International Journal on
"Technical and Physical Problems of Engineering"
(IJTPE)
Published by International Organization of IOTPE

ISSN 2077-3528
IJTPE Journal
www.iotpe.com
ijtpe@iotpe.com

March 2014 | Issue 18 | Volume 6 | Number 1 | Pages 187-191

REMOTE SENSING AND GIS APPLICATIONS IN ARCHITECTURAL DESIGN

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Abstract- An architectural design is embracing primarily design of buildings or urban landscapes, as opposed to the construction documents and management required to construct it. For successful implementation of design visions, it is necessary to have a good creative skills, imagination, and artistic talent in design. Modern requirements of architectural design demand an ability of integration of a number engineering disciplines. It relates especially in regeneration elements of design particularly in urbanization. It has been suggested for regeneration one of the central streets of Baku as "Murtuza Mukhtarov", capital of Azerbaijan (Figure 1). There is a proposal to take down mainly one-and two-story houses that do not have architectural significance. Instead of those is to construct houses or shops that are falling into the architectural ensemble. In some of areas between the buildings is suggested to pave the squares.

There is no doubt that existing complexity of the design from the point of consideration all required features of the area it is necessary to use and apply the resent advances of modern technologies.

It has been demonstrated a success of implementation of architectural design with approach of space technology methods. Remote sensing was used as a good instrument for data collection with detailed consideration of the area and around of features such as existing buildings (date of construction, number of buildings story, type of buildings-offices and leaving houses etc.), communication system, environmental and ecological condition of the area, whether statistical information. As the consequences those collected data was integrated into the geographic coordinate system with further GIS development. It is obvious that the success of the design will depend of the number of data integrated into the GIS. It will allow considering comprehensive approach during the development of design and construction processes. In the meantime, the use of such technology creates an excellent environment for the management of the project as a whole.

At the same time, it has been recommended an issue of impact of possible natural disaster and hazardous consequences for risk assessment and scale of damages. It was demonstrated the use of data based on the processing space images for the purpose of architectural design. It is reflected advantages of the use of space technology and their weaknesses for the applied case.

The result of investigation attempt was applied for the street regeneration design of "Murtuza Mukhtarov" which highly need for renovation and restoration under undertaking of requirements of design.

Keywords: Architectural Design, Regeneration, Remote Sensing, Data Processing, GIS, Space Technology, Infrastructure Monitoring.

I. REMOTE SENSING METHODS AND GIS TECHNOLOGY IN DESIGN PROCESS

The use and application of space technology in a huge cases in particularly for the case of town planning is a more suitable means due to the covering a large areas, high accuracy, availability of application in the unacceptability areas etc. Moreover, according to the created and developed database there is an advantage to be very sensitive to any available change occurred in the investigated and selected areas.

Today, more than at any time before, buildings and other structures are incorporating a multitude of new technologies, materials, and processes. There are several reasons for this, including:

- Environmental and ecological issues
- Safety aspects in view of increasing natural hazards
- Attractiveness in terms of a building being a corporate 'icon', and
- Growing pride of homeowners in their properties.

II. DESIGN AND CONCEPTS

Architects, designers, builders, environmentalists and, (last but not least), consumers have already begun to embrace new technologies in areas that promise lower energy consumption and hence lower running costs.

III. NEW REQUIREMENTS

Discussions with the insurance and re-insurance sector show that they have ever-greater concerns about the statistical increase in 'extreme weather' in recent years, coupled with the fact that more and more dwellings

are being built in earthquake- and flood-prone zones. In the wake of the devastating earthquake in Turkey in 1999, the idea of attempting to design an 'absolutely earthquake-safe building' was born. It is therefore proposed to adapt European building standards to these trends and to enable structures to cope with:
- Wind speeds of up to 220 km/h (10-second gusts)
- Flooding to depths of up to 3 m
- Earthquakes of up to 7.5 on the Richter scale
- Subsidence of 1.5 m during the lifetime of the building
- Severe hail and exceptionally heavy rain, and
- For some areas of southern Europe, bush-fire resistance.

