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LAND INFORMATION SYSTEM (LIS)-BASED DIGITAL PHOTOGRAMMETRY FOR MAPPING

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ABSTRACT

Photogrammetry-supported GIS is concerned with the accuracy of the data used in GIS offering ways of direct visualization and easier interpretation in a real-world scale. Matching the mosaic images usually implies that the radiometric intensity data from one image representing a particular feature must be matched to the intensity data from the second image, representing the same feature. After the production of mosaic for the study area, stereo pair of the final form the ArcView software was used to prepare a digital map with multi layers. The layers, which were 12 layers formed: College of science, Architecture department, College of politics, College of engineering, Engineering labs, Lectures halls, Collection of college's buildings, Service buildings, Main roads, Pedestrian roads, The parks, Gardens. After the completion of the drawing layers have been producing digital map in its final form with full database and some statistical analysis.

Keywords: digital mapping, photogrammetry, LIS, GIS, arcview, mosaic, surveying.

1. INTRODUCTION

By digital photogrammetry, we mean input data are digital images or scanned photographs. Digital photogrammetry has its root in the late sixties when Hobrough (1968) began experimenting with correlation, even though the solutions were analog in nature. For almost 20 years, correlation techniques remained the only noticeable activity in digital photogrammetry. Research efforts in digital photogrammetry have increased tremendously in recent years due to the availability of digital cameras, satellite imagery, high quality scanners, increased computing power, and image processing tools.

A digital photogrammetric system should perform not only all the functionalities that as analytical stereo plotter does, but should also automate some processes that are usually performed by operators. Since digital photogrammetry is rather new, it is easy to generate a list of problems. In some aspects, the present state can be compared with analog instruments in the thirties or with analytical stereo plotters in them seventies. Most problems arise due to the extremely large size of digital images. An aerial photograph of 23×23 centimeters, scanned at 20 micrometers resolution, requires over 200 megabytes of storage. Storage of such a large amount of data is no longer a problem. Hard disks with gigabytes of storage data is another problem. As an example, local transfer time of a 15-micrometers digitized aerial photo is a few minutes (Ibraheem, 2012).

There are a number of important factors that caused this rather rapid development in digital photogrammetry. Some of these factors may be summarized as: [Availability of ever increasing quantities of digital images from satellite sensors, CCD cameras, and scanners. Availability of fast and powerful workstations/computers with many innovative and reliable high-tech peripherals, such as storage devices, true color monitors, fast data transfer, and compression/decompression techniques. Integration of all types of data in a unified and comprehensive information system such as GIS, Real-time applications such a quality control and robotics, Computer-aided design (CAD) and industrial applications, lack of trained and experienced photogrammetric operators and high cost of photogrammetric instruments.

Because of these key technological advances; cost; labor; and new areas of applications (GIS and CAD), digital photogrammetric systems have been and are being designed. The main idea is to use digital images, scan the model area with a three-dimensional "floating mark" with sub-pixel accuracy. Then use a digital 4 workstation to compile the required features to form an intelligent description for an information system such as GIS and CAD systems (Madani, 2001).

2. ADVANTAGES OF PHOTOGRAMMETRY-SUPPORTED GIS

Photogrammetry-supported GIS is concerned with the accuracy of the data used in GIS offering ways of direct visualization and easier interpretation in a real-world scale (Neto, 1999).

The GIS is a relatively new technology that joins the computer science advantages with the modern systems of capture of data, so that it allows the integration and the treatment of all type of information of a computer team, in a simple way on the part of any user that requires to work with this information (Karlsi *et al*., 2009).

With the advent of geographic information systems, a powerful method is available to store graphical and descriptive data with all their links. Digital photogrammetry and the GIS provide a group of advantages and benefits in the architectural tasks impossible to obtain with such an efficiency, velocity and economy by means of other procedure (Karlsi *et al*., 2009).

The use of time as another component in GIS has drawn some attention lately. The time component is must for an effective application of these computer-based techniques beyond the more limited applications of digital mapping and CAD systems. There are three coordinates for space location, time, attribute, and the image; these are the ingredients for an environmental GIS that by the use of information science may answer the needs of global/environment changes of the world.

Digital photogrammetry and remote sensing data also produce a tremendous amount of information. However, these systems usually collect data not just on a single case, but also on multiple dates, allowing the analyst to inventory, and also to monitor. The ability to monitor development though times, provides valuable information about the processes at work. Furthermore, remote sensing and photogrammetry often provide valuable information about certain biophysical measurements that could be of significant value in modeling the environment. While photogrammetry has proved to be an economical method for topographic mapping, remote sensing has proved itself to be an effective tool for resource management. Conventional frame aerial photography used in photogrammetry can be characterized as low altitude, analog, and capable of providing stereoscopic viewing while satellite imagery is generally very high altitude and digital such as IKONOS and SPOT. However, photogrammetry and remote sensing are merging. As photogrammetry becomes digital, and the resolution of satellite images improves, the tools developed in each respective discipline can be applied to the other. Both technologies can be effective means to detect manmade or natural changes on the ground on a cyclic basis for map revisions basis (Madani, 2001).

3. DIGITAL PHOTOGRAMMETRY FOR A COMPLETE GIS

Integration of digital photogrammetry applications into Geographic Information System (GIS) databases offers new possibilities for the end-users. This integration allows photogrammetric data collection in a raster/vector based GIS environment. The progress is achieved in stages. These operations are carried out using digital image processing, geocoding, and monoplotting techniques. In this electronic age managing and distributing data and imagery across an enterprise is a very complex operation. With the family of products designed to eliminate the nightmare of tracking imagery and data across the network. With GIS, you have a system that manages geoimaging data (imagery, DTMs, and digitized raster graphics) from acquisition to exploitation, to storage, to distribute. Since every business is unique, a modular product line provides the tools to manage large amounts of geoimaging data throughout practically any production environment - as well as making it easy to turn a web into an imagery e-commerce site (Madani, 2001).

