GLL
Geomatics, Landmanagement and Landscape No. 1 · 2013, 41–50

THE APPLICATION OF GROUND-BASED AND AERIAL PHOTOS IN SURVEYING AND VISUALIZING ARCHITECTURAL OBJECTS IN MŚCIWOJÓW

Bogusława Kwoczyńska

Summary

The article presents the possibility of using pictures taken with aerial and ground-based metric measuring cameras in surveying and visualizing architectural objects. The areas of interest include historic and damaged buildings belonging to the farm complex in Mściwojów, in Lower Silesia. To prepare vector architectural drawings, digital photogrammetric station Delta, as well as a digital autograph VSD were used. The digital terrain model was generated on the basis of aerial photographs, and the visualization of the whole village with the body of water in Mściwojów was developed using MicroStation software.

Keywords

architectural survey • visualization • ground and aerial photo

1. Introduction

Surveying historic buildings involves creating the fullest documentation of objects possible, but it also involves the use of advanced equipment and technology allowing the restoration and reconstruction of object shapes in a precise manner. This is possible by using the knowledge and experience of many specialists, including surveyors specializing in photogrammetry. Surveying boils down to a collection of documents produced as a result of research, detailed measurements and analysis conducted by conservators and specialists in various fields of science and art. Surveying is the foundation and initial condition for protecting monuments from destructive forces of nature and man, and reconstructing them in the event of damage [Zawieska 2008]. Because of the created documentation, surveying is important in conducting maintenance of monuments. Its basic component is architectural survey, which includes:

- horizontal projections,
- facades – external wall plans (mostly photographic maps),
- documentation of the roof truss.

Short-range photogrammetry plays an important role in the process of creating this documentation. Photogrammetric documentation presents the spatial state of an object and allows for performing measurements on the created model. It is the basis for monument reconstruction and can also be used for comparison in reconstruction of a similar object. This is common in the case of no original documentation being available. Such issues has been handled by CIPA for many years [Lerma García 2002, Kasser and Egels 2000, Kasser and Egels 2001, Patias and Karras 1995, Batic et al. 1996].

Photogrammetric works try aiming to survey architectural monuments by the careful documentation of a present state. Photographs of buildings taken for this purpose can not only be used in cartometric studies but they can also be the basis of such documentation. Photogrammetry allows to obtain the needed material in a remote way and it is therefore often irreplaceable in measuring unreachable elements. It can be freely used for the measurement of highly irregular components. Photogrammetric studies also have another important use. The final effect of photogrammetric works, often created in 3D, can be posted on websites allowing everyone to see remote and sometimes difficult to access places and enjoy the sights unavailable for everyone. Often such websites are created precisely to promote these places and encourage tourists to visit them.

Source: http://www.msciwojow.pl/

Fig. 1. Aerial view of Mściwojów

2. Research object characteristics

Architectural objects covered by the study are located in the municipality of Mściwojów in the central part of the province of Lower Silesia in the Jawor county. In the village Mściwojów there is a historic mansion from the 17th century along with a complex of farm buildings, a tower and a wall (Figure 1).

3. Research methods

To perform studies on architectural objects which employ photogrammetric methods, most often digital photographs are used. These are photographs obtained either directly from digital cameras or scanned from analog photographs taken mostly by metric or semimetric cameras. Sample studies are based on photographs taken by metric cameras UMK 10 and RC 20.

Ground-level images were taken as normal (optical axes of cameras were also approximately perpendicular to the facades of the buildings) and the basic length of the photographs was assumed taking into account both precision of the study and stereoscopical observation conditions.

The stereograms were aligned using natural characteristic points which were background details for the objects under study. The coordinates of these points were measured independently from the photogrammetric methods (using reflectorless total station in case of the tower in Mściwojów), and also some of the coordinates were obtained analytically (by adjustment of photogrammetric network – in case of the farm building façade).

