Web-GIS based urban management information system: the case of satellite cities in Istanbul

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Abstract

A Geographic Information System (GIS) is defined as a computer based tool useful for capturing, storing, retrieving and manipulating, displaying and querying both spatial and non-spatial data about given areas to generate various planning scenarios for decision making. On the other hand, an Urban Management Information System (UMIS) is an economic resource that can benefit decision makers in the planning, development, and management of urban projects and resources using statistical data such as social, economic, demographic, housing and health data. Since Internet technology reduces the cost of data management and information distribution to mass usages as in UMIS, web based systems are mostly used for a UMIS applications throughout the world. Nowadays, the number of satellite cities is rapidly increasing in Turkey, especially in Istanbul. A satellite city for Istanbul can be defined as a mini city established outside Istanbul that has its own shopping centers, schools, social clubs, cinemas, restaurants, etc. Though it is not a municipality by itself, it needs to conform to the requirements of both the municipality it belongs to and its management. In this study, a prototype web-GIS based UMIS is developed for satellite cities. The system integrates the digital base map and statistical data of a satellite city that can be input through a user-interface and offers a variety of querying and reporting options. The developed system is tested for one satellite city in Istanbul and the results showed that it is promising as a starting system for other similar applications.
Keywords: geographic information system, urban management information system, satellite city.


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1 Introduction

Geographic Information System (GIS) is defined as a tool useful for capturing, storing, retrieving and manipulating, displaying and querying of both spatial and non-spatial data about given areas to generate various planning scenarios for decision making. It is a computer based tool for mapping and analyzing things that exist and events that happen on Earth. GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits 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 [1].

Urban Management Information System (UMIS) is an economic resource that can benefit decision makers in the planning, development, and management of urban projects and resources using statistical data such as social, economic, demographic, housing and health data. UMIS combines map images with other kinds of information (like tabular data) for the purpose of analyzing spatial relationships among data related to locations in the city [2]. It includes physical, technical, social, economic and administrative data, base maps, land use maps, master and development plans, the land information and cadastral maps. The system can make queries from legal documents, reports about the spaces, the citizens and result thematic maps like building, population and infrastructure maps [3]. The building maps show building occupancy, construction type or date, number of floors, license information, users information and so on. The system may contain transportation maps, traffic-density maps, shortest path for the firefighters or ambulance drivers. According to the population, the decisions can be made about the locations of the social facilities like schools, health centers or green areas, utility service areas, telecommunication, gas, electricity [4]. There are many UMIS applications around the world and most of them are web based since Internet technology reduces the cost of data management and information distribution to mass usages and also has become a tool to convert local government into an "open system" that makes the public services accessible [5]. But development of such systems needs a very careful study due to the importance of the integration of GIS, relational database and web programming issues.

Satellite cities, which are the target of this study, are also in need of UMIS since they are interpreted as mini cities established on county sites and have their own shopping centers, schools, social clubs, cinemas, restaurants, etc. Management of such cities needs to conform both the requirements of the municipality it belongs to and its internal management.

2 Prototype UMIS for satellite cities

The aim of this preliminary study is to gain experience and know how necessary for the development of web-GIS based UMIS. The prototype UMIS developed in this study is a part of a larger system (City Information System for Satellite

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Cities) that the authors are working on as an applied research project. The subsystems of the main system are given in fig. 1.