4. COMPUTERISATION OF CADASTRAL MAPS

The justification for computerizing cadastral maps includes the following (The reduction of duplication in maintaining a cadastral base for many users, As a result of converting maps from one scale to another, and To bring the cadastral map onto the same coordinate and mapping system as large scale topographic maps, thereby facilitating LIS/GIS applications).

An important issue in establishing a digital cadastral data bases (DCDB) is that computerization of the cadastral maps in general cannot be justified for land registration or land market reasons. Therefore computerization of the map requires the support of other users both financially and institutionally (Williamson and Enematk, 1994).

At the institutional level, there is an issue of who is responsible for maintaining the DCDB and distributing the updates. Obviously it is necessary for one organization to administer the DCDB although there are various models using both government and the private sector to maintain the system (Williamson and Enematk, 1994).

5. LAND INFORMATION SYSTEM (LIS)

Large-scale geographic and land information systems (GIS and LIS) are developing rapidly in local and state governments and other organizations across the country. These systems handle critical information related to land parcels, transportation, utilities, and other infrastructure and facilities. They are changing the way organizations operate and make decisions, and therefore, they affect the daily activities and lives of the citizens and customers of these organizations (Williamson and Enematk, 1994).

As such, large-scale LISs provide great opportunities, but they also involve important challenges. Surveying and GIS professionals need to work together to ensure the integrity and reliability of the data incorporated into large-scale LISs. GLIS directly addresses the development of large-scale LISs and related professional issues.

The attributes of different types of geospatial data-such as land ownership, roads and bridges, buildings, lakes and rivers, counties, or congressional districts-can each constitute a layer or theme in GIS.

GIS has the ability to link and integrate information from several different data layers or themes over the same geographic coordinates, which is very difficult to do with any other means. For example, GIS could combine a major road from one data layer as the boundary dividing land zoned for commercial development with the location of wetlands from another data layer. Precipitation data, from a third data layer, could be combined with a fourth data layer that shows streams and rivers. GIS could then be used to calculate where and how much runoff might flow from the commercial development into the wetlands. Thus the power of GIS analysis can be used to create a new way to interpret information that would otherwise be very difficult to visualize and analyze (Williamson and Enematk, 1994).

6. CASE STUDY

The development of the GIS of the study area goes through several distinct stages. The first is data collection and conversion, the second is editing and final is database development as well as brows and query functions through a user interface. Emphasis is placed on the method of organization determined to maximize brows and query efficiency and friendliness, by dialogue buttons, menus scripts under ArcView (3.3).

This paper was intended to introduce a design system to manage survey datasets through the production of GIS-ready information using appropriate standard and computing application. The trial implementation does instigate sufficient results at present stage whereby the test datasets consisting of raster image and feature classes were being managed carefully through the platform of producing and delivering GIS-ready information. ArcView functionality is proved offering capabilities for geospatial data interchange, manipulation and management as well. The ArcView application has clearly shown the successes of the concept of data integration on-the-fly from multiple heterogeneous geospatial data servers.

6.1 Data collection and conversion

Both analogue and digital data are gathered for the study area including: A digital base map for Baghdad University site. Eight digital Arial photos provided by surveying department as shown in Figure-1. Historical data, photographs, reproduction and surveying details. Additional descriptive information was also collected (Ibraheem, 2012).

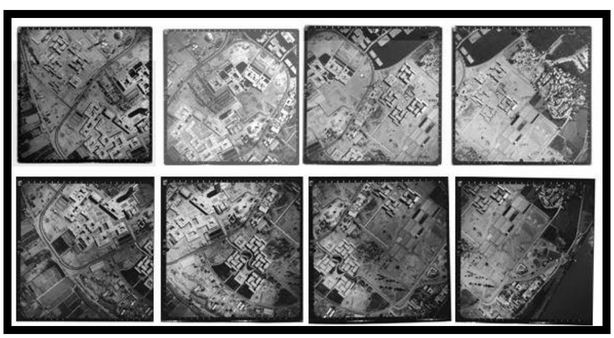

Figure-1. Eight digital Arial photos of Baghdad University site (Ibraheem, 2012).

A mosaic is an assembly of series of overlapping aerial photographs to form one continuous picture of the terrain. It may consist of a single strip of photographs, termed a *strip mosaic*, or it may be contain many overlapping strips (Moffit and Bouchard, 1988).

The images used in this study captured from space with focal length (152.16 mm), flying height (456.48 m) and scale the image (1 / 3000), which is illustrated in Figure-2. The completion of this work needs to several enough aerial photos of the area. The mosaics have been found that the University of Baghdad covered pace aviation is flight (110, 111). The entire airline has four images so that there is a common area shows each image of the photo that followed in the line of flight, one is called the forward overlap or overlap the front and the amount (60%). And also there is an overlap (side lap) or (End Lap) hereunder (30%) were converted this image to a digital format (Digital form) using (Scanner).

Matching the mosaic images usually implies that the radiometric intensity data from one image representing a particular feature must be matched to the intensity data from the second image, representing the same feature. This implies more than just matching image intensity data correlation, because the same piece feature may look considerably different radio metrically from different point of view, or at different time. Figure-2 shows the matching the mosaic of eight digital Arial photos of Baghdad University site by using ERDAS LPS (V 9.2) software.

After the production of mosaic for that study area, stereo pair of the final form the ArcView software was used to prepare a digital map with multi layers. The layers, which were formed: roads layer, colleges layer, residential sectors layer, sport fields layer, parking layer, sub roads layer, gardens layer and urban places layer. After the completion of the drawing layers have been producing digital map in its final form with scale of 1:10, 000. This scale is appropriated to the scale of digital aerial photographs that were used in the production, which in turn was to be used to produce the digital map; thirteen points were selected as check points to compute the resulted accuracy Root Mean Square Error (RMSE) by using the following equations (Ibraheem, 2012):

$$\mathrm{R}_i = \sqrt{\mathrm{Rx}_i^2 + \mathrm{Ry}_i^2} \qquad (1)$$

where

R_i = The RMSE for check point *(i)*.
Rx_i = The X residual for check point *(i)*, (the distance between the source and the transformed coordinates in x direction).
Ry_i = The Y residual for check point *(i)*, (the distance between the source and the transformed coordinates in y direction).

