AN ALTERNATIVE TECHNIQUE FOR UPDATING DIGITAL MAP DATA WITHIN A PILOT PROJECT IN EGYPT

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ABSTRACT :

The updating of digital maps has always been a time consuming task, one that many organizations either have avoided or deferred for years. Digital mapping technology offers the promise of easier-- and therefore, the potential for more frequent updating.Improvements have been made in creating interactive graphic editing and updating capabilities, yet not all updating scenarios have lent themselves to make such updating from the database management system (DBMS).

We have tested non-graphic updating procedures in a pilot area of 1.5 square kilometers in Giza city in Egypt using ESRI'S ARC/INFO on Micro-Vax computers. The Users recognize that coverage's graphics are maintained separatly from the user-accesable attibute database (INFO files). This is done for good reasons which are not questioned here. What we have tested here is an alternative technique for allowing updating to coordinates and topologies through INFO DBMS without low-level binary management of the graphic files. The proposed technique uses ARC AMLs only and allows linkage to be managed entirely by high-level arc routines.

The primary advantage of such technique is that it allows the updating to be expressed as automatic coordinates changes with topologies and vise versa. In addition, the developed technique will have significant potential in improving the interfaces between existing digital maps and any external non-graphic database or digital information from external updating sources such as total station, remotely sensed imagery,..etc.

KEY WORDS : Database Models, DBMS, Digital Mapping, Egypt, Spatial Database queries, Topology.

INTRODUCTION

The problem of growth an economic expention fased by planners and mapping organization and the corresponding need for rapid access to map data have led to the development of digital mapping technology. Digital mapping can be defined as the digital representation of the spatial and/or the planimetric distribution of map characteristics. It contains spatial information such as the location of different map entities, and non-spatial information such as feature codes attached to the spatial information to be identified in the digital form [Cooper 1989; Akif 1990].

In GIS/LIS, digital maps generally are formatted as either vector or raster data. Vector data describe areal features as polygons and linear features as line seggments, both composed of digital points whose locations are expressed in coordinates. On the other hand, raster data partition land parcel into a regular grid with location specified by address or row and column numbers, [Wallace et al. 1988]. Moreover, Vector format data in the form of topological facts and metric location and shape create an even more explicit digital map. A topological data structure enables the construction of a consistent digital map that contains relations among features which provides capability to edit vector data and ensure logical consistency and hence is essential in the creation of digital map files, [Spooner, 1989].

Egypt has recently moved towards fully implementing digital mapping and Geographic/Land Information Systems throughout the country. One of the major problems that has been encountered is to update the existed old maps which are not in digital form. Therefore, many researches have been conducted to find out the most convenient technique for updating these existing old maps. This study is one of these researches which aims mainly to update the large scale digital maps within the Egyptian circumstances from the topological attribute records stored in the DBMS and using ESRI s ARC/INFO software modules and many other routines developed in ARC MACRO Language (AML).

INTIGRATED VERSUS LINKED ATTRIBUTE GRAPHICS IN DBMS

The Database management system (DBMS) constitutes one of the backbone components of any GIS/LIS. The objectives of any DBMS is to enable the user for a quick and easy access to data held within the system free from complexity of data storage, searching, sorting or updating mechanism. Many database management strategies depend upon a knowledge of the specific form of queries that are to be handled prior to data entry such as hierarcical and network database models, [Date, 1990]. A relational database on the other hand which is used in this research enables the user to develop different uses and combination of uses of the data after entry has taken place. It does this by maintaining data in form of tables which are collection of rows and columns. The rows are termed records or tuples while the columns within a row are termed the field of the tuple. We can combine two or more of these tables by grouping them based upon common references for the purpose of updating the database, [Stanlay, 1989].

