GISMO - A Geographical Information System for a Municipality Office

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Abstract

The purpose of this work is to highlight the importance of introducing digital mapping and providing geographic information systems (GIS) for municipalities. One of the major components in completing any GIS project is the availability and readiness of data. Unfortunately, most of the municipalities in Lebanon, lack the GIS awareness and hence the readily available data in GIS format. Our initiative in this aspect came to emphasize the importance of building a digital data model at the municipality level.

The potential uses of GISMO are as varied as the problems a GIS can help solve. GISMO offers decision support tools available to provide informed decisions to manage the problems of today's municipality requirements.

Keywords: Geographic information systems and digital data model.

1. Introduction

Municipality officials have hard choices to make about where to spend their scarce resources – especially with limited funds and limited personnel. Thus, the municipality sometimes was not able to respond to certain questions related to analysis, or it took the municipality staff dozens of hours to undertake a decision making process. For example, if a resident wants to open a pharmacy, the law states that every two neighboring pharmacies should be at least some meters apart. GISMO can provide the best location for the new pharmacy within a few seconds.

So applying GISMO may result in significant money savings to the municipality by saving staff time. Consider how many requests for information are handled by a municipality. It is common for municipalities to exhaust their staff time by simply answering the public's requests for information.

GISMO helps in improving the economic level of the community. When the business people get acquainted with GISMO, they will soon realize how important and valuable is the data generated by GISMO for running their companies.

GISMO provides the user with a menu of all available themes. Users pick the themes of interest. In addition, the user may select many features either by drawing shapes or by clicking on them. For example, in case of developing a new road, the municipality engineer draws the desired roads and GISMO will highlight the related parcels and buildings and provide statistics about its condition. These statistics may include the individual price of each property involved in the road construction, the property owner's address, and an estimate of the total amount to be paid as compensation for property owners.

GISMO also helps industries in finding the best location for their companies, where many factors should be taken into consideration (for example, the adjacent lots should include complementary industries, or considered as a market to the new industry).

The rest of the paper is organized as follows: Section 2 discusses data conversion. Section 3 describes the database design process. Section 4 presents GISMO, and section 5 concludes the paper.

2. Data Conversion

Data is perhaps the most crucial element in implementing a successful GIS program [1] [3]. Fortunately, GIS strategies can incorporate data from a variety of sources. For every data layer, the spatial information can be added using scanning and digitizing. The non-spatial data can be accessed from tabular databases.

Data acquisition is widely recognized to be the most significant aspect of creating a GIS application in terms of time, money, and effort. It is commonly judged to be 80% of the total work [4].

Data conversion covers every data layer involved in GISMO. This includes buildings, lots, water networks, telephone systems, trees, photos, electrical systems, and sewer lines. However, due to the limitation of this paper, we will discuss only the buildings data layer. For more detailed information, interested readers are referred to [2].

2.1 Buildings

Data for buildings are very important. GISMO covers this set of data in two different ways - either spatial or non-spatial.

2.1.1 Spatial Data

This layer is derived from hardcopy maps obtained from a municipality (in this case, the chosen municipality is Kab Elias, Lebanon). These are cadastral maps having a scale of 1/2000. Data compilation was done first by having a softcopy of all of these maps as raster images, using A0 scanner to get a digital copy of each paper map (see Figure 1). Once images are produced, they are registered and rectified based on the local coordinate system (stereographic projection - Lebanese version). Once this process is completed, creating a vectored layer for the buildings outline will be commenced.

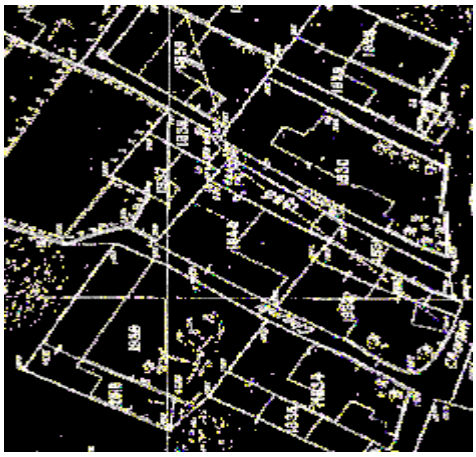


Figure 1 - *Raster image of a map.*

Vectorization process consists of line drawings that accurately represent the shape and position of important features visible on the Earth's surface; this can be done in two ways:

1. Using digitizing board: In this approach there is no need to get a digital copy of the maps. The hard copy of the map is placed on the digitizing tablet. ArcInfo is then launched to register the map by defining specific tics on the map. Adding lines to the map by using the digitizing tablet is done next. Then tics are added indicating the start point, continuation, and the end point of the vector. The process is repeated until all the lines on the map are covered. This will yield a vectored layer.
2. Onscreen digitizing: This approach is followed throughout this work. It is done using AutoCAD 2000 where every line that is related to any building found on the raster image will have its

corresponding vector on the vectored layer (see Figure 2). If a municipality consists of several maps, then a vectored layer must be created for each map. The maps are then joined through an edge matching operation (see Figure 3), where matching the coordinates between all the coverages are converted into a single coverage. One of the coverages, referred to as the match_cover, will serve as a reference for matching the coordinates; its coordinate will remain stationary. Finally, all the maps will give a single view of a larger area stored as a file. This file is added as a theme of type ".dwg" and then is converted into shapefile ".shp" (GIS format) where it will appear as a single theme (see Figure 4).