Depending upon the residuals, the RMSE in X coordinate, the RMSE in Y coordinate, and the total RMSE can be computed from the following equations:

$$R_x = \sqrt{\frac{1}{n}\sum_{i=1}^{n} R_{xi}^{\ 2}} \qquad (2)$$

$$R_y = \sqrt{\frac{1}{n}\sum_{i=1}^{n} R_{yi}^{\ 2}} \qquad (3)$$

$$\mathrm{R}_T = \sqrt{\mathrm{R}_x^2 + \mathrm{R}_y^2} \qquad (4)$$

where:

R_T = total Root Mean Square Error (RMSE).
n = number of check points.

The resulted accuracy ((Root Mean Square Error (RMSE)) computed by using a special equation (4) as described above was (55) cm.

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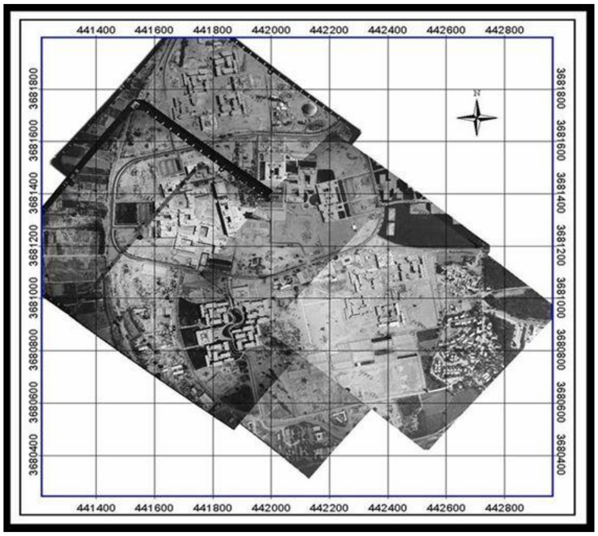

Figure-2. Matching the mosaic of eight digital Arial photos of Baghdad University site by using ERDAS software.

In this paper we cut the portion of Arial photos for Al-Nahrain University, the size of the cutting portion image is (5.5 ×13.7) cm, (491×205) pixels. Figure-3 shows the final map of Al-Nahrain University, which we chose and worked on it to make an initial data base for this university.

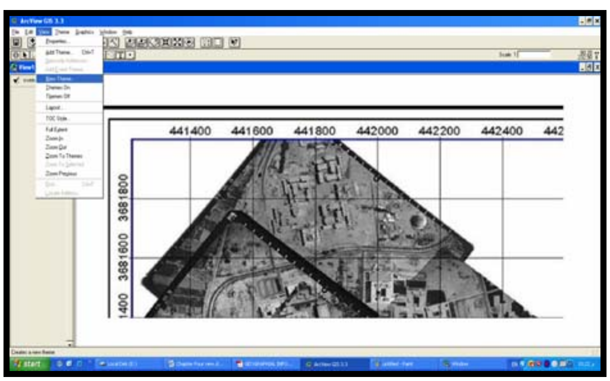

Figure-3. A thematic map of the whole area included in the ArcView software of Al-Nahrain University site.

By this way we can draw the following themes: College of science, Architecture department, College of Politics, College of Engineering, Engineering labs, Lectures halls, Collection of college's buildings, Service buildings, Main roads, Pedestrian roads, The parks, Gardens. By selecting all the themes the map will be as shown in Figure-4.

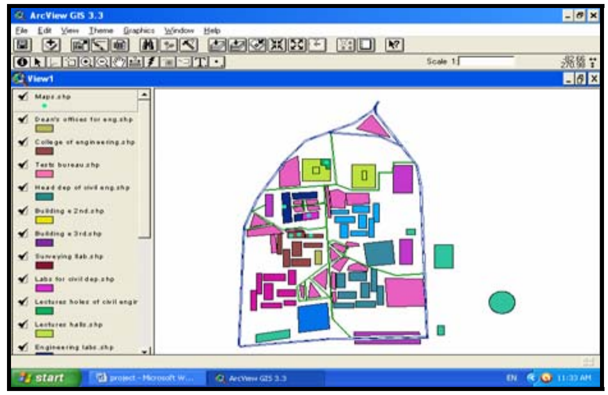

Figure-4. Whole themes or the case study.

6.2 LIS Structure and analysis

The LIS's structure is performed into the ArcView environment, which provides easy and efficient data management and analysis. The specific application includes the integration of the above mentioned coverage into ArcView as themes and the implementation of the database.

Zooming in the map, a more detailed display of the area is obtained, facilitating the investigation process. Through the use of the menu, the desired entity type is displayed, further divided into sub-types, according to specific characteristics. The Start-up screen of the system displays a map of the whole area included in the ArcView software as shown in Figure-3 previously. An error of less than 1.0000 pixels is acceptable. An error of greater than 1.0000 indicates that the points were inaccurately measured or poorly identified. But in this study the resulted accuracy Root Mean Square Error (RMSE) was (0.0775) which was very acceptable.

By this way we can draw the following themes:

a) Architecture department
b) Collection of colleges 'buildings
c) College of politics
d) College of science
e) The parks
f) Garden
g) Pedestrian roads
h) Main roads
i) Service buildings
j) Engineering labs
k) Lectures halls
l) Lectures halls of engineering college
m) Dean's office for engineering
n) Tests bureau
o) Whole themes

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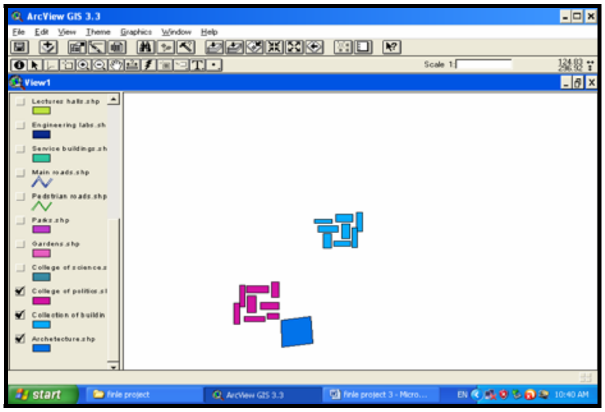

Figure-5. Architecture department /collection of colleges' buildings/college of politics.