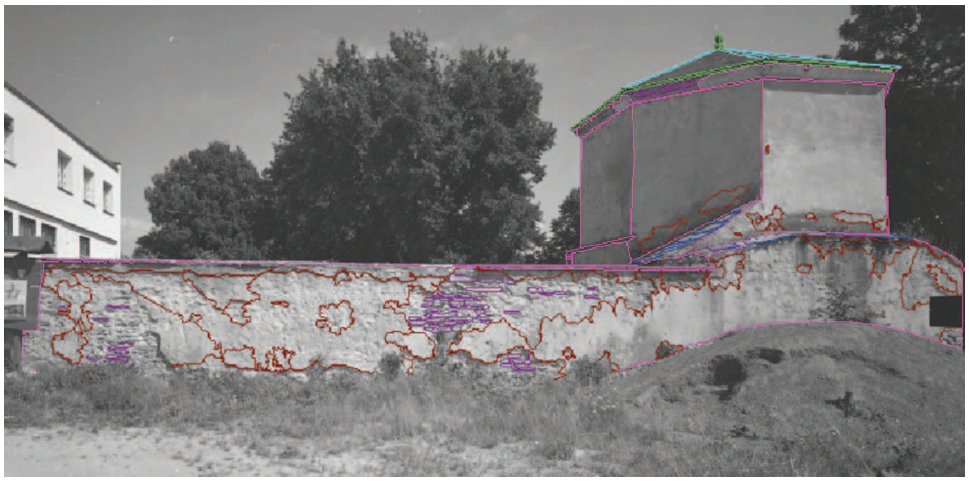
Elaboration of tower in Mściwojów

The historic tower along with a wall is located near an orangery belonging to the mansion houses in Mściwojów. Its north and south facades were elaborated photogrammetricaly with use of two different tools (VSD digital autograph and Delta digital station). The photographs were taken in the year 2008 using UMK 10/1318 camera and then were scanned with the resolution of 24 μm (Figure 2).

The description of the tower required internal alignment and interalignment on the VSD digital autograph to be performed beforehand. The precision of the results can be supported by the achieved results in which the average coordinate errors of photopoints are: $m_x = 0.01$ m, $m_y = 0.02$ m and $m_z = 0.01$ m. In the case of the south façade the description was based on Delta digital station. Surveying of the object was possible after previous alignment of the model for which the photopoints and following RMS values were achieved: $m_x = 0{,}01$ m, $m_y = 0{,}02$ m i $m_z = 0{,}10$ m.

Description of the south facade of the farm building in Mściwojów

In the central part of Mściwojów next to the garden formed in the 17th century belonging to the von Bibran family there is a complex of farm buildings (Figure 3). Nowadays these buildings are damaged and require renovation. Some of them are residential buildings, the others are farm buildings.



Source: Stajniak 2010

Fig. 2. South facade of the tower in Mściwojów

Source: own elaboration

Fig. 3. South elevation of farm building in Mściwojów

Surveying of the south facade of the farm building was performed based on the ground-based photographs taken with UMK 10/1318 camera in the year 2008. The photographs were scanned in the resolution of 24 μm per pixel on the Digital Photogrammetric Scanner Delta 2 by GeoSystem.

The elongated shape of the building required eight photographs and due to this terratriagulation was used. The object was described in the local coordinate system, assumed for the central base of shooting. The surveying was performed using a digital photogrammetric station Delta. Because the scales of the photographs were similar, conducting the terratriangulation was comparable to the processs of aerotriangulation performed on aerial photos. Employing terratriangulation allowed adjustment of the block of all photos in GeoSystem MSG program. Adjustment was performed on 12 natural photopoints. As a result of adjustment of the block of photos the following average errors of photopoint coordinates were achieved in the XY plane m_{XY} = 0.08 m and in case of height, m_Z = 0.14 m.

Application of aerial photos in creating a 3D model of Mściwojów

Nowadays, technological development in the IT industry offers many possibilities of application of aerial photogrammetry products. Basing on the Digital Terrain Model or Digital Surface Model with application of suitable graphical tools one can create 3D visualizations of objects like for example models of cities or towns. Such models are numerical, three-dimensional (3D) representations of selected elements of urban space, integrated with the library of descriptive data.

Depending on their complexity models can include buildings, rivers, road, railroad networks, bridges, lakes, forts, graveyards, forests, wooded areas and sport facilities, high industrial buildings, district borders, allotments, and so on. The more elements, the more faithful the representation depicted. The objects can be placed in the Digital Terrain Model and also descriptive data can be attached to them. Thanks to such actions a complete 3D model of an area can be obtained, and it would show most realistically the spatial representation of the terrain. Such visualizations are nowadays one of the basic products of photogrammetry.