The major controversial element in GIS is the linkage between geometric data and feature attribute data, [Herring, 1989b]. The classical approach is to split the two data types which usually creates a gap that must be hurdled every time a combined spatial edit or query is executed. The other extreme appraoch is to place all attribute and geometric information in the same DBMS. This latter appraoch simplifies the GIS system and makes real-time topological maintenance. This means that topology is always valid and can be changed without reconstructing the whole topological attribute files. Besides, a single DBMS for attribute and geometric information provides a possibility of integrated spatial-attribute queries (Ad-hoc query) from the DBMS, [Herring, 1989a].

In this study, we have used ARC/INFO software package which separates the topological attribute files (AAT & PAT INFO files) from the graphic files, [Morehouse, 1989]. Thus, any topological attributes updating can not be interpreted as graphic results. Also, although ARC cartographic package does allow some attribute manipulation, it is not optimized for this task. It does however provide very powerful graphic processing capabilities which may be extended through its internal Macro language (AML or SML). Thus, if we are able to perform searches and updating of topological attributes behind a powerful graphic cartographic interface, we are able to assemble the major components of GIS using tools which are familiar to us and which can be turned to our particular requirements, [Chapman et al., 1989].

Various facets connected with digital data acquisition, handling and updating are dealt with in several literatures, [Nassar et al., 1992].Becuase the scope of this paper is limited, the emphasis is placed on the most pertinent technical issues for updating the captured digital map data using a proposed updating technique from the DBMS. However digital data acquisition, handling and the coventional techniques for updating digital map data will be first outlined.

DIGITAL DATA ACQUISITION, RECOVERY AND CLASSIFICATION IN EGYPT

For testing the proposed updating technique for large scale digital map, a map of scale 1:2500 for a pilot area called Beni Magdoul village has been chosen in Giza city in Egypt. This village has an area of approximately 1.5 square kilometers. The choice of this area in particular is due to the existence of a variety of features such as roads, buildings, cultivated lands and irrigation and drainage networks. The digital data acquisition, handling and updating processes in this study have been carried out using ARC/INFO software modules and a number of routines in a pac kage developed in this study in AML language and called AUDIGMAP. ASU, [Hassen, 1992]. The various options and their functions available in this package along with their integration with ARC/INFO commands and modules as achieved in this research are included in figure (1).

The digital data acquisition and handling processes through this study can be summarized as follows:
- Digitizing the hardcopy map for the chosen pilot area using a manual digitizer.
- Building the topolgical attribute files (AAT & PAT INFO files) using the clean command in ARC/INFO software.
- Handling the encountered digitizing errors using the technique shown in figure (1) which involves a routine (option 2 in the developed package) to detect and correct the overshoot arcs and the undershoot arcs in the digitized data automatically.
- Reconstructing the topolgical attribute files using the build command in ARC/INFO software.
- Classifying map entities in terms of their land uses or functions automatically using option (3) in the developed package. Finally, the digital data are recovered from the cartographic and geometric errors and thus be ready to be updated, [Nassar et al., 1992].

THE PROPOSED ALTERNATIVE TECHNIQUE VESUS COVENTIONAL TECHNIQUES FOR UPDATING DIGITAL DATA

Without accurate information about the lands and waters, and without an up-to-date information of country's lands resources and their boundaries, the government and the people are handicapped in controlling their own destiny. It is not possible to make the best use of the land and natural wealth, or to prevent its mis-use, without good-up -date factual knowledge of the country and its features, [Meyor, 1991]. Digital mapping technology offers the promise for easier and more frequent updating which has great potential in practice. With digital map technology, continuous maintenance of data files can take place. In addition, the map user can be provided with the most up-to-date data available. Thus, it seems rational to anticipate that there will be an increasing transition from the traditional technique for map updating to update the existing digital database, [Makarovic, 1982].

The updating of digital map has usually traditionally been performed through one of the following approaches, [El-Shiemy, 1990]:
- A new photo vesus digital map file (figure 2).
- A new large scale map vesus digital map file (figure 3).

