UTILIZING REMOTE SENSING DATA AND REAL TIME KINEMATICS GPS SURVEYING FOR AM/FM SYSTEMS

A.Çabuk [a], S.N.Çabuk [b]
[a] Anadolu University Department of Architecture, Iki Eylul Kampusu, Eskişehir, Turkey
acabuk@anadolu.edu.tr
[b] Eskişehir Tepebaşı Municipality, Eskişehir, Turkey
sncabuk@anadolu.edu.tr

KEYWORDS : Spatial Information Science, GIS, Surveying, GPS/INS, Management, AM/FM, IKONOS

ABSTRACT:

Geographic Information System is an important tool for collecting, storing, searching, analyzing and printing of geographical information. Riyadh Municipality is fully aware of the great importance of the GPS / GIS application.

The objectives of the municipality was briefly as follows:

- Automated mapping of the underground water and storm water facilities (gullies, manholes and pipes)
- Creating digital network information (data and maps) operated by computers
- Facility management system for these utilities
- Preparing reports, thematic maps, queries for any part of the system and following up the information of maintenance and operation
- Integrating this information with other data such as roads etc.

The main objectives of the project was to provide Riyadh Municipality with the results of the survey of manholes and gullies for ground and storm water in Riyadh City and the establishment of GIS database for storm water and ground water utilities.

INTRODUCTION

The project area covers Riyadh Municipality boundaries, which consist of 16 Municipalities and 145 districts.

The major task of the project is to survey of approximately

- 9638 manholes
- 17310 gullies

Each surveyed point will have a unique ID developed by the project, UTM Easting, Northing coordinates and Elevation (AMSL). The surveying will be carried out using Total Stations and GPS of static, fast static and kinematic (RTK). The field crews will be able to have cm-level precision by using the above-mentioned techniques.

PROGRESS OF THE WORK

As mentioned above, the main objective of the project is to provide Riyadh Municipality an AM/FM System for Ground and Storm Water Facilities. The main purpose of this study is to provide the results of the survey of manholes and gullies for ground and storm water in Riyadh City and the establishment of GIS database. On October 28 / 2001 GPS Ground Control Points establishment started by 3 teams and went on at the rate of 40 points daily as an average and we completed approximately 2000 GPS Control Points. There were 3 survey teams each team consist of 3 persons (2 engineers/operators and labour) for surveying the manholes and catchbasin. These teams collected data for each manhole and gullies for ground water & storm water. The observations and data collection started on 14 November 2001. Surveying of all ground water manholes and gullies were completed (2380 manholes and 1385 gullies in the total) by 28 November 2001. Surveying of all storm water items were finished by 16.02.2002. The study areas were determined using IKONOS image of Riyadh and the work areas were marked and plotted daily. The hardcopies of these images were also a guide for survey crews to locate the points.

The collected data were transferred into a text document daily and saved with the survey date as a file name. These text files were transferred to Microstation using a in-house developed application program. The information about the surveyed points was transferred into drawings and MS Access Database automatically using our application according to the text file. The office team developed an accurate base map using MOMRA`s National Coordinate System standards. This base map transferred into Microstation. MS Access Database were linked to Geomedia. All the collected points were created in Geomedia by geocoding of database table. The information in Geomedia environment was updated automatically because the database is used as an external reference in Geomedia and any changes in database are automatically transferred in Geomedia. On the other hand all the as built plans of the utility were scanned and registered according to base map. These images were used only as a guide to locate the directions of the pipelines. Our office team digitized the pipelines using these images as a guide with a house made automatic mapping application tool. Some applications were developed for data linking, data editing and pipeline drawing. In the office team we were working with seven people to organize the system, prepare the working areas and proper information for survey crews, developing application programs and enter the data.

