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GEODETIC AND PHOTOGRAMMETRIC MEASUREMENTS IN THE AREA OF HISTORIC GRANGE IN MŚCIWOJÓW

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Summary

Digital photogrammetry is a field of photogrammetry in which aerial and ground photographs, obtained either directly from digital cameras or from scans of photogrammetric photographs. These photographs are processed by special software. Digital photogrammetry is an important step in the development of this field, because of the application of computers. Photogrammetric methods make working with an object more comfortable, as no direct contact with the object is required. Methods and solutions employed by todays photogrammetry have become very useful in many engineering and industrial aspects (measurements of deformations, surveying measurements).

Keywords

digital photogrammetry • surveying

1. Introduction

The aim of the work is surveying. This determines the dimensions, shape and location of the object in space and other given qualities of the object identified on ground-based images. Another aim of surveying is to design and develop a digital relational databases of historic objects, which may contain information beyond the description of objects geometry. A photograph is a source of a huge amount of information regarding the object under research. Despite its possible disadvantages (e.g. not capturing all the details precisely because of the bad shape of a surface), it has big informational potential. It allows the performance of many measurements in a disproportionately short time. Therefore it is not surprising, that photographs are treated as documents and are included into the further surveying files. Diversity and flexibility of measuring tools that are available nowadays enables one to find an optimal solution. Multiplicity of technological variants makes it possible to adjust both technical and economical parameters to suit current conditions and needs.

2. The aim of surveying

In order to standardize the methods of measurement and the technical documentation, technical guidelines, the G-3.4 were created: "Surveying of urban areas, green areas and architectural objects". An official document containing the official and aims of surveying was issued on April 11th 1980, by the president of The Head Office of Geodesy and Cartography:

„The aim of surveying is to depict existing spatial configuration, fuctional and technic structure and décor of elaborated objects."

According to technical guidelines (G-3.4), surveyings has in view obtaining complete materials and information, which represent current state of the object. It is to be a historic document as well as a source material for further research, technical and design elaboration. The materials are used first of all by protection of the objects, their adaptation and for very important – revaluation. It covers the whole of conservation activities, which have in view restoration of former historical and artistic value for antiques and historic monuments. In the case of objects of art and old buildings, surveying is performed mainly when the object exists, but the design documents are missing.

Before surveying, it is necessary to check any existing materials, their usefulness and if possible use them in the course of work. The obtained set of information is presented in graphical, description and photographic way [Czokański and Przewłocki 1990].

3. The range of architectural surveying according to technical guidelines of G-3.4

Architectural surveying includes:

- objects of brick (stone) architecture,
- objects of wooden architecture,
- interiors,
- details of architectonic decor (interior and exterior),
- objects of small architecture.

Objects of so called small architecture are included as well in urban survey elaboration, and in architectural elaborations as well. Qualification in this case is dependent on needs of performed project [Technical guidelines G-3.4 1981].

The range of urban and architectural survey, may be supplemented with a survey of technical aboveground and underground infrastructure including water-sevage, gas, electricity, telecommunications, central heating installations [Sitek 1991].

4. Photographic survey

Photographic survey is very important from the use of photographic point of view. It may be used in the frame of architectural, urban and construction surveying, or

as a separate service. Created photographic documentation constitutes illustrating material which is a supplement of graphic materials and helps by mapping. Such issues has been involed by CIPA from many years [Lerma García 2002, Kasser and Egels 2000, Kasser and Egels 2001, Patias and Karras 1995, Batic et al. 1996].

Photographs which are part of the documentation, should present photographed object with small deformation and perspective exaggeration:

1) the whole object,
2) parts of the object,
3) elevations,
4) elements of architectural decor,
5) details,
6) distinctive construction elements.

All data concerning the way and accuracy of performing photos, used photographic equipment, lighting and other technical details are given by the instruction. Photographic documentation of architectural decor details should include photographs of decor elements (stone, wooden, painted, ceramics, stucco work etc.), grates, balustrades and stained-glass windows.

The range should be in details settled with the customer. Professional photographic survey is necessary in the course of detailed project analysis, renovation planning, decor and adaptation planning, technical state of the object determining, for archival purposes, documentation of the state of works (e.g. before sale or lease), prior to beginning of an investment, for judicial expertise (photograph is treated as an independent piece of evidence – it possesses evidence power after experts opinion), specialists, heritage conservation, etc. Photographic documentation will register all plaster damages and stains, caused by atmospheric, chemical and biological factors. It shows color changes on metal elements, caused by rust [Przewłocki 2008].

5. Historic object surveying

Surveying is a complex process, which is based on registered picture(s) of a measured object. It begins with setting up and measurement of a geodetic and photogrammetric control network. Next, photographs are taken, and on the basis of them, study works are initiated [Boroń et al. 2007]. Up to now analog cameras were used (for example UMK 10/1318), whose principle of operation is based on picture recorded by light on photosensitive material. The quality of photographs depends on the proper choice of photosensitive material, correct exposition and proper realization [Augustynowicz 2008]. At present, digital cameras are commonly used, with established elements of internal orientation (calibration), parameters of lens distortion [Boroń et al. 2007]. They register spectral shapes in the form of matrix. Each pixel has a number attributed, which determines the value of spectral answer.

A digital image gives additional advantages i.e. possibility of processing images in real time, or obtaining multispectral imageries. However, it has a much smaller resolution in comparison to an analog one. What has influence on a smaller accuracy of measurements (photograph from analog camera corresponds to several dozens of digital photographs with respect to resolution). An important aspect is the angle of view of the lense: cameras with long focal length give higher accuracy of flat coordinates than their wide angle equivalent, when making photos from the same distance, and the radial displacements are smaller.