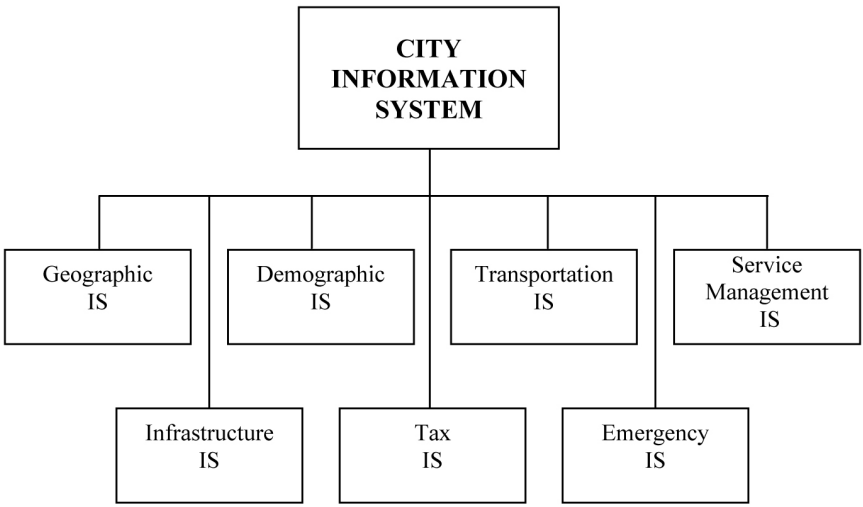

Figure 1: City Information system for satellite cities.

Utilities of these subsystems which are still under construction are given below:

*Geographic Information Subsyste*m: Creation of maps by digitizing and/or coordinate entry, forming layers of infrastructure, natural resources and buildings; and related input forms, queries and reports.

*Demographic Information Subsyste*m: Creation of city resident records, and buildings information; and related input forms, queries and reports.

Transportation Information Subsystem: Main roads, streets, parking places and traffic flow directions information; and related input forms, queries and reports.

Service Management Information Subsystem: Services given in the satellite city, financial issues and scheduling of these services; and related input forms, queries and reports.

Infrastructure Information Subsystem: Water, natural gas, waste water, telephone and electricity networks and their subscriptions; related input forms, queries and reports.

Tax Information Subsystem: Real estate and environment taxes; and related input forms, queries and reports.

Emergency Information Subsystem: Security, fire extinguishing, health, weather conditions, earthquake and similar emergency information; related input forms, queries and reports.

The prototype developed in this study integrates only some partial utilities of the geographic, demographic, transportation, service management and infrastructure subsystems of the main system.

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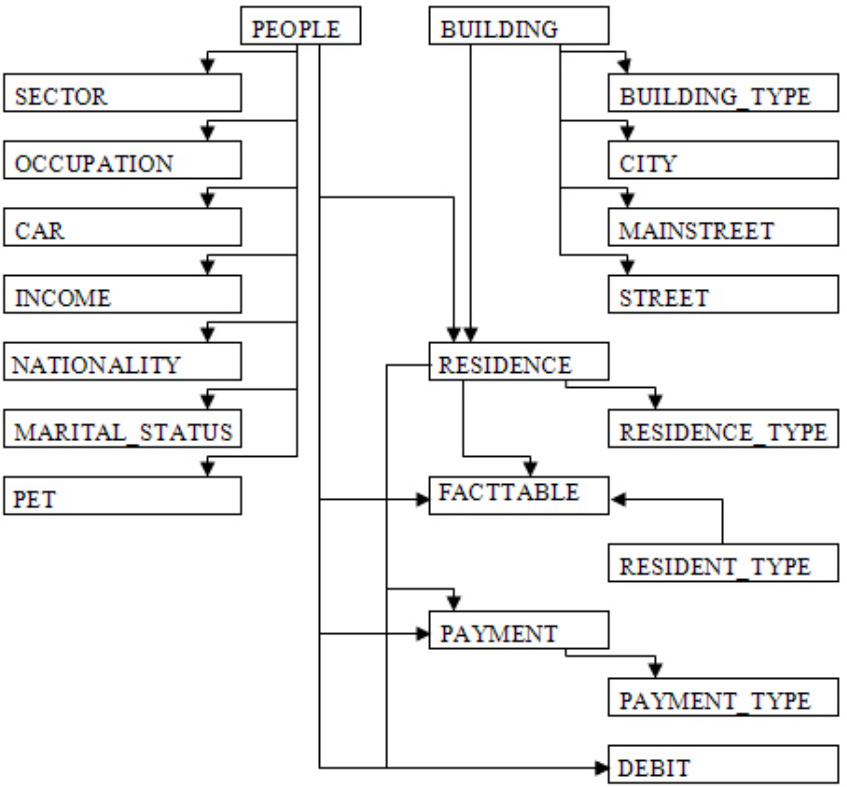

Figure 2: Relationship diagram of the database.

