

# EXPERIENCES ON THE PHOTOGRAMMETRIC DIGITAL MAPPING FOR ISTANBUL LAND INFORMATION SYSTEM

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## **ABSTRACT :**

The paper presented is a report about a large scale Digital Mapping and Land Information System in Istanbul metropolitan area. Beside this, the experiences gained by authors who worked in this project as controller and as consultant, has been discussed from the point of view of productivity and technical aspects. Their considerations and observations had been explained in this paper, too.

## **1. INTRODUCTION**

Istanbul is one of the biggest cities in the world located on the two continents, Europe and Asia, with a population of 10 millions and covering an area of 940 sq. kilometers. The city is getting larger rapidly.

In July 1987, Metropolitan Municipality of Istanbul began to implement a Land Information System in Istanbul (ILIS) Metropolitan area.

First subproject of ILIS was the digital mapping. The purpose of the project was to produce the digital base map of Istanbul with scale of 1/500 and 1/1000. In the past, of course there were many maps of Istanbul. However, they were not in the same standard. They had been made in many different times and in very diverse scales.

The main purpose of digital mapping is considered to be the creation of digital cartographic data for ILIS. The final product is a digital data set suitable for a data base.

The aims of this project are:

- . Digital mapping and digital updating,
- . Production of large scale base maps,
- . Digitizing of cadastral information and integration of these with the data base.

The authors of this paper, who are staff members of Geodetic and Photogrammetric Engineering Department of Engineering Faculty of Yıldız University in Istanbul, were responsible for the control and the consultancy of this project /3/.

## **2. GROUND CONTROL**

For the ground control, 225 ground control points of the metropolitan network in the national coordinate have been used. This network is connected to Universal Transverse Mercator Grid System (UTM), with 3° wide zones. For height control, 46 existing height control points have been used.

The project area was divided into 21 blocks related to geometrical position each has 300 Models, 1370 full control points were carried out

on the peripheral of each block with an interval of  $i=2b$  and 1280 vertical control points were located on the surface of the whole block homogenously with an interval  $i=4b$ .

1300 application points were located on the whole project area for the terrestrial application. The point density in all areas was planned at least 4 points per sq. kilometer.

In 45 days approximately 3500 points, including full control, height control and application points were located and signalized in the project area.

In 6 months with 16 survey teams 9000 angle and distance measurements and 4000 km. levelling were made. For this purpose electronic theodolites with data recorder and Zeiss Ni-2 levelling instruments had been used.

The ground control network was totally adjusted by using the GNA (Geodetic Network Analysis) on an Intergraph System (I 252). Standard deviation in the planimetric control network is 5.7 cm. and 1.2 cm. in height control network.

## **3. AERIAL PHOTOGRAPHY**

Aerial photographs were taken using a Zeiss RMK camera with a forward motion compensation (FMC). The format is 23x23 cm. with focal length of 305 mm.

The scales of the photographs were 1/4000 and 1/3000; for map production of 1/1000 and 1/500 respectively, the flying height was chosen according to the scale. The flight direction was planned as east to west for 1/4000. Only for 43 sq. km. area, the flight direction was north to south, where scale of photograph was 1/3000. Forward overlap was planned as 80% and side overlap was planned as 30%. 15000 black and white photographs were taken to cover the project area. The aerial photography missions started at the middle of September 1987 and completed in one month, time.

#### 4. AERIAL TRIANGULATION

Project area was divided into 21 Blocks /3/. Each block consisted of approximately 300 models. For aerial triangulation and for digital mapping, 60% forward overlapped photographs were selected. Tie points were identified from natural objects such as corner of buildings and ends of lines drawn on the roads or very sharp objects. Aerial triangulation measurements were made on the 8 Inter Map Analytical (IMA) instruments, using stereocomparator mode.

Before measuring some informations had to be entered into the data base. This included project information, camera information, fiducial mark coordinates, block, strip, photograph and model informations. After measuring fiducials, adjustment of inner orientation was performed by conformal transformation with 4 parameters. Residuals were kept below 10 micrometers for relative orientation, after 9 parallax points had been measured. Tolerance of residual parallaxes was 5 micrometers. Approximately 10 control points in each model were measured. Root mean square error was below 3 cm.

For aerial triangulation adjustment, the PAT-MR (PC Version), "Block Adjustment with Independent Models" program has been used. Each block was adjusted separately.

#### 5. DIGITAL MAPPING

##### 5.1. Hardware and Software

During Photogrammetric Digital Map Production, a system configuration described in /1/, was used. The main part of hardware, is a dual processor Intergraph 252. The communication between the main computer and the peripheral units is provided through ETHERNET. The disk capacity is 2 GB and core memory is 32 MB. The operating system is VMS. 8 IMA, 2 WS, IBM PC/2 and plotters are connected to the Local Area Network.