MAPPING AND GIS IMPLEMENTATION

The collected data was transferred in a text file daily. This file contain x, y, z coordinates for each point. Text files contain also code of each item. The example for a text file is given on Figure 1. Coding was developed using below listed information:

- Municipality code – 2 digits – numeric
- District code – 2 digits – numeric
- Street code – 3 digits
  - Primary street 3 digits – numeric
  - Secondary street first digit character (x) last 2 digits is numeric
- Type of item 1 digit character
  - **G** for underground water items
  - **S** for storm water items
  - **I** for catch base
- ID for each item – 5 digits – numeric (ID begin from 1 and continue for all collected data)

Coding system is given in Figure 2. All text files were prepared daily using the collected data for each day by using x, y, z coordinates. We developed an application for creating these text files. This macro transfers x, y, z and ID from field survey equipment, finds the district for each point and writes it in text file. The text file names are the date of the day, such as 10NOV01.txt for the collected data on 10 November 2001. Mapping is performed with a macro under MicroStation. Macro reads x, y coordinates for each item from text file and draw all points automatically on the locations which are read from text file. The GIS contains two different type of graphic feature. These are

- Lines for pipelines
- Points for catch base, groundwater, manholes and storm water manholes.

Lines, which represent pipes, are drawn by snapping the points by a house made automatic mapping application tool. We developed a tool for digitizing the pipes. Operator combines two manholes according to registered as built maps using this tool. By clicking the manholes all the information such as x,y,z coordinates, municipality name, district code, street code, manhole number extracted and are transferred to the proper fields in the database representing beginning and end points of pipeline. After clicking the end point, the length of the pipeline measured automatically and is written in length field of the database. The slope of the pipeline is calculated using the length of the segment and `z coordinates of beginning and end points – depth of manhole` information of the segment. An example is given in Figure 3. The database contains for point feature below mentioned items

- ID – was taken from field survey code
- X – was taken from field survey
- Y – was taken from field survey
- Z – was taken from field survey
- Street names – was taken from field survey code
- District names – was taken from field survey code
- Municipality names – was taken from field survey code
- Type of item – was taken from field survey code
- Type (normal or exit)
- Maintenance date
- Maintenance type
- Maintenance period
- Depth of manholes
- Diameter of manholes and line code
- Net name
- Contract numbers
- Contractor name

The database contains for line features below mentioned items.

- ID
- Code
- Maintenance period
- Maintenance type
- Maintenance date
- Type of pipe
- Length of pipe
- Slope of pipe
- Invert elevation
- Diameter of pipe
- Line code
- Net name
- Contract numbers
- Material
- Contractor name

These features are collected in Ms Access database. In house developed macro reads the code from text file and creates the fields in the database and put the information in the database automatically. These fields are

- Municipality names
- District names
- Street names
- Types of items
- ID for each item

An operator using another macro in micro station simply links the other features for the points. By using this macro, after clicking an item, a data entry dialog (Figure 5a) appears and operator can enter the data for each item. These data will be linked in Ms Access automatically. The data may also be modified using this macro as illustrated in Figure 5b. The features that are entered by the operator are listed below:

- Maintenance date (date)
- Maintenance type (character)
- Maintenance period (character)
- Depth of manhole
- Type of manhole
- Diameter of the cover

All the ground and storm water maps compiled by Municipality were scanned. The Riyadh map and as built maps of municipality were registered and transformed by using the topographic maps that are compiled as part of project 116 of MOMRA and MOC roads, for digitizing of the pipelines. An example to such a map is given in Figure 6. This project has accomplished the development of a national seamless standard basemaps for all mapping and GIS implementation studies. Pipelines were being digitized from these maps in MicroStation for the pipelines layer. These lines were guide for drawing line features of GIS. After creation of the line feature, user could link the data to the pipelines by using another macro. All the

data that were linked by the operator were stored in Ms Access. The features, which were entered by operator, are listed below.

- Maintenance period
- Maintenance type
- Maintenance date
- Length of pipe
- Slope of pipe
- Type of pipe
- Diameter of pipe
- Type of facility (underground water or storm water)
- Code of pipeline

After creating all the graphic features and the data, the delivery was made in the Intergraph Geomedia 4 format. The Geomedia file was created with geocoding of the database. Figure 9a-d show some examples about the final GIS delivery.