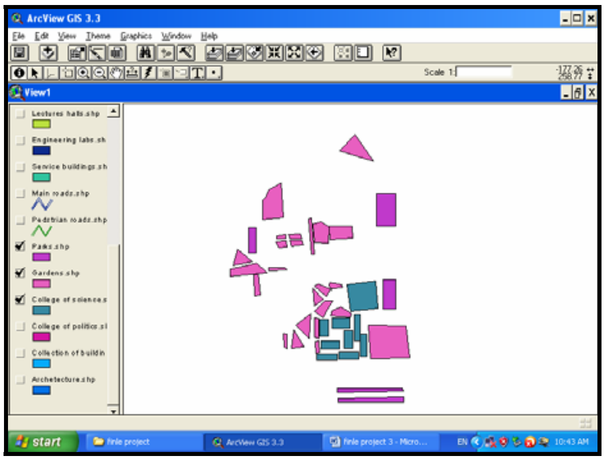

Figure-6. College of science/the parks/gardens.

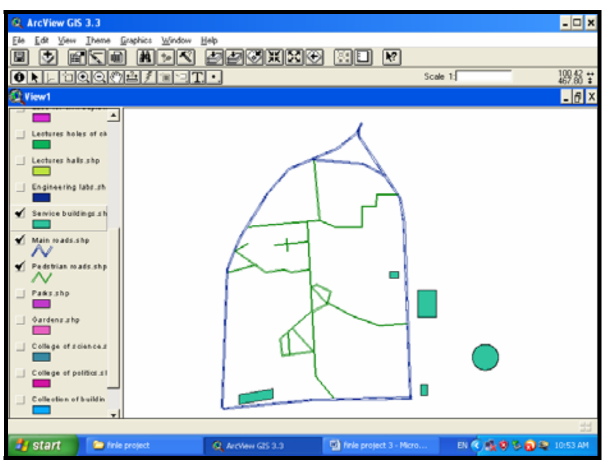

Figure-7. Service buildings /pedestrian roads /main roads.

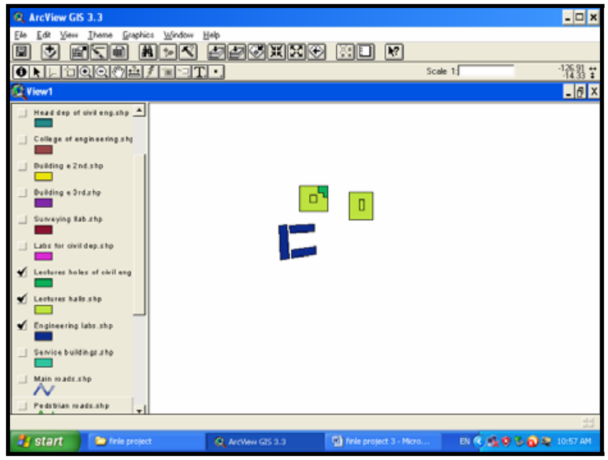

Figure-8. Engineering labs /lectures halls/lectures halls of Engineering.

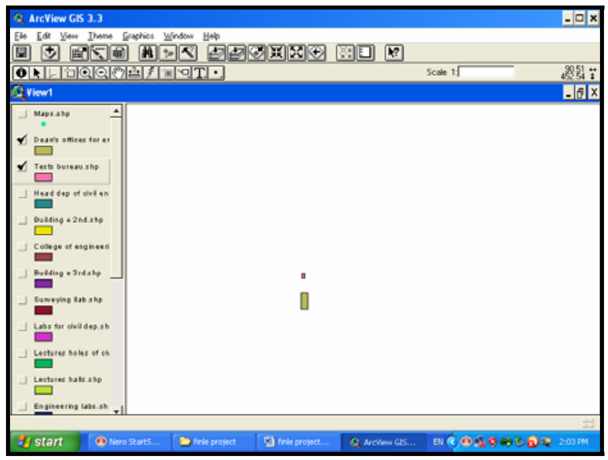

Figure-9. Tests bureau/ Dean's office for Engineering college.

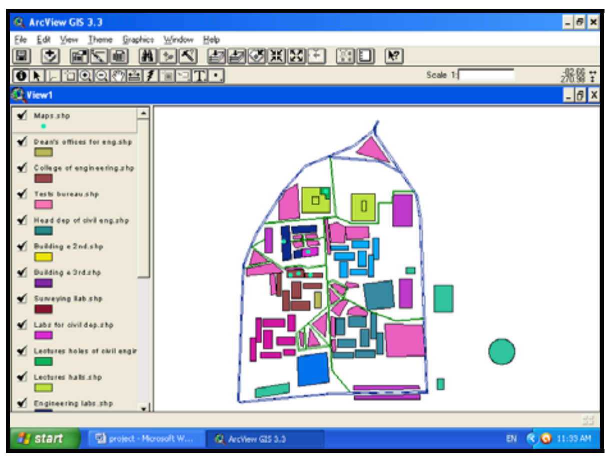

Figure-10. Whole themes.

