectral is 4 m. Processing of resolutions of both imageries was executed to the result of satellite imagery in natural colours and spatial resolution 1 m (Pan-Sharpened).

Next this imagery was processed to the local co-ordinate system.

Thematic plan

The system was enriched by series of descriptive information graphic referenced, and relating number of problems of everyday life, which can be very useful for both clerks of a department and occupants of a district. Supply accumulated under the name of thematic plan is prepared to be open not only in an internal intranet network of a department, but also in global internet network. It consists of following thematic modules:

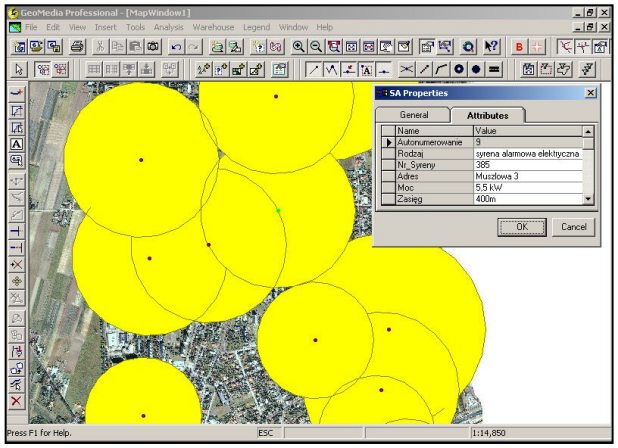

Fig. 5. The layer of public safety with marked a border of alarm sirens audibility and profile of one of sirens
Rys. 5. Warstwa bezpieczeństwo publiczne z zaznaczoną granicą słyszalności syren alarmowych i charakterystyką jednej z syren

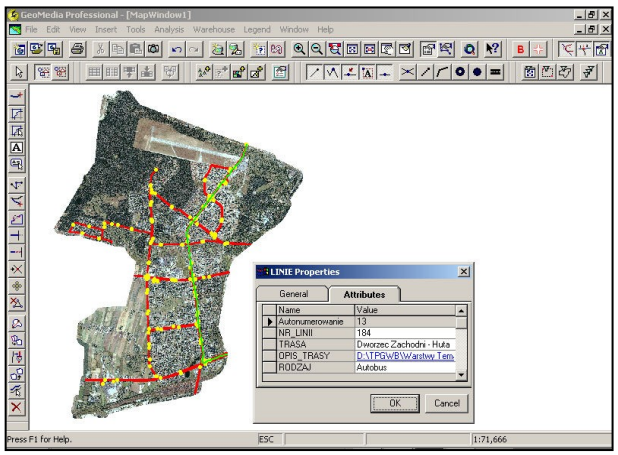

Fig. 6. The layer of communication with course of all communication lines and location of stops (bus/tram) and profile of one of communication lines
Rys. 6. Warstwa komunikacja z przebiegiem wszystkich linii komunikacyjnych i lokalizacją przystanków oraz charakterystyka jednej z linii komunikacyjnych

Summary

Unquestionable advantage of the system using is quick and comparatively simple access to existing data as well as the efficiency of working. Thanks to integrating descriptive database with graphic layers, information resource is coherent – does not therefore occur possibility of differences appearing among graphic and descriptive parts of the system.

The system makes possible further extension about new categories. It permits on extension of descriptive data along with appearing new data. Moreover it disciplines works and guarantees growing of efficiency.

Currently the system is used (with success) in one of districts of Warsaw City. Similar solutions applied in self-government units would facilitate "life" both clerks of departments as well as clients who we all are.

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