SURVEYING THE MANHOLES BY REAL TIME KINEMATIC AND TEST RESULTS FOR THE RTK IN RIYADH

The principles of real time kinematic (RTK) GPS is similar to the relative static positioning GPS. The main difference between these methods is RTK uses real time results using radio communications. By using RTK it is possible to obtain cm level precision in position. RTK system uses different hardware than static/fast static techniques, such as

- One radio modem to broadcast the measurements to the rover that calculated in the base station,
- Another radio modem with rover to receive the radio signals,
- A control unit (PSION) to operate the software about RTK systems for accessing all information of points.

Hardware list of RTK that we used in the base station are listed below.

- GPS receiver (Z Extreme, Z Surveyor)
- GPS Antenna
- GPS Receiver & GPS Antenna link cable
- Radio Antenna
- Antenna lock
- Radio Modem (SATEL)
- Radio Modem & Radio Antenna link cable
- External Battery to be used for radio modem
- Radio Modem & GPS Receiver link cable
- Controlling Unit (PSION)
- Controlling Unit & GPS Receiver link cable
- Stander holder & trible
- Antenna Stander & lock

Hardware list that we used by our survey crews are listed below.

- GPS Receiver
- GPS Antenna
- GPS Receiver & GPS Antenna link cable
- Radio modem (SATEL)
- Radio Antenna & GPS link cable
- Controlling Unit & GPS Receiver link cable

Test results for the RTK survey in Riyadh for storm water manholes and catchbasin are explained below. Crew has started to observe the manholes in Jazerah Region, which has not been any manhole observed before. A base station has been used, which has been determined and observed before. Work has been carried on from 8.00 AM till 12.00 PM and approximately 110 manholes and catch basins have been observed by one survey team using RTK with no signal loose. In the second period of work, which has been started at 13.30 PM, a lot of signal loose has been detected that continues all workday. The total number of the observed points decreased and it was appr. 30 for this period is 30 according to the satellite positions.

RESULTS

The establishment of graphical and non-graphical database constitutes the most significant component of any GIS attempt, as much as 90-95% of the total investment. Saudi Arabia is a dynamic country with rapid structural changes in urban and rural areas. There are, however, very few basemaps or high-resolution images available to reflect these rapid changes. Besides, local survey, mapping and subdivision activities lack any acceptable standard and format. Small scale maps of Saudi Arabia (1/50,000 and smaller) have been produced by Ministry of Petroleum 10-30 years ago. These maps have not been updated afterwards. As to the large scale maps, they are produced by Ministry of Municipal and Rural Affairs (MOMRA)., under the contracts ranging from P101 (mapping project belonging to the Western Saudi Arabia) to P116 (Riyadh mapping). However, unfortunately these maps are also rather old (as old as 25 years), the last project of P116 photographed in 1995. They are, therefore, far from representing a great part of urban, even rural areas. Each of MOMRA photogrammetric project took 4-5 years to complete.

Owing to the reasons mapping projects are very important for Saudi Arabia. The project presented in this article is very significant for high precision mapping, facility management and automating mapping. In the office work we got some problems by converting the Microstation Geographics *.dgn file into Geomedia. The problem was with the Mslink numbers which were created by Microstation Geographics as a primary index field for graphic features and database. We tranfered the file to Arc View shape format to solve this problem and then we add the shape files as a new feature class in Geomedia. As a result for RTK survey in Riyadh, our crews had very efficiency product between 7.00 AM and 12.00 PM in the work performed in Riyadh according the position of the satellites. After 12.00 PM even some reduce in the quantity of the satellites detected but survey work could continue till 3.00 pm. After 3.00 pm the radio or satellite signals has been completely lost. Radio signal cut off has been detected when crew is 1 km away from the base station using 1Watt radio modem. Effect on the radio signals determined during the work according to the high buildings, trees, radio or TV towers, military areas.

Note : Figures will be given in poster presentation.