The updating scenario of digital maps within the above approaches is based upon updating the geometric attribute file (graphic file) and then updating the corresponding topological attribute records that are stored in the associated database files. Nowadays, tremendous improvements have been made within these approaches to increase the graphic editing capabilities. However, none of these approaches tried to make such updating from the topological attribute records using the DBMS. This may be due to the available traditional sources of updating maps such as classical surveying techniques and areal photography.

The recent achievements in the field of database technology and its current powerful capabilities gave reason to reconsider the currently used map updating techniques and promote further development to them. This has been motivated by the recent sources of updating data in digital form such as total station surveys and remotely sensed imagery supplemented by the immeasurable capabilities of digital computers. Therefore, the main concern here is to present a non-graphic procedure

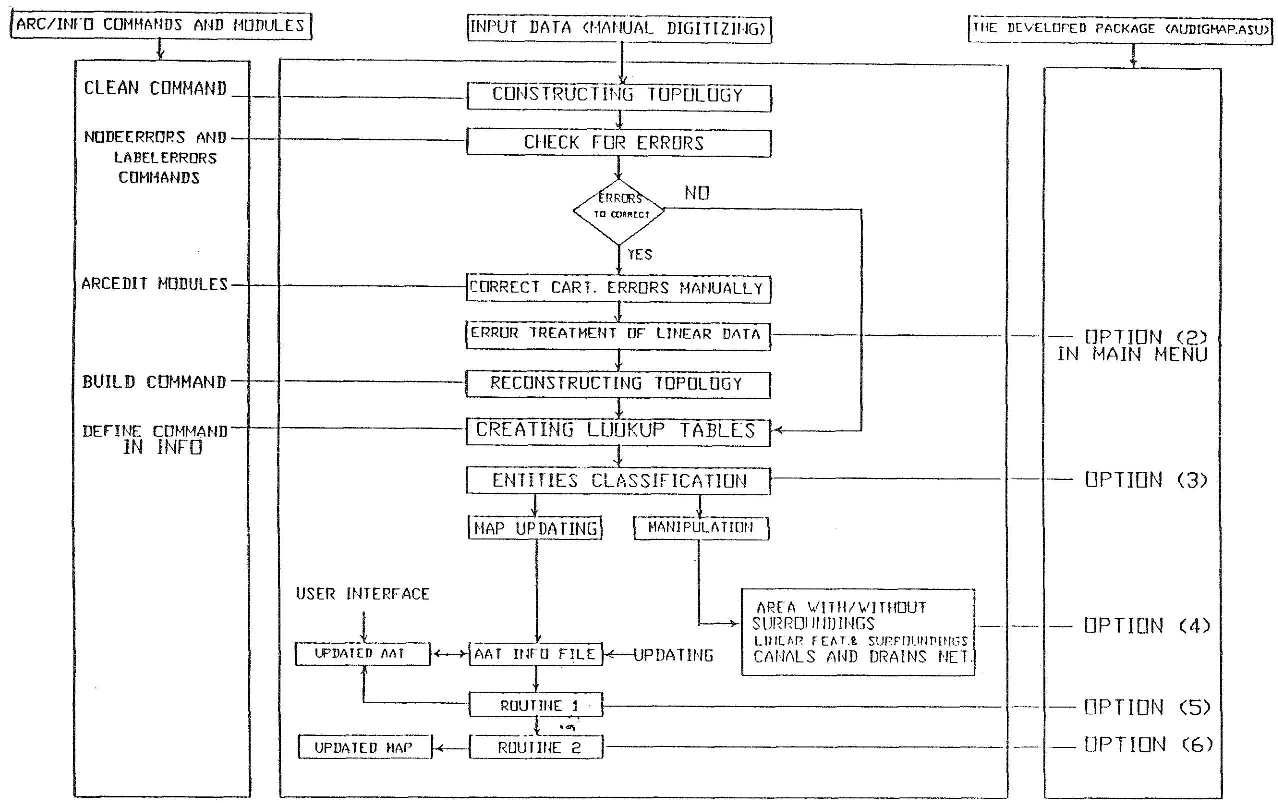

Figure (1) "The Various Options In The Developed Macro Package And ARC/INFO Modules For Digital Data Processing, Manipulation and Updating"