The 3D model of Mściwojów was developed using data obtained using a digital photogrammetric station Delta basing on aerial photos taken in the year 2004 in the scale of 1 : 26000. They were panchromatic pictures taken using RC 20 camera, which were scanned with the resolution of 14 μm per pixel. The measurement was performed basing on a block of photographs covering the terrain within the boundaries of Mściwojów.

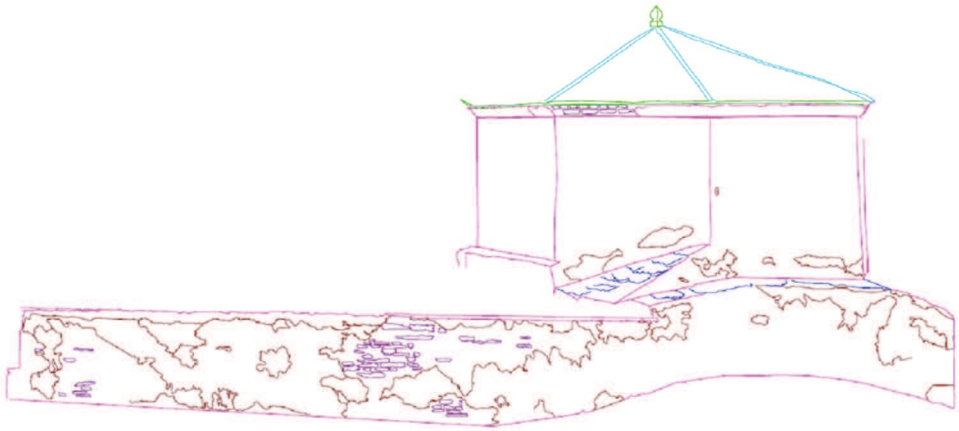
Alignment of the pictures was performed in the process of digital aerotriangulation with the use of natural photopoints obtained from the topographical maps in the scale of 1 : 10000. As a result of the alignment such average errors were achieved in the XY plane m_{XY} = 0.77m and in case of height, m_Z = 0.56 m.

4. Research results

Facade models (wiremesh and solid) and vector drawings obtained during photogrammetric works are often used by architects and conservators to create architectural documentation for historic buildings of religious or secular value. They serve as source of information necessary to recreate for example the precise state of the

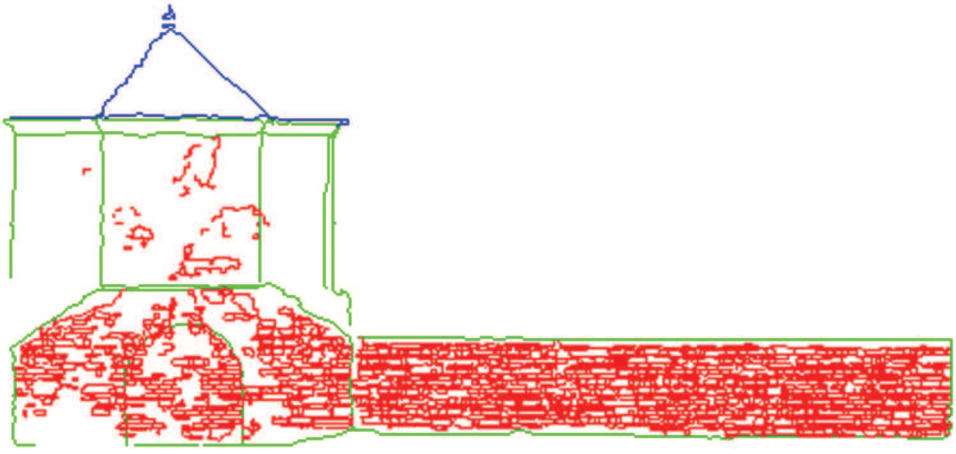
object from before the renovation, creation of orthoimaging of the object or a very precise sections [Kędzierski et al. 2008].

The sections are often accompanied by computer made models of objects with use of CAD software. 3D reconstruction of an object is nowadays a very popular presentation of architectural documentation and photogrammetry. As a source of data for this purpose, it is still one of the best methods to use.



