

MAPPING FROM HIGH RESOLUTION DATA IN GIS SOFIA LTD.

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ABSTRACT:

The high-resolution data have attracted much attention in photogrammetry and GIS. In the paper main approach for updating urban cadastral information using remote sensing and GIS data are described. The aerial photography over the part of the territory of Sofia Municipality is executed and the results after the adjustment are shown. An experiment in 4 variants was conducted to assess the accuracy of aerial triangulation that can be reached by means of digital photogrammetric system PHOTOMOD (Racurs Co., Moscow). The results show a reliable accuracy. High-resolution satellite images from IKONOS and QuickBird taken during the years 2000 to 2008 are used. The obtained products are orthophotomosaics (panchromatic and pan-sharpened), which are used for the aims of GIS SOFIA Ltd.. Orthophotoplans at 1:10000 scale for the mountain and 1:5000 for the plane regions on the territory of Sofia Municipality are produced. The results after the adjustment are shown in the table. In the concluding part of the paper image based presentations like satellite and aerial images are shown in the field of 3D visualization. Data collection and its various combinations are explained. The procedures for building and terrain modeling – alternative approaches for urban visualization are also described.

1. INTRODUCTION

Geographical Information System - Sofia Ltd. (GIS SOFIA), established in 1999, is a Sofia Municipality company. The main function of the company is to create and maintain the cadastral information system of Sofia Municipality, including cadastral maps at 1:1000 and 1:500 scale. The company is structured in 9 departments. One of them is Photogrammetry Department, which main task is applying digital photogrammetry for building up and maintaining the cadastre.

2. THE AERIAL PHOTOGRAPHY

The aerial photography includes 405 colour pictures, covered around 98 sq. km - near the Vitosha and Balkan Mountains, taken by analogue aerial camera Zeiss RMK TOP 30/23 at 1:5000 scale and scanned by DeltaScan with 12 μm pixel size. The project consists of two sub-projects: Vitosha Yaka and Balkan.

2.1. Project characteristics

Vitosha Yaka Project covers 86.80 sq.km area (217 cadastral sheets at 1:1000 scale, size 80x50 cm). The terrain is flat, lightly hilly and hilly not dense urban area with predominantly low houses. Average height of the terrain above sea level is 710 m. The area is near Vitosha Mountain.

Balkan Project covers 11.41 sq km area (28.5 cadastral sheets at 1:1000 scale). The terrain is flat, lightly hilly and hilly not dense urban area with predominantly low houses. Average height of the terrain above sea level is 620 m. The area is near Balkan Mountain.

2.2. Information sources

The coordinates of pre-marked on the terrain ground control and check points are measured and determined by GPS-

receiver Topcon GGD with an accuracy of ± 2 cm in position and ± 3 cm in height.

The DTM, necessary for ortho-rectification, is generated from existing contours with interval 5 m.

2.3. Producing the orthophoto-plan

All orthophotoplans sheets at 1:1000 scale are made by digital photogrammetric system PHOTOMOD 4.2. The accuracy of the final product is shown by the mean square differences between geodetic and photogrammetric coordinates of the ground control points: In X - axis ± 3.7 cm; in Y - axis ± 3.4 cm; in XY - plane ± 5.0 cm.

PHOTOMOD is an up-to-date system using primary data from film or digital aerial cameras, as well as pushbroom CCD and radar spaceborne sensors. The software package allows flexible workflow organization. It supplies user with the capabilities to perform the complete cycle of photogrammetric processing without engaging any third-party tools.

3. THE EXPERIMENT - ACCURACY OF PHOTOMOD AERIAL TRIANGULATION

For evaluation the capacity of a digital photogrammetric system of special importance is the accuracy of the aerial triangulation, performed by the system. For this reason an experiment in Photogrammetry Department was made. The aim of the experiment was to establish the accuracy of the aerial triangulation performed by the corresponding modules of the digital photogrammetric workstation PHOTOMOD. The experiment was conducted in 4 variants under same conditions, but with different quantitative parameters. A part of Vitosha Yaka Project is used as test area.

The mean square differences between geodetic and photogrammetric coordinates of the check points on the terrain in different variants are in the following range:

In X-axis: ± 4.5 to ± 7.3 cm, in Y-axis: ± 4.3 to ± 9.3 cm, in XY-plane: ± 6.3 to ± 11.8 cm, in Z-axis: ± 8.0 to ± 26.7 cm.

General information about the experiment project:

Blocs of aerial pictures	1
Strips of aerial pictures	6
Aerial pictures	14+17+18+18+19+19 = 105
Approximate picture scale	1:4710
Average flight height above the terrain, m	1440
Ground pixel size, cm	5.7
Pre-marked points on the terrain	36
Pictures per 1 pre-marked point	3
Tie points	786

4. THE SATELLITES IMAGERY

4.1. QuickBird satellite project

Pan-sharpened QuickBird Standard Ortho-ready satellite images, dated August-September 2007 and March-April 2008, covered the whole territory of Sofia Municipality (1341.8 sq. km). They are used for production of orthophotoplans at 1:10 000 scale for the mountain and 1:5000 for the plane regions on the territory. Because of the nature of activity of GIS SOFIA Ltd. sufficient number of geodetically determined points is provided. Specific elements from the terrain, which are clearly visible on the images and defined at earlier geodetic surveys, are used.

Orthorectification by use of DEM generated from contours at 5 m is performed. The obtained RMS error in position of 59 ground control points is ± 1.31 m.

4.2. IKONOS satellite project

Fifteen panchromatic and fifteen multispectral images from IKONOS, dated June 2005, over the whole territory of Sofia Municipality are processed.