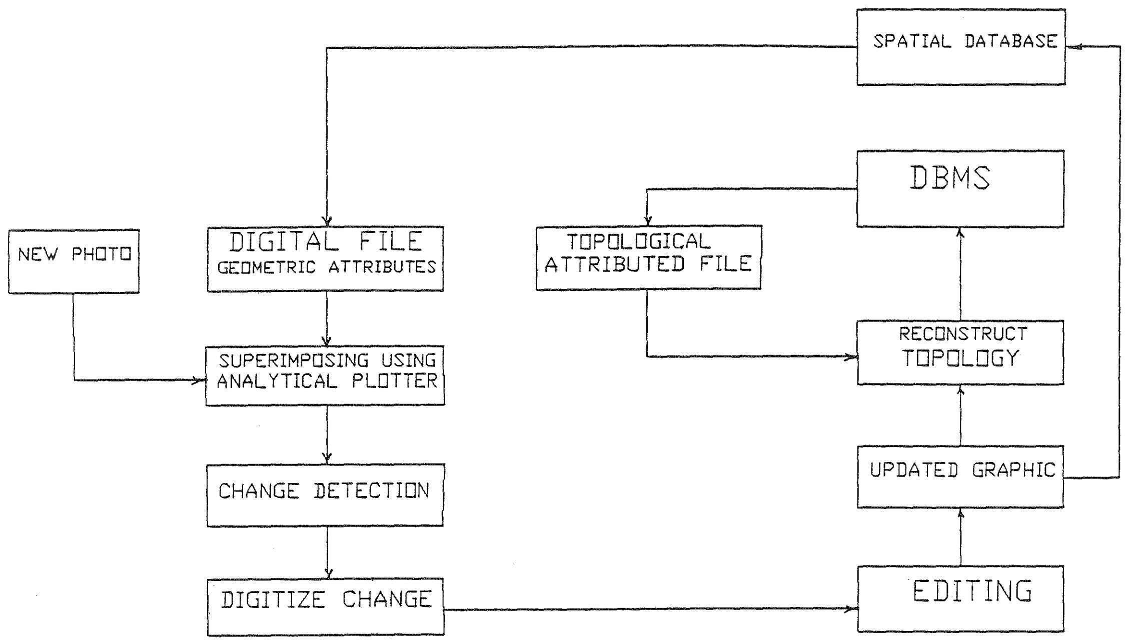

Figure (2) "Updating Of Digital Map Using New Photo"