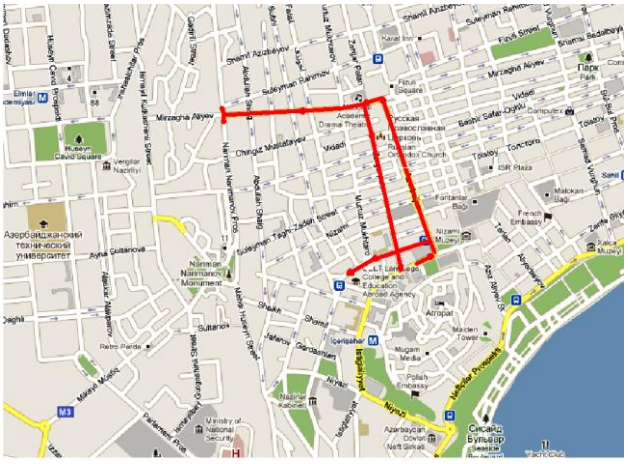

Figure 1. The sketch of "Murtuza Mukhtarov" street in Baku, Azerbaijan with the transport net system

IV. HOW SPACE TECHNOLOGY DOES HELP?

It is necessary to emphasize that one of the most important and controversial uses of satellites today are that of the Earth monitoring. Today many satellites study features on the ground, the behavior of the oceans, or the characteristics of the atmosphere as a sources for collection required information bases making a right decision in the final stages of any implementation and development. Satellites that observe the Earth to collect scientific data are usually referred to as "Earth observation satellites." Sometimes the interpretation of their data has been controversial because the interpretation is difficult and people have used the data to call for substantial changes in human behavior.

The recent advances and developments in information and communication technologies, education and health care, agriculture and agro-food processing, geo-strategic initiatives, infrastructure and energy and critical technologies and strategic industries have been realized in light of the space technologies. Earth observation techniques which apply optical and thermal spectra of the electromagnetic wavelengths have so far developed considerably. Although there is done a lot in this area beforehand, a long way is still ahead. The background of using microwaves for remote sensing goes far the decades ago while it was remaining in the experimental domain and exploratory status for years. It is only in the recent couple of decades that different kind of remote sensing techniques have been commercialized and used widely. Recently developed remote sensing systems are actually accounted for as a new earth observation technology with promising results and future. Its potentials and capacities by itself and being a strong complementary tool for optical and thermal remote sensing are undeniable currently.

Discussions with city officials indicate that there is an urgent need to upgrade many inner-city areas to make them more places that are attractive which to live and work. In addition, some city authorities would like to see new buildings constructed in such a Building Sector. Based on the various discussions outlined above, and a review of recent and expected future research and technology development activities in the space sector, efforts within the ESA Technology Transfer Program (TTP) have been focused on three major areas of application for the available space technologies:
- Safe houses/buildings with respect to the natural and human-induced environment
- Healthy houses/buildings with respect to medical and mental well-being
- Ecological houses/buildings with respect to sustainable energy supply, natural resource consumption and manufacturing processes.

The objective of the work has been undertaken for identification of regeneration of the central street of city based on the collected data for further development of Geographic Information System (GIS) using remote sensing methods. Studied area of city has been discovered using the field observation guided by existing streets information and application of Global Positioning System (GPS) technology.

The spatially referenced database is satisfied the need for accurate and easily accessible street features information. Field crew has been collected GPS point data at the street embraced all features as a whole within the investigated area. The GPS gathered data during the fieldwork were entered into the GIS. The GIS was used to generate statistical, spatial, and thematic data. A comprehensive set of spatially referenced streets zones information has been generated (Figure 2).

The steps of research achievements were consist following:
1. Research - all pertinent and relevant existing data at the streets in the studied area were collected and reviewed.
2. Field Investigation - field crew using GPS units, collected latitude and longitude readings at the pipeline crossing of public roads, railways, and rivers within the study area.
3. GIS Development - GPS data collected by the field crew has been used for development of pipeline system layers based on GIS.
4. Outcomes - GIS has been developed with reflection of generation of the statistical, spatial, and thematic data. In the meantime, hard-copy maps and digital GIS files were produced. The final product of investigations was unique database specifications as digital base maps layers.