2.1 Prototype subsystems

The utilities taken into consideration for the subsystems included in this prototype are given below:

2.1.1 Geographic information subsystem

The base map is the basis of the GIS activities and involves the conversion of an existing available map into a digital format. In this study this map contains the city boundary layer and two more layers for buildings and for streets. Geographic references of each building and street are kept in the geodatabase of this subsystem.

2.1.2 Demographic information subsystem

This subsystem includes building information (building type, address, construction date, etc.), residence information (occupancy, pet, car, etc.) and people information (demographic data, professional data, etc.). It is possible to get several query reports from the system such as the buildings on a specific

street where disabled people live and the building to where a special car belongs. The results of these queries are also shown on the base map.

2.1.3 Transportation information subsystem

Transportation information subsystem includes only the basic road and street information. There are a few query reports related to them such as buildings on a specific street. The query results can again be easily shown on the map.

2.1.4 Service management information subsystem

Includes payment requirements for the related services given by the satellite city administration and the related payments done by the residents. There are also some query reports in this subsystem such as residents that have debit accounts, payments to be done by the residents for special services and monthly payment requirements for a specific time period. There is also the possibility of showing the results of these queries on the base map.

2.1.5 Infrastructure information subsystem

Electric-gas-water meters information of the residents are kept in this subsystem. There is only one query report and it is for displaying and showing on map the residence that a specific meter belongs to.

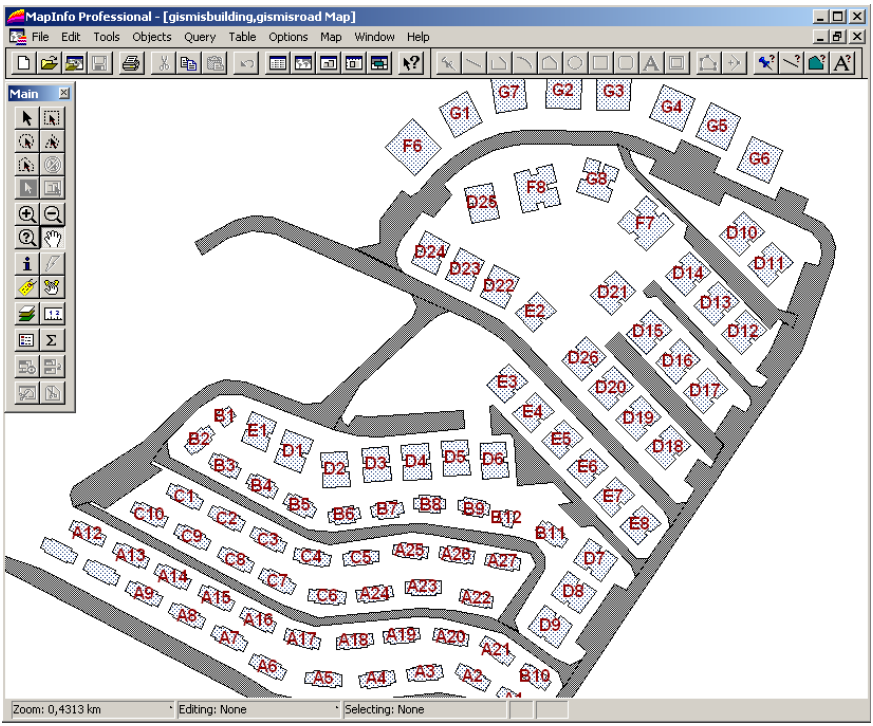

Figure 3: Base map of Hisarevleri satellite city.