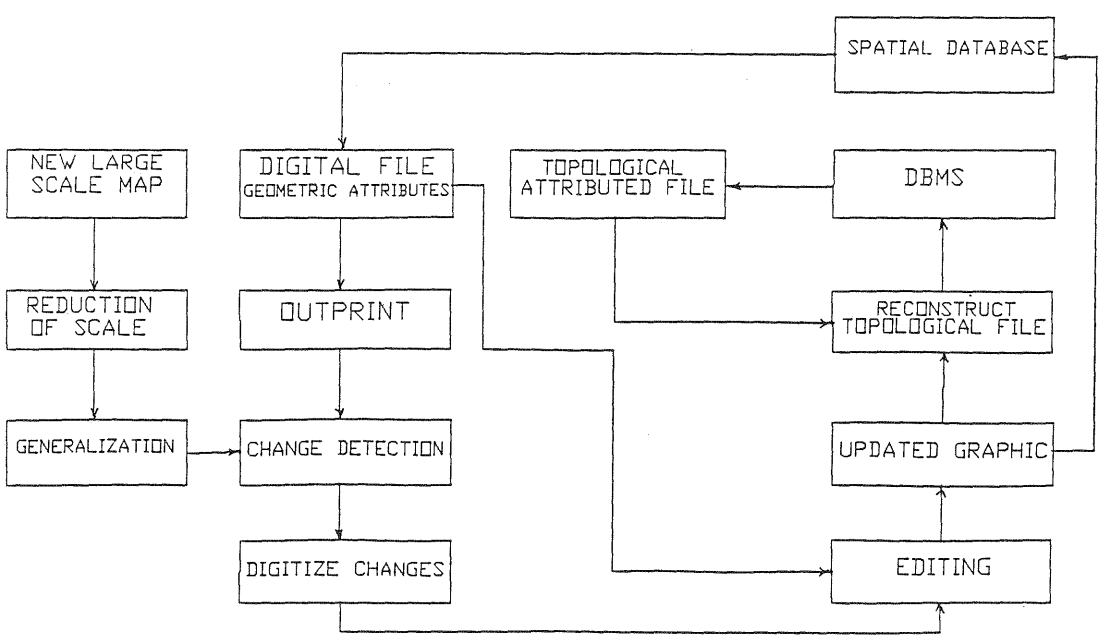

Figure (3) "Updating Of Digital Map Using New Large Scale Map" for updating digital map from the DBMS and its applications to the current circumstances of large scale maps in Egypt.

It is cleared that the current used approaches for updating digital maps depend mainly on the digitization process for the detected changes. This can be generally be accomplished using a stereo-plotter and a manual or automatic digitizer. In addition to the high cost and time consuming required for making such digitization, the process of detecting the changes especially in the case of using a new photo approach requires professional skills for making such detection. Moreover, these approaches take also a lot of time in its lengthy graphic technique which eventually leads to increase the updating cost of the required skillful personnels or the equipments that make such updating. With the recent and rapidly increasing capabilities of all types of computers and database technology, the drawbacks in the above mentioned approaches can be overcome by using an alternative technique to make the updating process from the DBMS and using a couple of AMLs routines (option 5 & 6 in the developed package).

The basic adea of the proposed technique for updating digital map data from the DBMS comprises of two stages; updating the topological attribute file (AAT)file using the DBMS INFO. Then applying these updating within the geometric attribute file using a couple of AMLs in the AUDIGMAP.ASU package. The first routine is used to transfer the coordinates from the geometric attribute file to the AAT file while the second routine is used to produce the final updated map. Since each map feature has an internal number assigned by ARC/INFO software and stored in both the geometric and topological attribute files, the developed technique takes advantage from this property in the process of transferring the coordinates to the AAT file and then updating the old geometric attribute file. The main scheme of the proposed technique is illustrated in figure (4).

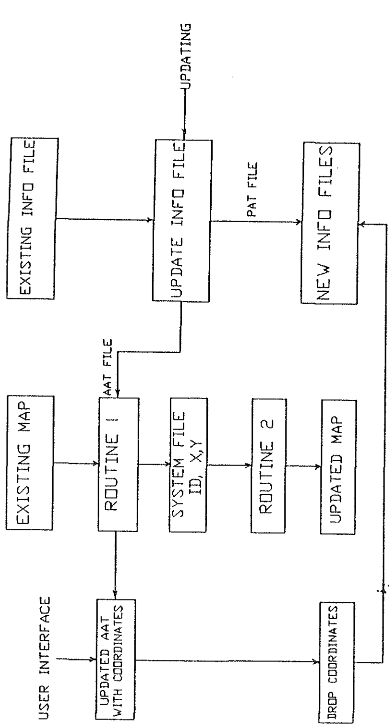

Figure (4) "The Main Scheme of the Developed Technique"

APPLICATION AND RESULTS

Each map feature class in ARC/INFO (point, line, polygon) has an associated feature attribute tables, i.e., AAT and PAT for line and polygon coverage respectively in the DBMS INFO. Each table defines the topological attributes for all features of the same class in the coverage and there is a record for each individual feature, [Morehouse, 1989]. The proposed updating technique is tested here, just for demonstration only, by adding a record and deleting another one in the AAT file and then applying the corresponding changes in the geometric attribute file. To make it clear, adding a new line represents the criteria of the added record and deleting the line represents the deleted record using the developed routines.