The software used on the system is as follows:

- VMS Operating System
- IMAN, IMA for stereoplotters
- IGDS Interactive Graphics Design System
- DMRS Database Management Retrieval System
- IPS Intergraph Plotting system
- ICS Interactive COGO System
- ETI Electronic Theodolite Interface
- GNA Geodetic Network Analysis
- PAT-MR/PC Aerial Triangulation Adjustment
- ATP Aerial Triangulation Package
- DTM Digital Terrain Modelling

##### 5.2. Digitizing

8 IMA analytic Stereoplotters are used for digitizing feature coding mode. With this aim, a Turkish "graphics font" and a symbol library which is within the national standards was created. All the necessary data were provided for the operators.

The topographic TOP-File and planimetric PLN-File are digitized and coded with corresponding symbol library. They are buildings and structures, boundaries, roads, tracks, railways, lines, masts and poles, water drainages and coastal features, vegetations etc. During the "Feature Coding", the topographic and planimetric data were stored in to 63 layers in the Intergraph system.

Digitized maps are plotted and transferred to the quality control.

##### 5.3. Field Completion

Field completion had been performed by survey teams equipped by Zeiss Elta 3 total stations. Field completion planned and performed; based on the editing request. Data collection in the field had been coded while data was recorded. Then the data was transferred to a PC and converted to IGDS graphic design files automatically.

##### 5.4. Editing

An editing request was prepared per model for field completion.

Field completion was done on the edited file and final form of the digitized model was obtained.

Editing process was carried out daily on the workstation.

##### 5.5. Quality Control

The quality control department checked the cartographic quality and completeness of the digitized models. By using the final form of the models, maps were extracted automatically. The final maps were derived from the digital data by automated plotting and produced according to national standards. The quality and control tests of the produced maps were carried out by the team in which the authors of this paper participated. The results are given in /3/.

#### 6. ISTANBUL LAND INFORMATION SYSTEM (ILIS)

Since the urbanization development is faster than planning it is necessary to make use of all the possible technology in urban management.

Municipality began to implement a Land Information System in Istanbul (ILIS). The aim of this system is to perform automated mapping for attribute data processing, spatial and geographic analysis and for management of properties and demographic informations/2/.

The purpose of this project is to have a database system with graphic and non graphic parts which will work connected to each other. For graphic part, the base maps had been developed by using aerial photogrammetry. Large scale photographs for 940 km<sup>2</sup> were taken and stereo plotting had been completed. The non-graphic information had been collected and entered into the computer for only pilot project area.

#### 7. EXPERIENCES ON DIGITAL MAPPING AND LIS

This part comprises of a brief list of the experiences in connection with large-scale digital mapping and LIS.

##### 7.1. Organizational Aspect

There were some organizational problems since the project area was too large and since it was the first national experience.

According to us, updating was an important problem, since the flight was made only once, covering the whole area. It might have been better if the digitizing process had been distributed to more than one contractor or the flight had been made step by step.

The members of the project working team gained

satisfactory technical knowledge and education during this successful project.

It has been seen that cooperation among different disciplines is very important.

Pilot project was successfully accomplished during the ILIS project, however succeeding operations could not be generalized as planned.

#### 7.2. Technical Aspect

Since there is not any national standards yet for digitized map production and information systems and the present standards were developed only for drawn maps, this is an important drawback. However the standards developed within the framework of this project are a great contribution.

The buildings, especially the ones that are located in densely built areas caused problems for development plan application, cadastral application and classical map production. This problem can be resolved by ground completion.

There is a certain drawback of the software program. Figures which contain more than one level, like road-wall, pavement-wall, etc. are drawn with missing parts when only one level is drawn.

There are some difficulties while transferring data to other data base systems because of the data formats and interface software. This should be made easy.

It was not effective to edit graphic or non-graphic data which were not compiled from their resources.

It was tried by the advisors and the supervisors to carry out the control process of the production of base maps depending on a map control database. It was very useful but it has not yet been developed for universal use.

#### 7.3. Economical Aspect

15 engineers and 110 others participated in this project. Digitizing process was made in 3 or 4 shifts by using 8 IMA. 5000 models were measured and 3500 base maps were produced. Therefore, the project which started in July '87 was completed in 3 years time. The cost of this project is 6.5 million US \$.

By using the software developed by the contractor firm, production and efficiency check was continuously made.

According to that, the efficiency,

in inhabited areas was 1.1 ha/h  
in uninhabited areas was 3.5 ha/h  
in the whole project area was 2.5 ha/h

Therefore, photogrammetric digital map production is 3 times cheaper and 5 times faster than the ground methods.

#### 8. CONCLUSIONS

This project has opened new horizons to survey professionals in TURKEY.

This is the first photogrammetric digital map production and LIS project in Turkey. It is as well the greatest in the world.

It is the first photogrammetric project done by a private company in the last 60 years in Turkey.

A foreign company (Kampsax-Denmark) was allowed to take photographs over Turkey for the first time.

There were strict confidential rules in photogrammetric applications, which were softened with this project so that private sector extended its horizons.

Digital Map Production is suitable to international standards and competitive in efficiency. In this project, national resources had been used and technological knowledges, experiences and talents have been gained.

Briefly, Istanbul project is a successful experience, for base map production. Because of that, Ankara Metropolitan Municipality had started a similar project in 1991.

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