2.2 System development environment

The system is developed using the following tools:
a. MapInfo Professional: Desktop map management software
b. MSAccess: Database management system
c. MapInfo MapXtreme: Internet based map server software
d. HyperText Markup Language (HTML): Web page creation tool
e. Active Server Pages (ASP): Internet programming tool

The geodatabase, which keeps spatial data of the map objects, is designed using MapInfo Professional and the relational database that keeps non spatial data described in the subsystems is designed using MSAccess for which the relationship diagram is given in fig. 2. Two databases are related to each other through ids of the map objects. The user interface, data input forms, query based reports and map displays are developed using HTML, ASP and MapXtreme environments.

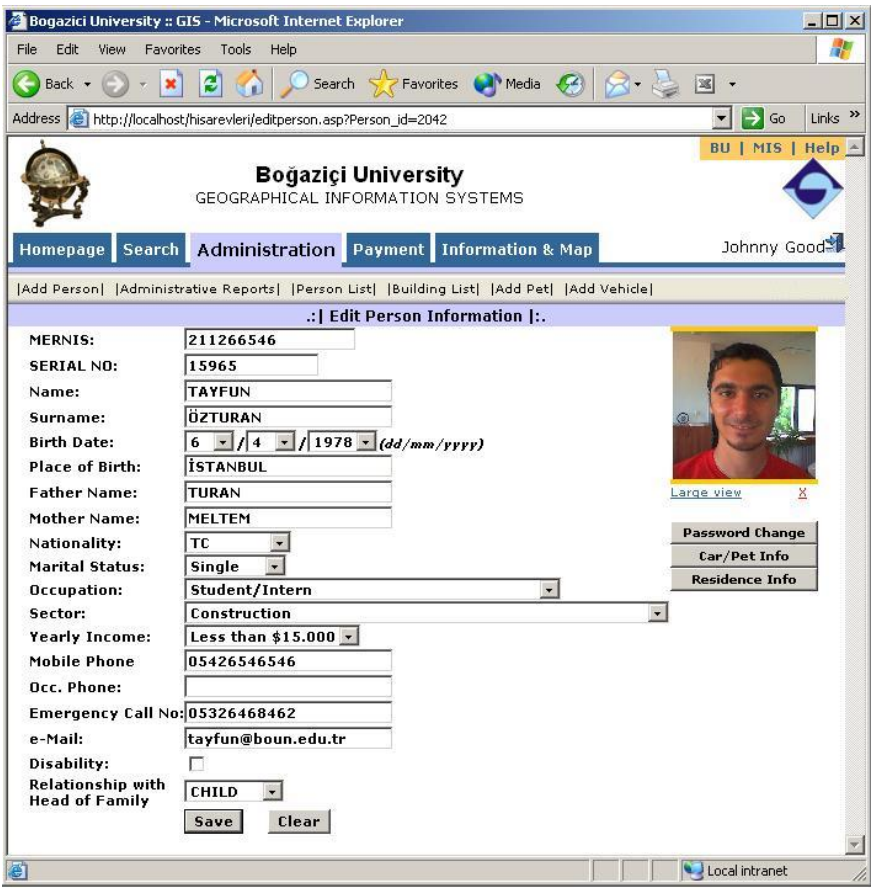

Figure 4: Person entry input form.

2.3 User interface

User interface of the system is web based and utilizes ASP technology. There are mainly five main menu items with many sub items in the user interface. All related input forms and query reports are allocated under these menu items. According to the type of the user (administrator or resident), different options are made available on the screens. Input forms for building, person, pet, car, payment requirement and payment are the main screens for data entry. Queries for residents, addresses, car/pet owners, streets, payments are all prepared as output reports and can easily be displayed on the base map. It is also possible to get related information for a map object by just clicking on it on the base map.