The obtained products are 2 mosaics (panchromatic and pan-sharpened), which are used for the aims of GIS SOFIA. Orthophotoplans at 1:10 000 scale for the mountain and 1:5000 for the plane regions on the territory of Sofia Municipality are made. The results after the adjustment are shown in table 1.

Points:	Control	Check	Tie
Number	95	75	301
RMS in X, m	± 0.70	± 1.47	± 0.13
RMS in Y, m	± 0.65	± 1.30	± 0.14
RMS in XY, m	± 0.99	± 1.99	± 0.21

Table 1. Ground control and check points residuals

4.3. Establishing changes on the Territory

Three panchromatic and three multispectral images from IKONOS, dated 04.09.2000, 11.07.2000 and 03.07.2002 covered a part of Vitosha Mountain Park are processed.

To establish changes on the territory of Vitosha Mountain Park satellite images from IKONOS are used. Orthorectified product covers 220 sq. km and was used for the change detection of the

forest territory. The accuracy, obtained for the check points on XY - plane is ± 4.96 m.

4.4. Updating of topographic map at 1:5000 scale

For the highly intensive activity regions of Bulgaria the large scale topographic map is produced at 1:5000 scale and for the less intensive ones – high mountain and forest regions – at 1:10000 scale.

The large scale topographic maps for the territory of Bulgaria have been produced in “1970” co-ordinate system and Baltic elevation system. Each map sheet with dimensions 50 x 50 cm in the scale of the map covers 2.50 x 2.50 km = 6.25 km² from the Earth’s surface.

The large-scale topographic map is subject to periodic revision depending on the respective needs. Due to the rapid change of the Capital Sofia infrastructure, it was necessary to revise the topographic map at scale of 1:5000 for a part of the city.

Main source of information for revision of the map was the orthorectified QuickBird satellite image.

Basic data about the selected image

The used image is panchromatic, Basic Imagery, which covers the central part of Sofia. It is an archive image, taken on 27 March 2003 at 09:17 hours GMT. The period, when the image is made, is very appropriate in view of vegetation of plants - nearly no leaves, which could stand in the way of important features. Although the early spring is characterized with an unstable weather conditions, in this case they are extremely appropriate – 0 % clouds. The time interval between acquisition of the image and the time of its purchase and start of further processing for orthorectification and deriving the vector information is within a period four months, which is completely satisfactory.

Use of Rational Polynomial Coefficients (RPC), supplied by QuickBird, with further polynomial transformations

The following approach is used:

- ✓ Transformation by use of the RPC is made.
- ✓ The precision of the obtained result is increased by means of 3D polynomial transformations of the basis of points, measured by GPS.

For the experiment 8 control and 15 check points, normally distributed within the range of the image, are used. The obtained maximum and RMS errors in location in the check points are 2.56 and ± 1.40 m.

The analysis of results shows that this approach ensures needed accuracy for scale 1:5000 in the range of the entire image.

When object boundaries are unclear and can not be identified properly, other sources of information are used:

- ✓ Data from the cadastral information.
- ✓ Field interpretation of the image.
- ✓ Field survey.

5. PROJECT IN THE FUTURE

Hansa Luftbild has flown over a territory of 1467.1 sq. km area. The pictures are taken by digital aerial camera DMC. For the urban area of 811.3 sq. km, GSD 10 cm, forward overlap 80%,

side overlap 30%. For the rural area of 655.8 sq. km, GSD 20 cm, forward overlap 60%, side overlap 30%.

The pictures are necessary to produce urban maps and orthophotoplans at 1:1000 scale by digital photogrammetric workstation PHOTOMOD.

6. 3D VISUALISATION OF A PART OF CITY OF SOFIA

Three-dimensional (3D) visualization and navigation within 3D-GIS environment in urban areas are expanding rapidly in a variety of fields recently. 3D modeling and true simulation of reality offers a flexible interactive system for providing the best visual interpretation, planning and decision making process. For special data management and analysis this technology is becoming more and more efficient. The acquisition of the models has been a topic of major interest and lots of various algorithms and softwares were presented in the scientific conferences in the past years. A challenge for the photogrammetry department of GIS Sofia was to choose the proper method and software for acquiring the 3D model of the City of Sofia. The tested specialized softwares for 3D modeling and virtual simulation were:

1. GTA, Neubrandenburg, Germany;
2. Geonova, Basel, Switzerland;
3. CiberCity, Zurich, Switzerland;
4. Arc GIS 3D, USA;
5. Geotech's Terrain Viewing Suite (GTVS), Turkey;
6. Photomodeler, Canada;
7. Aurora, Russia;
8. StrabVR, Austria.

For realistic visualization from a pedestrian's viewpoint a large amount of data is needed. This can be achieved by a terrestrial images mapped against the building facades. With some of these softwares the needed results can be obtained but other are not suitable or are too expensive. We choose the Austrian software StrabVr. Its major benefits are:

1. Attractive visualization and representation;
2. Easy way for implementation and various functionality;
3. Most of the work has to be made in AutoCAD which is very comfortable for CAD users;
4. Possibilities to work with all kind of images like: aerial, satellite and terrestrial;
5. The software can manage with huge number of buildings which is important for us;
6. The final file can be displayed in *.wrl file in internet.



Figure 1. 3D Model of Central part of Sofia

Depending of the specific of the projects as foreground of the buildings from available data base - satellite images, aerial and

digitized polygons with different types of texture are used. The most useful using this software is that one can show results in internet wherever one is. 3D visualization of urban areas become a common practice nowadays, because of the rapid development in industry and for that reason the intentions for the company concerning 3D modeling are to follow the modern conceptions in this field.



Figure 2. 3D Model of National Assembly of the Republic of Bulgaria



Figure 3. 3D Model of the Hilton hotel, Sofia

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