We make attributes tables for most themes have data base in our study case as follow:

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a) Head department of Civil Engineering

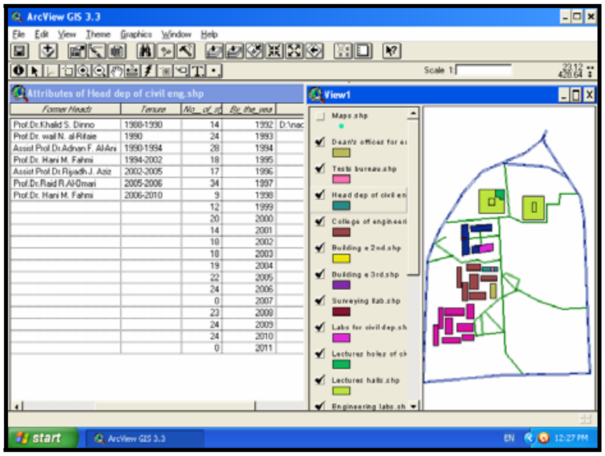


Figure-11. Head department of Civil Engineering.

b) College of Engineering

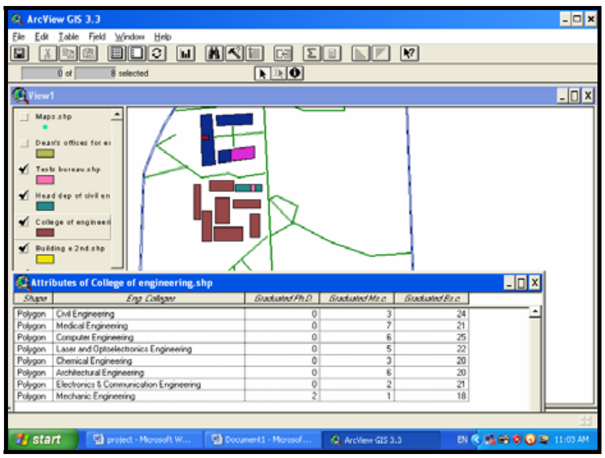
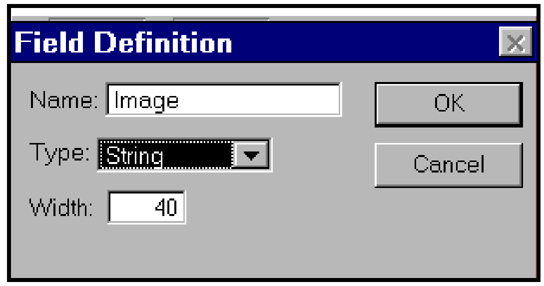


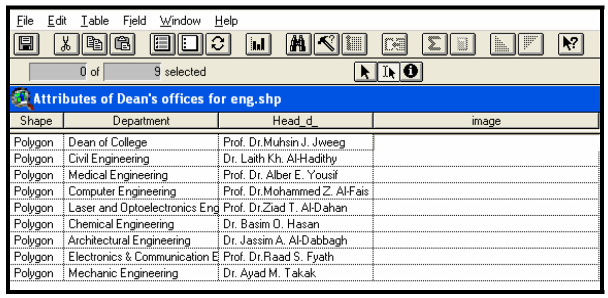
Figure-12. College of Engineering.

Hot links enable us to display images from external sources so that they are associated with particular features on our map. We can display any type of image, such as a chart or picture of a garden or insect. Such hot links can be very useful for providing additional information and for visualizing patterns or problems.

So we open up the attributes table for "the theme of study case we work on". Add a new field. In the Field Definition dialog box, Name the new field "Image" and be sure that its Width specified in the Field Definition dialog box is wide enough to contain the entire address of the external image that will be linked to the theme (I set the width at 40 in this case). Also, be sure to set the Type as a String because we are typing in a category, not a number.

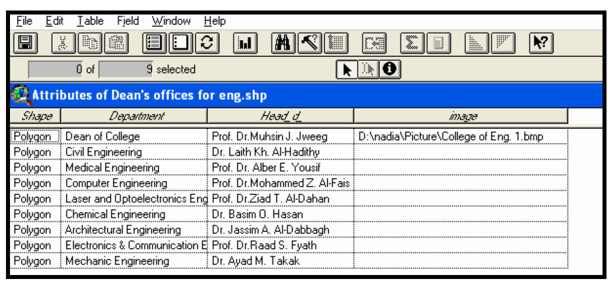


The table should look like this:



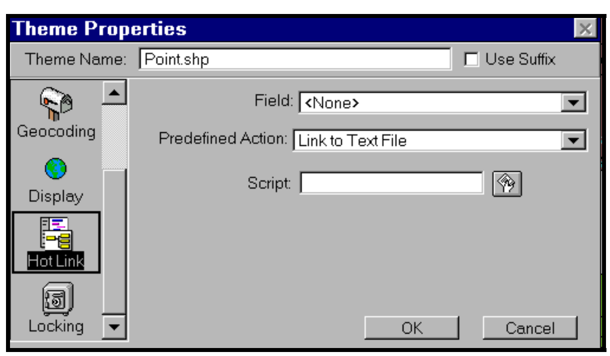
Shape	Department	Head_d_	image
Polygon	Dean of College	Prof. Dr.Muhsin J. Jweeg	
Polygon	Civil Engineering	Dr. Laith Kh. Al-Hadithy	
Polygon	Medical Engineering	Prof. Dr. Alber E. Yousif	
Polygon	Computer Engineering	Prof. Dr.Mohammed Z. Al-Fais	
Polygon	Laser and Optoelectronics Eng	Prof. Dr.Ziad T. Al-Dahan	
Polygon	Chemical Engineering	Dr. Basim O. Hasan	
Polygon	Architectural Engineering	Dr. Jassim A. Al-Dabbagh	
Polygon	Electronics & Communication E	Prof. Dr.Raad S. Fyath	
Polygon	Mechanic Engineering	Dr. Ayad M. Takak	

Go to the field "Image". Type in the "address" for the image that will be the hot link to our selected theme. We want as our hot link the image file
"College of Eng. 1.bmp", which is located in the D: directory. Thus, its address is:
D:\nadia\Picture\College of Eng. 1.bmp
Type in this address.