Source: Stajniak 2010

Fig. 4. Vector model of the south facade of the tower in Mściwojów

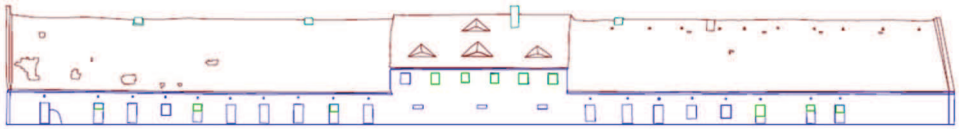


Source: Świgut 2010

Fig. 5. Vector model of the south facade of the tower in Mściwojów

The model of the tower in Mściwojów was created as a result of surveing both north and south facade of the object. All the losses in plaster as well as any other damage were marked on it (Figures 4 and 5). The graphical vector description is a result of the previously created stereomodels and always contains less information than the models themselves. It is visible, especially on the descriptions of complex forms and shapes, which are often subjectively represented, depending on the skills and resources of the specialist. Working on a stereomodel allows the specialists to faithfully recreate the geometry and to analyze more fully the style and characteristics of the object under research [Gołka et al. 2000].

During the survey of the farm building in Mściwojów, close attention was paid to the damaged parts of the facade and the roof. After vectorization, the drawing was saved in DGN format, which allowed to create a 3D model of the south part of the façade of the farm in MicroStation software. The final effect is visible on Figure 6.



Source: Wojnar 2011

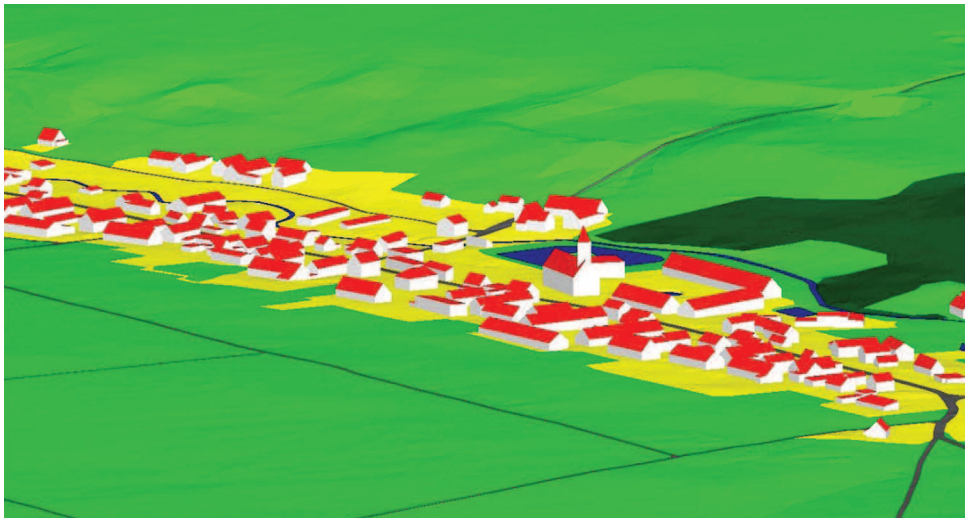
Fig. 6. Vector drawing of the south facade of farm building in Mściwojów

In order to obtain the Digital Terrain Model many situational and height measurements were performed for the infrastructure of Mściwojów (buildings, roads, body of water) as well as for the terrain itself (slopes, trenches) marking the boundaries of excluded areas (forests, orchards, shrubbed areas) and discontinuity lines. Vectorization of the object was performed in 15 layers. The result is visible in Figure 7.

Height measurements, lines of terrain discontinuity and exclusion borders were used to generate the Digital Terrain Model (DTM) in the form of a grid with unit 10 m. The DTM of Mściwojów generated on the photogrammetric digital station Delta was then exported to a format that allowed its further processing in MicroStation software. Then a TIN model (triangle model) was created along with grid models of buildings. In order to visualize the Digital Terrain Model and the buildings rendering with artificial textures were used. A file containing the buildings was then attached to the file containing the terrain data, in order to visualize in 3D the whole town. The end effect is visible on Figures 8 and 9.