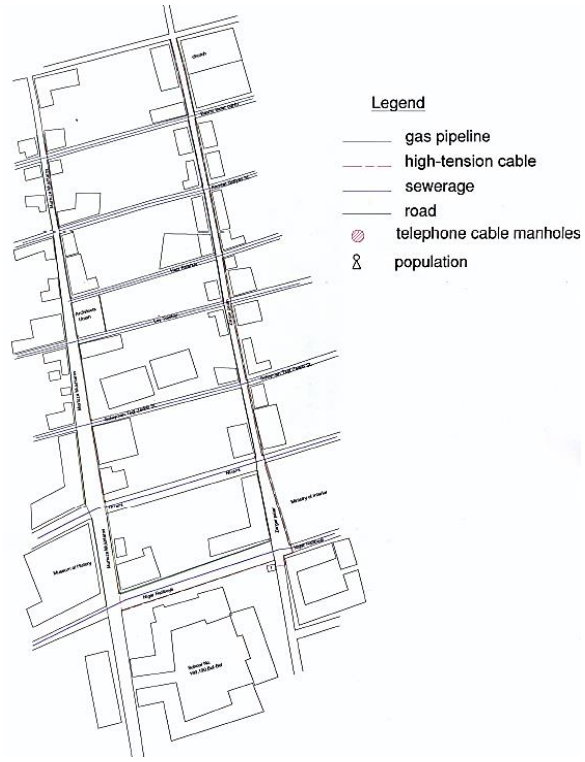

Figure 2. The features of the selected area measured by the GPS

The resulting spatially referenced database should satisfy the need for accurate and easily accessible information for regeneration of the street "Murtuza Mukhtarov". The database can be important tool for the protection and utilization of the significant resources. Due to the existed maps of the streets with inaccurate and/or too generalized information, there is a need to develop the GIS at least some of part of selected area. There is also a need for uniformity, since the maps contain varying levels of accuracy and scale.

GIS street mapping has many advantages over viewing spatial data on a map. GIS mapping allows for a level of analysis such as establishing networks creating buffers and modeling distance decay, which is not possible to produce on the hard copy maps. This approach is successfully applicable for linear system applications [1, 2]. It is a highly important to have a sufficient information related to the streets location for the reason of consideration of any available elements needed to be enclosed as a part of regeneration process. In case of any information, imperfection can be dangerous for implementation of successful regeneration of the street in point of view of architectural design and social issues.

The street systems have crossing elements. There is a huge of communication system integrated and operating as whole system. It demands application of high accuracy modern technology advances to be able to consider all available data and management capability. The need for development of the GIS for street regeneration is also related for population protection in the selected area. On the studied within the streets along selected, "Murtuza Mukhtarov" and "Zargar Palan" are populated around 1220 people (Figure 3).

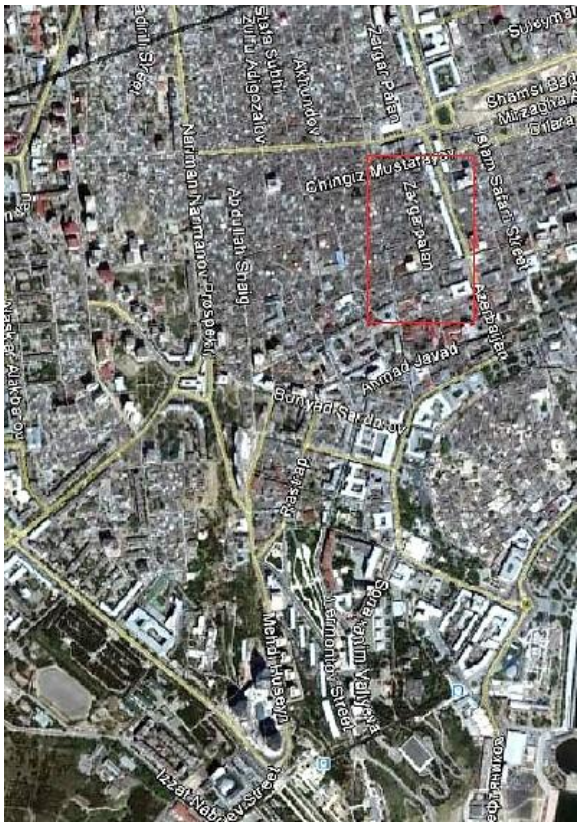

Figure. 3. Space image data processing for selected street undertaken for regeneration

Knowledge of the status of streets is the significant issue for a many entities, including city and region authorities, emergency officials and business and industry representatives. This study provides the relevant and updated information being to satisfied needs of customers responsible for street regeneration and staff who has involved for architectural design of the city.

V. METHODOLOGY

At the first stage of investigation, it was necessary to collect existing information along streets for further understanding and clarification of the status. This information has been undertaken for GIS development for street regeneration. In the next stage, the maps were used for identification of the existing configurations in the investigated area. Based on this the present status of the area and field investigation protocol were developed.

VI. FIELD METHODOLOGY

The field components of the study as the presence of buildings, crossings, communication systems (high-tension cables, gas pipeline, sewerage, and telephone cable manholes) have been involved. It has been usually used the presence of a 'witness post' that provides evidence for the field investigations. Pipelines often follow 'rights of way' long avenues of clearing where no development occurs.