Shape	Department	Head_d_	image
Polygon	Dean of College	Prof. Dr.Muhsin J. Jweeg	D:\nadia\Picture\College of Eng. 1.bmp
Polygon	Civil Engineering	Dr. Laith Kh. Al-Hadithy	
Polygon	Medical Engineering	Prof. Dr. Alber E. Yousif	
Polygon	Computer Engineering	Prof. Dr.Mohammed Z. Al-Fais	
Polygon	Laser and Optoelectronics Eng	Prof. Dr.Ziad T. Al-Dahan	
Polygon	Chemical Engineering	Dr. Basim O. Hasan	
Polygon	Architectural Engineering	Dr. Jassim A. Al-Dabbagh	
Polygon	Electronics & Communication E	Prof. Dr.Raad S. Fyath	
Polygon	Mechanic Engineering	Dr. Ayad M. Takak	

Go back to our map and open up the Theme Properties dialog box. On the left hand side of the dialog box, scroll down to the Hot Link icon and click on it.



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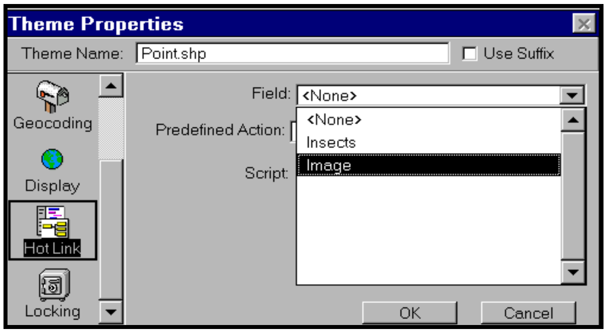
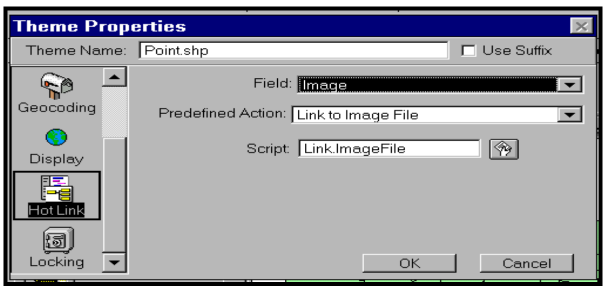
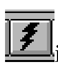
In the drop-down list for Field, select "Image", which has our address of the image.



For the drop-down list for Predefined Action, select "Link to Image File."



Click on the **OK** button.

Go to the Hot Link button  in the second row of buttons at the top of the screen and click on it. When you move your cursor over the map, it appears like a bolt of lightening. Click once on the theme we study to bring up the hot-linked

In our study we make a Hot Link for the pictures regarded with chosen theme and maps to illustration details in themes. And it should look like this.

a) Pictures of Engineering college

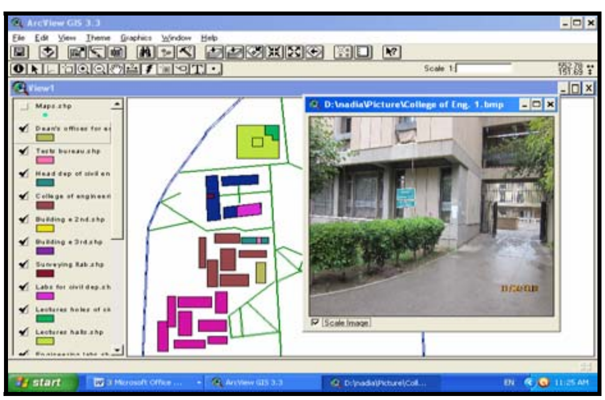


Figure-13. Pictures of Engineering college.

b) Head department of Civil Engineering

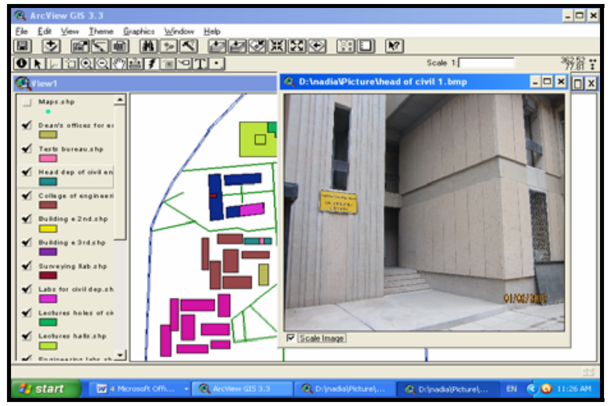


Figure-14. Head department of Civil Engineering.

c) Surveying lab

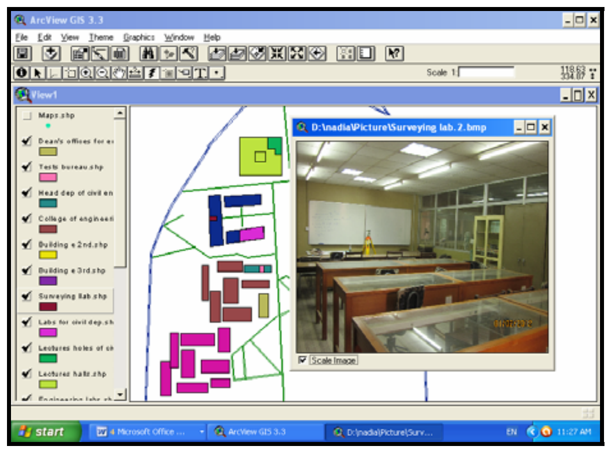


Figure-15. Surveying lab.

And according for the maps regarded with the themes of our study case the will look like this:

d) Lectures halls of engineering college

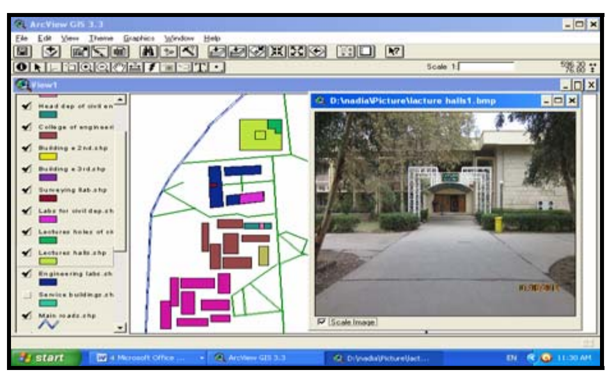


Figure-16. Lectures halls of Engineering college.