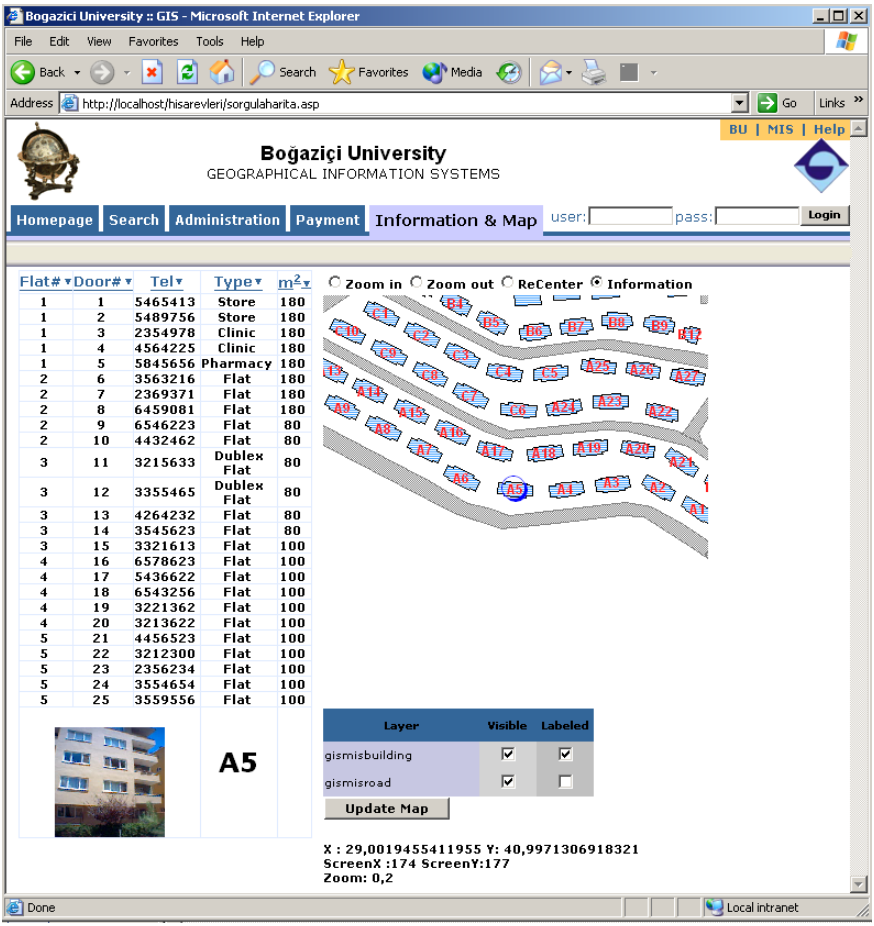

Figure 5: Building query report and its map display.

3 Application

This prototype is tested for a satellite city named Hisarevleri in Beykoz region of Istanbul. The city boundary layer of Hisarevleri is formed by digitizing the map given by Hisarevleri administration using scanner. Other layers are formed by drawing the polygons representing the buildings and the roads using the scanned map. An id and a label attribute are given for each polygon and these ids are used for relating these layers to the relational database. The building layer hold 103 buildings and the roads layer includes four main streets and seven streets. The final base map with building labels is given in fig. 3.

Data related to the subsystems are also supplied by Hisarevleri administration in written format. The data are entered to the database through the web based input forms by the students of the Department of Management Information Systems and data entry errors are corrected by Hisarevleri administration. Person entry input form is given as an example in fig. 4.

Using the data entered, the query reports acquired by the administration are easily formed by the system developed. These query reports are formed using both the geodatabase and the relational database designed before. Search tab of the user interface is used to create the required query in the relational database. Using the relation formed through the objects ids to the geodatabase, the results of this query is shown on the base map. This map can be zoomed in, zoomed out and repositioned. The visibility of the layers and the object labels are optional for the users. Besides the map display, by clicking the information button, the output report for the query is also displayed on the screen. Building query report and its map display is given as an example in fig. 5.

4 Future work

In this study, a preliminary prototype web-GIS based UMIS for satellite cities is suggested. This prototype is tested for Hisarevleri satellite city in Istanbul and found to be a promising system to start with. As future work, the subsystems that are under construction should be fully completed and the integration of these subsystems must be definitely done. The authors recommend the followings as further improvements for the applied research project:

a. Integration of social, economic and educational information to cope with managerial problems
b. Integration of the system with GPS technology
c. Change of the user interface for a better subsystems integration
d. Use of SQL server as database environment due to the limitations of MSAccess

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