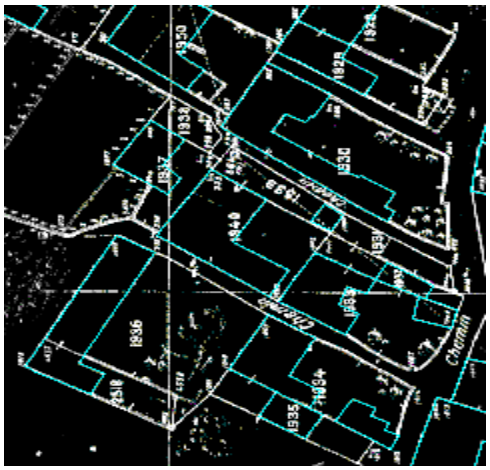


Figure 2 - *The vectored layer as shown above the raster image.*

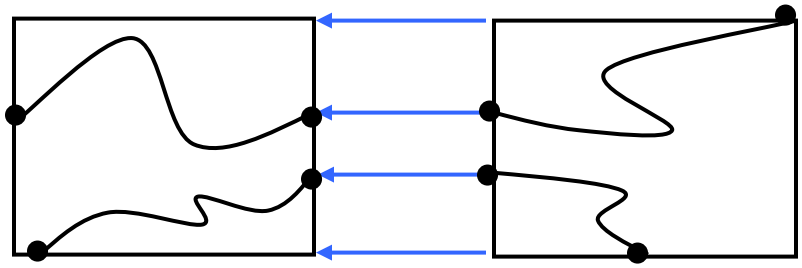


Figure 3 - *The edge match operation used to match border coordinates between coverages.*

Figure 4 - *The Buildings theme which is a file of extension ".shp".*

2.1.2 Non-Spatial Data

At this point, we'll continue building the database for the Buildings theme before performing the analysis and creating the final map.

So far, the automated map was developed. Before analysis can be done, we still need to specify additional data, (for example, the type of building). To do this, descriptive attributes are specified to the Buildings theme such as: *use*, *building owner name*, *number of floors*, *color,* and the *parcel number*, as well as a *photo* of the building.

Parcel/lot number was available on the Parcel theme. An overlay between the Buildings theme and the Parcel theme using geoprocessing wizard, was created to allow a building in a certain parcel take that parcel number.

3. Database Design

The database design for the GISMO is prepared to document all the GIS database themes that were integrated in the land base data model. The GIS database as well as some of the tabular data used in the implementation of this project was obtained from the municipality, in hardcopy format. However, most of these files were digitally compiled where the data were converted to AutoCAD files (technically called layers) and finally back to ArcView files.

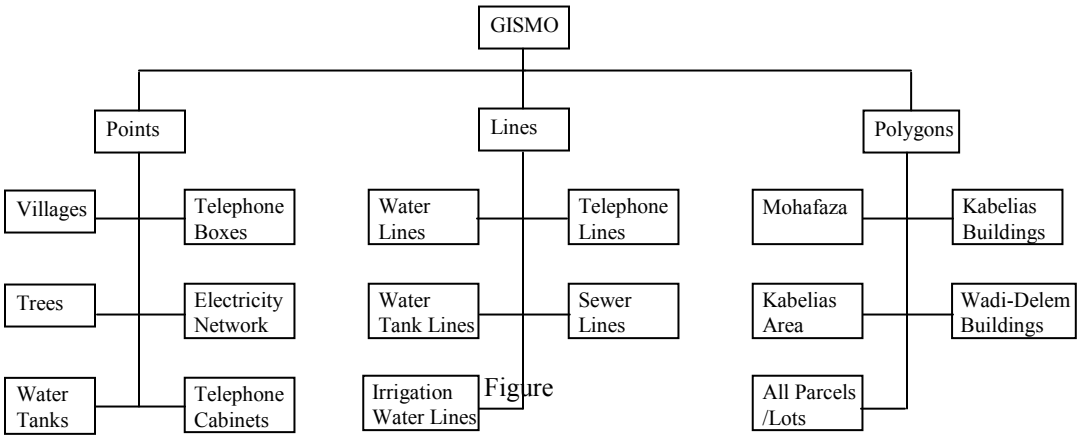
4. GISMO

GISMO is comprised of hardware, software, data to support the capture, management, manipulation, analysis, and display of geographically referenced data for solving complex municipal management and planning problems.