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e) Civil Engineering labs

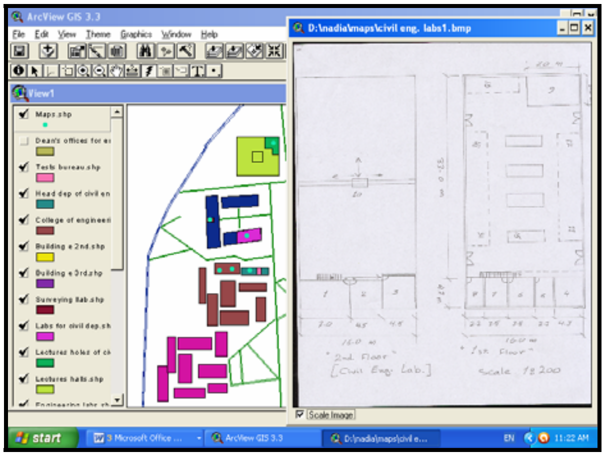


Figure-17. Civil Engineering labs.

f) Lectures halls for Civil Engineering department

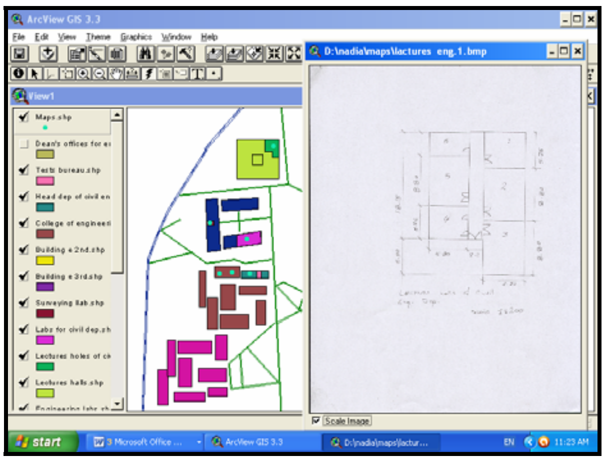
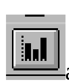
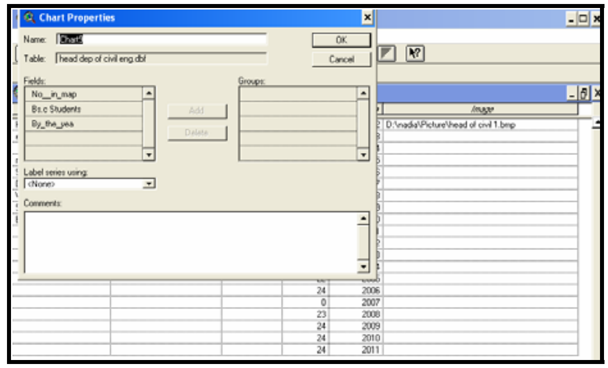


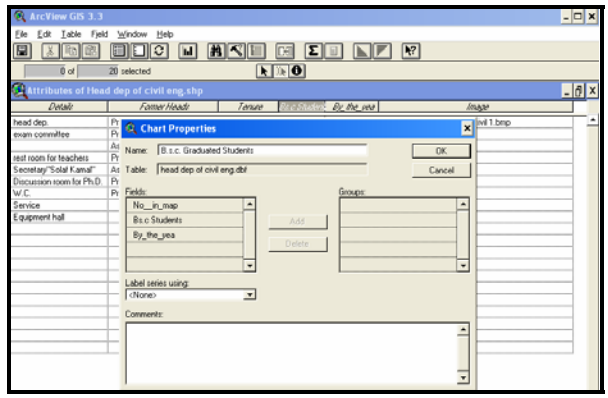
Figure-18. Lectures halls for Civil Engineering department.

Graphs can enhance our ability to interpret spatial data. They provide a visual tool to compare patterns that we might otherwise miss if we were simply looking only at the database Tables we have seen in Arc View. Graphs are also crucial components of making convincing presentations to others in government, business, and education.

Now click on the chart button  at the top of the screen below the menu. The Chart Properties dialog box now appears.



Let us examine the dialog box. At the top is a small box with the name of our chart, "Chart 1." Here you can type in a new title for the chart. Type in the phrase "B.Sc. Graduated Students"



Just below the "Name" of the chart is the "Table" whose data we will be using to create our new chart; in this case, we are using data from "Head Dep. of civil Eng.".

Below on the left is the category "Fields," which contains a list of the fields in our Table. In the middle are two buttons whose labels are dimmed because they are not active yet. On the right is the category "Groups" with an empty box below it. The basic idea is to select the fields that we want in our graph and add them to the box under the category "Groups."

Click on the field name "B. Sc. Students" on the left under the heading "Fields" and notice that the button labeled Add is no longer dimmed, which means that we can now use it.