In order to apply and examine the proposed updating technique, a small part of the pilot area under investigation, which suffices our purpose here is selected and shown in figure (5). The sahded area with a User-Id = 990 will be divided into two parcels with a line has a User-Id =2000. The two adjacent shaded areas (with User-Id 1230 & 1270) will be merged to constitute a new large one with a User-Id = 500 by deleting the record in the AAT file representing the intermediate line that has a user-id = 211 between the two parcels.

The updating of the AAT file is made manually using the keyboard of the Micro-Vax workstation. the updated information is a list of coordinates and IDs for the updated map features that result from the data collector of the total station or any other updating sources that can give the coordinates of the updated map features. ARC/INFO users recognize that coverage s graphics are maintained separately from the user accesable topological attribute database (INFO files). Accordingly, any topological attribute updating (adding records, deleting records,..) can not be interpreted as graphics results. Thus, the developed technique allows updating to the geometric and the topological attribute through the DBMS (INFO) without low level binary management of the graphic files.

The proposed technique is carried out using a couple of AMLs routines and allows the coupling link between the INFO and the ARC cartographic package to be managed entirely by the high level of the ARC routines. The routine (1) used in this study concerns with transferring the coordinates from the old geometric attribute file for the unchanged arcs to the updated AAT file and creating a Vax/Vms file containing the coordinates and the Ids for the unchanged arcs and new arcs in the updated map. While routine (2) concerns with reading the resulted system file and producing the updated map. Figure (6) indicates the results of applying the developed technique on part of the pilot area under investigation. From this figure, it is cleared that as a result of applying the developed technique and making the updating specified in the AAT file, Three polygons are identified with IDs equal 990, 9900 and 500.

POTENTIAL AND FURTHER CAPABILITIES OF THE DEVELOPED TECHNIQUE

The developed technique has noticeable potential concerning digital map updating. In addition, it has been found that it can encompass further

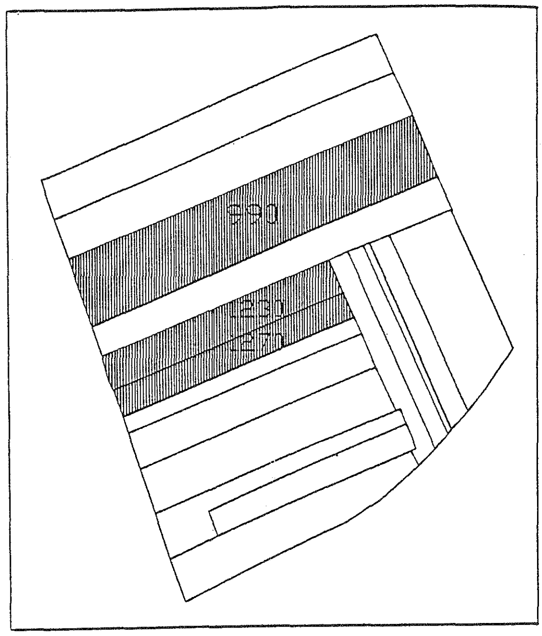

Figure (5) "Test Area Before Updating"

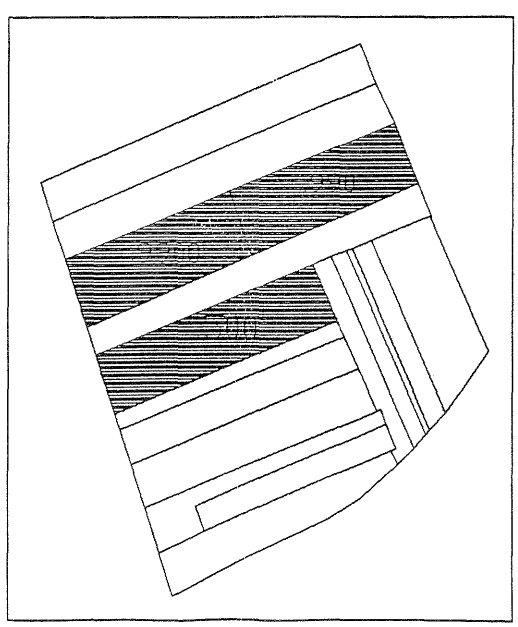

Figure (6) "The Test Area After Updating using
The Developed Technique"