The choice of method and specification depends greatly on complexity of the object. Photographs made by metric camera, can be recognized as an ideal central projection, however existing deformations resulting from the fact that the object is not flat, can not exceed established accuracy. It is the condition of considering the documentation as metric.

Surveying is usually performed in a local reference system. Processing a single photographs and stereoscopic elaborations, requires the adjusting of points with known positions in space (photopoints). Photopoints are indicated in a special way or chosen as characteristic points on the object, or natural details of terrain and registered on photographs. Their number and layout are adapted to the specific object and demanded accuracy. Survey of photopoints is performed by the polar method, or by angular forward intersection. Points which are hard to access, or impossible to access are surveyed using reflectorless total station [Augustynowicz 2008]. Registration of photographs for stereograms is seldom performed with use of analogue equipment. Technical progress in electronics and informatics caused great changes in the study works. Digital images processing software, replaced old analogue converters, and digital photogrametric stations took place of mechanic autographs. The final phase of survey consists in printing documentation in appropriate scale and archiving of digital originals [Boroń et al. 2007].

6. Own investigation

6.1. Choice and characteristic of the investigation object

In investigations of photographs of elevation of historic elevation of grange annexe in Mściwojów village (Figure 1).

Mściwojów village is situated in Lower Silesia Voivodeship, Jaworski district. The settlement is located at the foot of the northern arm of Strzegomskie Wzgórza at the height 190 m over the sea level. Wierzbak river of the Odra hydrographic basin flows across the village.

Natural and cultural heritage of the village

Mściwojów village offers many natural qualities and interesting historic monuments. Some of them are as follows:

- Roman Catholic Church of Holy Mary the Virgin built in baroque style in 18th century, number of register 149/L,

- parish Cemetery, Roman catholic parish in Mściwojów, number of register 843/L,
- grange annexe, number of register 215/L (Figure 2),
- decorative garden (commonly called Mściwojów park), number of register 559/L,
- water pond, „Mściwojów" of 57 ha area,
- documented archeological finding of Łużycka culture.

Source: www.msciwojow.pl

Fig. 1. Aerial photograph of Mściwojów village

Source: Plan of Revitalization of Mściwojów Settlement 2009

Fig. 2. Part of historic grange annexe

6.2. Source materials and method of their obtaining

Field work, was divided into two phases: a) geodetic and b) photogrammetric. First, surveying the control network was designed for the creation of conditions for supplementary surveys. The network had 17 points, located around surveyed grange building. All points were stabilized in terrain. For all the points of the network; topographical descriptions were prepared. Control network was linked to the network of III class, to adjust it and calculate coordinates X, Y, Z in a proper national coordinates system. The software, *Winkalk* was used to do it.

Calculated coordinates were used to create a land survey and height map by the method of direct measurement. Next, the survey of grange building was performed including accurate measurement of small architecture elements. Windows, doors and ceilings were measured. As a result, 3D information of the object was obtained. Additional source material to photogrammetric elaboration were analogue photographs made using UMK 10/1318 measuring camera, and next scanned on Geo-System Digital Fotogrametric Scaner "Delta – 2", with resolution 1058 dpi. (Figure 3).

Source: own investigation

Fig. 3. The left photograph of stereogram

The project of making photographs included: selection of the UMK camera position (stereogram), selection of stereograms kind (horizontal) and the focus of UMK camera lens (100 mm). The most advantageous for the future elaboration was performing frontal photographs, facing the plain of the object.

From among the taken photographs, those which enabled full coverage of the facade, and those which provided established resolution on the whole picture were selected. Additionally those which did not fullfil conditions of joining in stereo pairs,

were removed. To obtain full information about elevations, selected photograms were set together in stereo pairs. Next signalization, selection and measurement of photopoints were performed. On accessible walls of building, photopoints were marked by small, sticked on crosses.

6.3. Creation of thematic levels and their vectorisation

After orientation phase, the next phase was digitalisation – mapping of the research object. To obtain full survey of the grange building elevation, vector levels were created, with suitable attributes: name, color, line weight.

Following levels were created:

1) roof (color: yellow),
2) elevation (color: fuchsia),
3) windows (color: green),
4) doors (color: blue),
5) chimney (color: aqua).

Source: own investigation

Fig. 4. Window of data accumulation. Digitalization of the object. Partially covered elevation

Figure 4 shows weak points of the method. Thick bushes on the right side of the building, cover a great part of the elevation. Additional obstacles, in fact make the access to the windows difficult. The last window in the building was practically impossible to measure, and was omitted from the measurements. There were some obstacles in the case of doors, partially covered with bushes.

7. The results of investigations

In elaborate surveys of complex architectonic documentation, unified land surveying and photogrammetric methods are irreplaceable.

The present paper contains a profile of information connected with surveying. Different kinds of surveying were presented. Specification of presented methods, and their applications for different surveys, adequate situations and conditions.

In the photogrammetric methods last years have become appreciated not only by surveyors. Their popularity growth and the number in their application is broadening. Contemporary methods are used in technical sciences, like engineering, architecture, geodesy, or the described above surveys, and also in medicine, and tourism.

Photogrammetric methods provide objectivity and richness of details. Photograph contains a lot of information, registered in a very short time. Time aspect is a significant factor for accuracy of measurements.

Measurement of an unlimited number of points can be repeated several times. Additional asset is the fact of registration of points which are unaccessible to direct measurement

Photogrammetry does not require direct contact with object. Problem of elements, which can be dangerous for surveyor (very tall, or unstable buildings), or inaccessible points can be solved by this method. Application of photogrammetric methods has influence on limitation to minimum burden some fieldwork. Measurements which are usually time consuming and dependent on weather conditions have been moved to comfortable office conditions.

Highly developed technology, enabled automation of the photographs processing. Results of elaboration should be supplied in digital form. This enables their interactive use by different specialists.

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