The streets are required to be marked by 'witness posts' during processing. For researchers involved for street regeneration the witness post contains same useful information as the operator name and an emergency

contact phone number. Field staff was experienced in the use of GPS and GIS systems were employed to collect required data among selected area. These field crews were directed to collect GPS point data at the streets with all crossings and other features.

VII. GIS DEVELOPMENT

The further stage after the GPS data, digital photographs, and other documentation were collected based on each field investigations and transferred into Microsoft Excel spreadsheet, a method was applied for data projection and conversion and subsequent GIS development.

VIII. DATA PROJECTION AND CONVERSION

The deliverable of the digital data for this project must be seamlessly integrated with the existing data. This required that all digital data generated for this project based on a Gauss Kruger coordinate system, Zone 8 using Pulkovo 1942 as the reference datum related for the investigated area. Therefore, all data brought into the project GIS were converted to Gauss Kruger. ESRI's ArcGIS/ArcInfo 9 suite of GIS software was used throughout the work. The resulting deliverables in projects are in the form of ESRI '.shp' files. ArcGIS/ArcInfo is vector-based software that is the industry standard for GIS-based research.

ArcGIS software includes the following suite of integrated applications: ArcMap, ArcCatalog, and ArcToolbox as well as 3D Analyst, Spatial Analyst, Network Analyst, Geostatistical Analyst and needed for work other extensions. Each of these applications was valuable for conducting the GIS research for this work. ArcMap, a map-centric application was used for basic mapping and editing tasks, as well as analysis.

ArcCatalog was used to manage geographic and tabular data, create, and edit metadata. ArcToolbox was used for data conversion and geo-processing. ArcInfo, an enhancement to standard ArcGIS software was also used because it provides advanced editing capabilities [3, 4]. A base GIS was developed using the following data sources:

'.shp' files of digital vector data, 1:100000 scale topographic maps (Pulkovo 1942 datum), Mosaicked 12 LANDSAT Enhanced Thematic Mapper Plus (ETM+) scenes, Digital orthophoto generated from QuickBird or IKONOS imagery for most sensitive zones in study area.

For more detailed analysis of the streets are generated the orthophotos from very high spatial resolution satellite images like IKONOS (1 m). The coordinate values in the latitude and longitude columns of the .dbf file of GPS points representing the location of streets were displayed as *x* and *y* values using ArcMap. These values were exported as a ".shp" file and their projection defined as latitude/longitude (Pulkovo 1942) using ArcToolbox.

Although these GPS points were stored in the latitude/longitude reference system, the file displays properly when added to the project GIS for the reason of projection "on-the-fly" to Zone 8, PULKOVO 1942.

In the stage of the final editing process was completed and the vector layers in the ".shp" files representing different data has to be further processed in order to create topology. Topology is the procedure for defining spatial relationships, such as line connectivity, in a database.

IX. CONCLUSIONS

1. It has been suggested the regeneration of the "Murtuza Mukhtarov" street in Baku, Azerbaijani capital undertaken use of modern requirements of the architectural design challenges.
2. Due to the high density of human, social, technological and communication features of the selected area for regeneration it was demanded to use of technology making available contenting internally all information sources.
3. It has been used and applied space technology capacity for the purpose of street regeneration as a successful tool for this implementations.

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BIOGRAPHIES

Nargiz A. Babayeva was born in Baku, Azerbaijan on December 06, 1989. She received B.Sc. degree in Architecture Completed Courses from Azerbaijan Architecture and Construction University, Baku, Azerbaijan. Currently she is a Master student in the indicated area at Azerbaijan State Academy of Fine Art, Baku, Azerbaijan. She has been employed as a Junior Engineer for a company providing engineering services for the international companies operating in Baku, Azerbaijan.

Rustam B. Rustamov was born in Ali Bayramli, Azerbaijan, on May 25, 1955. He is an independent expert on Space Science and Technology. In the past, he was in charging of the Azerbaijan National Aerospace Agency activities as an Acting Director General. He has mainly specialized in space instrumentation and remote sensing and GIS technology. He has graduated Ph.D. at the Russian Physical-Technical Institute, S. Petersburg, Russia. He was invited for the work at the European Space Agency within the Framework of the United Nations Program on Space Applications at the European Space Research and Technology Center, The Netherlands. He has appointed for the United Nations Office for Outer Space Affairs Action Teams (member, Vienna, Austria), United Nations Economical and Social Commission for Asia and the Pacific (national focal point, Thailand), International Astronautically Federation (Federation's contact, France), Resent Advances in Space Technologies International Conference Program Committee (member, Turkey). He is an author of 11 books published by the European and United States famous publishers and more than 70 scientific papers.