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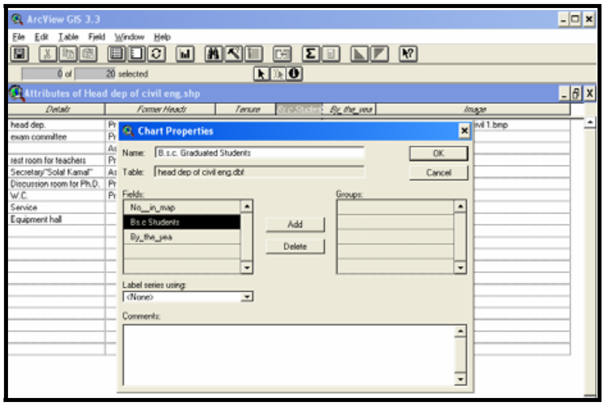
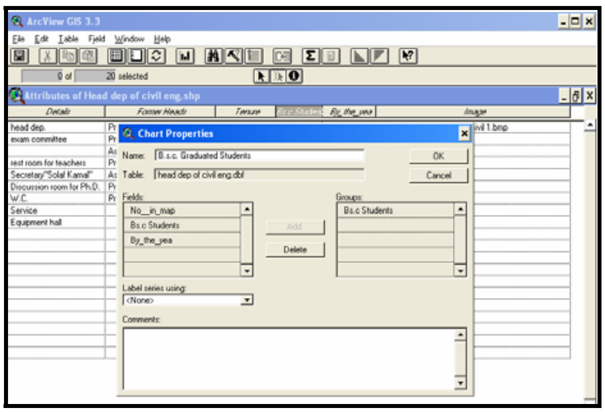
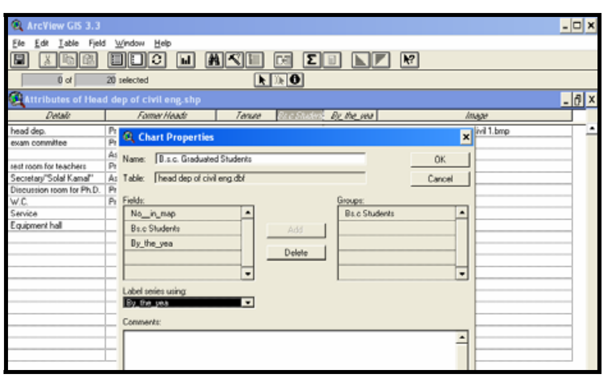


Click on the "Add" button. Now the field "B. Sc. Students" is added in the box on the right under "Groups."



Now add the fields "Numpest2" and "Numpest3" to the box under "Groups" in the same way. You will have to use the scroll bar in the "Fields" list to find these fields.

Now look at the small box in the middle on the left of the Chart Properties dialog box with the heading "Label series using:" In its drop-down list (which now lists "None") select the field "Strategy" (which contains the types of pest-control strategies). This will enable us to label the graph with the names of the B. Sc Graduated Students.

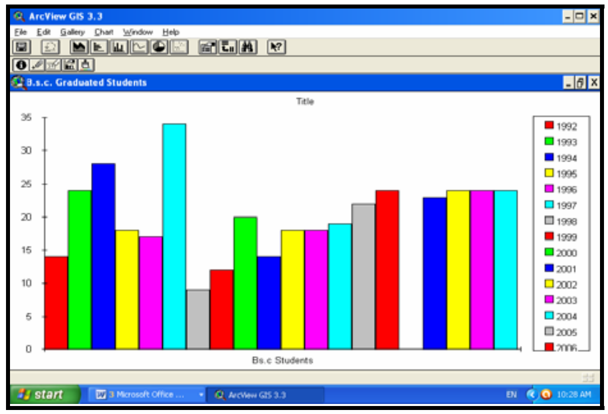


The field "Strategy" now appears in the small box below the heading "Label series using."

Click the OK button at the top right in the dialog box and a bar graph automatically appears.

(Note: if you cannot see all the labels in the graph clearly, put your cursor in the corner of the border around the graph and drag the corner out to enlarge the graph.)

Right now we have the labels for the number of B. Sc in the different time periods in the X axis according to the years.



By this way we can draw the following charts of our themes in study case:

a) B. Sc. graduated students by the year

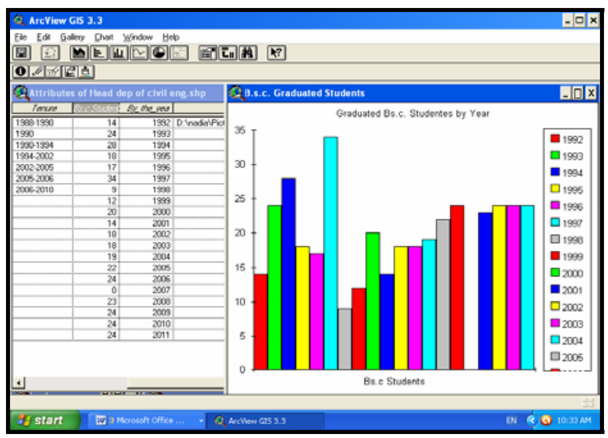


Figure-19. B.Sc. graduated students by the year.

b) Ph. D and M. Sc. and B. Sc. graduated students for Engineering college

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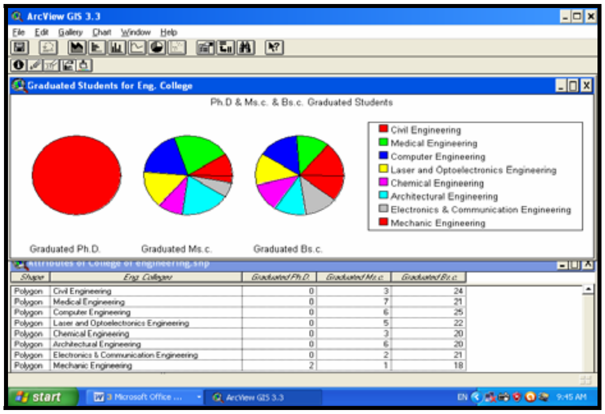

Figure-20. Ph. D and M. Sc. and B. Sc. graduated students for Engineering college.

CONCLUSIONS

It is well known that GIS has already become a standard tool for handling spatial data. GIS are now more commonplace in Iraq. Adding multimedia material and organizing friendly entries and alternative search techniques, the system then becomes an efficient tool for different users. Until only a few years ago the map was perceived as a static, plain view of preselected areas, available at fixed scales and, due to the development of the landscape, often out of date. Now, it is evolving into a dynamic, continually updated network of interrelated databases with volumes of geographically referenced information linked to a comprehensive digital cadastral database. As shown above, our study results in efficient Land Information System for the study area. This system may be improved, by adding the following steps:

a) Promote and ensure the reliability and integrity of large-scale land information systems and Facilitate collaboration between GIS and surveying professionals at the local, regional, and national levels.
b) Promote the use of sound surveying and mapping principles in the development and the use of land information systems.
c) Foster the development and adoption of useful standards, specifications, and procedures for the development, operations, and the use of land information systems.
d) The LIS's structure conducts the user's navigation through alternative searching paths, created by the application.

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