capabilities concerning spatial database queries. The following are the highlights and prospects of the proposed technique concerning these two respctive items.

Concerning Map Updating

The operator in the developed updating technique deals only with the database tables. Thus, it is not required a skillful personnel to make the required updating compared to the previously mentioned updating approaches. Accordingly, the proposed technique can be implemented without professional skills. The system operator can update the reqired topological attribute records without the necessity of long time period training on a particular GIS system. Also, the developed techniqueallows to update the connectivity attributes using the developed AMLs routines and through INFO DBMS without low-level management of the graphic file. This will help greatly in the process of planning, updating and analyzing of networks such as city streets, water ways and telephone lines.

Moreover, the developed technique can be refined to accept data from other updating sources of large scale maps, like for instance, total station digital data that are stored in the data collector in the form of IDs and X,Y coordinates can be combined with the old AAT INFO file to form a new updated AAT file and running the developed routines to form the new updated map.

Concerning DataBase Queries

The link established between the topolgical attributes and the geometric attributes in the proposed updating technique can be developed to give a capability to make spatial queries with non-procedural or declarative queries in INFO DBMS as illustrated in figure (7), where the user has to specify only what results are required without specifying how the data will be handled to give such answers.

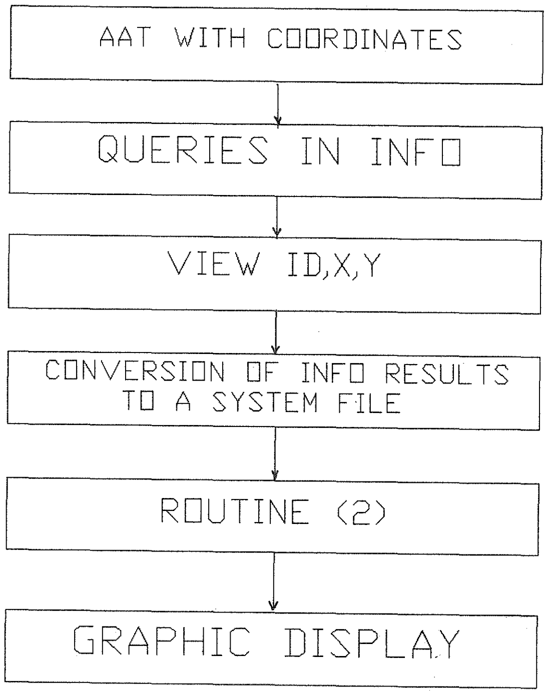

Figure (7) "An Alternative Way For Displaying Graphic Info Queries"

CONCLSIONS

The investigation in this study proved that with the recent and rapid improvement in database management technology, updating of large scale map data can easily be made within the database tables without the complexity of making such updating from the graphics with great efficiency and relatively short time. In addition, the proper design of the relational DBMS used in this study and its capability in updating objects make the proposed updating technique simple and more efficient to be implemented without professional skills at a higher degree of success and a shortness of executing time.

This study presents an alternative technique for the management of topological attribute from the DBMS to update large scale digital map and for the coupling of graphics and attibute database. The further integration of these database components can solve and optimize the Ad-hoc queries from the DBMS where the user can make non-procrdural spatial queries and display the graphic results from the DBMS using the described alternative way in this study and through a developed couple of AMLs routine. Besides, this study indicates that the total station can play an important role in updating large scale maps especially using the proposed technique presented in this paper.

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