GISMO takes advantage of data, which the municipality already has. The data that the municipality wishes to see may already exist in the computer systems.

GISMO lets you find your own view of information. Each individual user has the power to determine what to see, why to see it, how to see it, and how to use it. For instance, in the case of Electricity Network theme, each pole is given a different icon in the legend where each one corresponds to a certain type. So users are able to modify the themes legend in the way they desire.

GISMO has 16 themes that cover all the municipality assets as well as the infrastructure. Data layers are separated into data files with unique attributes, where each layer has its own properties. Figure 5 shows the structure of GISMO as a hierarchy. For instance, GISMO's Buildings theme is characterized by building owner, parcel number, and number of floor, as well as a photo that displays an image of the building through a hot link facility (see Figure 6). This will help municipality personnel in having a spatial view of the characteristics of that building, and help estimate the buildings' rental value.



Figure

Figure 5 – *A hierarchical view of the GISMO structure.*

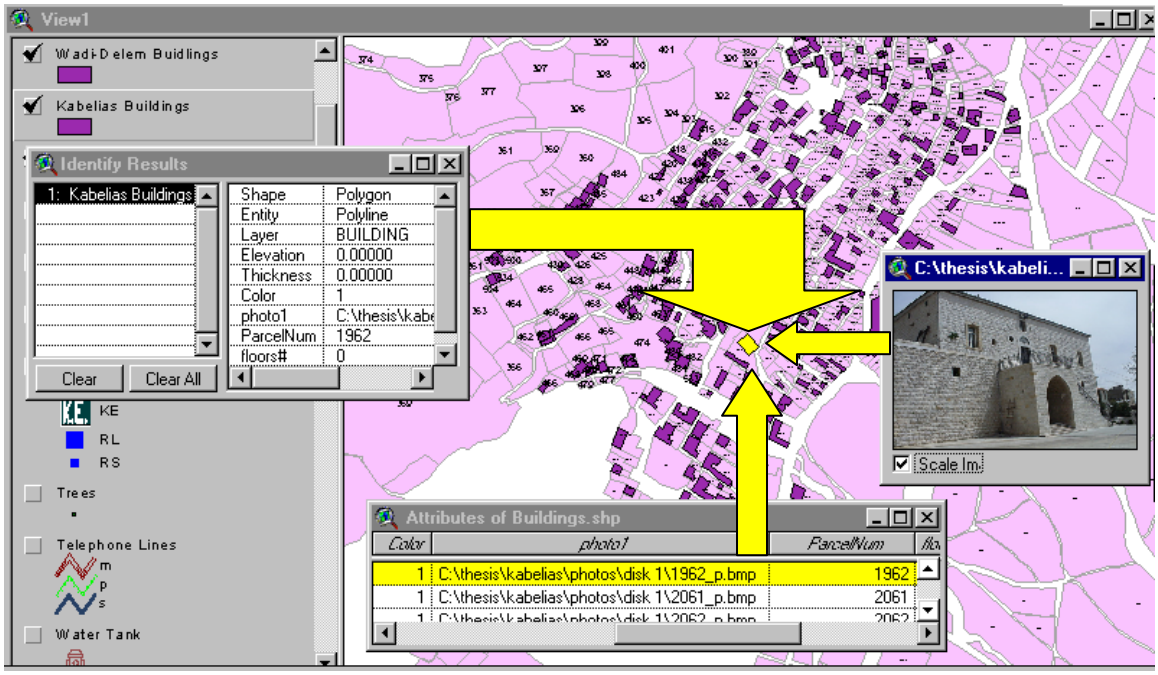


Figure 6 – *The Building theme and the underlying attributes.*

5. Conclusion

Building the digital database model for any system is the key element in the overall design process. This paper presented a geographical information system for a municipality office. Further work may include incorporating support systems for taxes, utilities maintenance, and traffic and road maintenance.

References

[1] Booth, B. ArcInfo 8 – Getting Started with ArcInfo. Redlands, CA: Environmental Systems Research Institute. 1999.
[2] Kaddoura, Y. O. *GISMO: A Geographic Information System for a Municipality Office*. Masters Thesis. Lebanese American University. August 2001.
[3] Maggio, R. *AGIS-Based Municipal Information Management System as an Integrated Approach to the Management of Urban Databases*. http://www.odyssey.maine.edy/gisweb/spatdb/egis/eg97150.htm. May, 2001.
[4] Southern, L. E., and Arnold, J. *Integrating Cadastral Mapping into Local Government*. ArcUser: The Magazine for ESRI Software Users. Vol. 3, No. 4. October-December 2000.