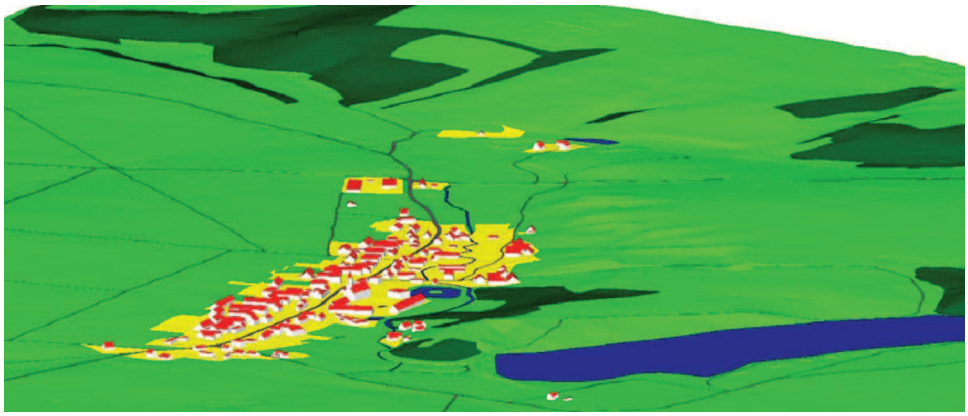
Source: Stajniak 2011

Fig. 7. Mściwojów. A vector drawing



Source: Stajniak 2011

Fig. 8. Visualization of a part of Mściwojów



Source: Stajniak 2011

Fig. 9. Visualization of Mściwojów from a different angle

5. Summary

Employing photogrammetric methods in surveying and describing buildings is a very good solution. Once made stereograms can be processed in steps depending on the needs, ergo an object partially developed can be furtherly developed at a later date so that it suits the current needs. It allows to significantly lower the costs of surveying and conservation of buildings [Kwoczyńska 2012]. Creating 3D models of single objects and complete towns and cities is very popular nowadays. 3D visualizations can be simplified models of areas. These can be later used for animations. They are very helpful in creating full architectural documentations.

References

Gołka J., Haliński J. 2000. Fotogrametria cyfrowa w architekturze- nowe możliwości inwentaryzacji i archiwizacji obiektów. Archiw. Fotogram., Kartogr. Teledet.,10, Kraków.

Kędzierski M., Walczykowski P., Fryśkowska A., 2008. Wybrane aspekty opracowania dokumentacji architektonicznej obiektów zabytkowych. Archiw. Fotogram., Kartog. Teledet., 18a.

Kwoczyńska B. 2012. Inwentaryzacja i wizualizacja obiektów architektonicznych wykonana na podstawie zdjęć metrycznych i niemetrycznych. PAN, Komisja Technicznej Infrastruktury Wsi. Infrastr. Ekol. Teren. Wiej., 1/II 2012, Kraków.

Stajniak M. 2010. Inwentaryzacja obiektu zabytkowego w Mściwojowie z wykorzystaniem fotogrametrycznej stacji cyfrowej Delta. Praca inżynierska napisana pod kierunkiem dr inż. B. Kwoczyńskiej, Uniwersytet Rolniczy w Krakowie.

Stajniak M. 2011. Opracowanie modelu 3D Mściwojowa na podstawie zdjęć lotniczych. Praca magisterska napisana pod kierunkiem dr inż. B. Kwoczyńskiej, Uniwersytet Rolniczy w Krakowie.

Świgut F. 2010. Opracowanie zdjęć naziemnych wykonanych kamerą UMK10 na autografie cyfrowym VSD AGH. Praca inżynierska napisana pod kierunkiem dr inż. B. Kwoczyńskiej, Uniwersytet Rolniczy w Krakowie.

Wojnar A. 2011. Opracowanie elewacji zabytkowego budynku z wykorzystaniem zdjęć metrycznych. Praca magisterska napisana pod kierunkiem dr inż. B. Kwoczyńskiej, Uniwersytet Rolniczy w Krakowie.

Zawieska D. 2008. Rekonstrukcja 3D obiektów bliskiego zasięgu na podstawie zdjęć archiwalnych Archiw. Fotogram., Kartogr. Teledet., 18a, Szczecin.

CIPA Supported Publications

Batic J. et al. (eds) 1996. Vestnik – Photogrammetry as a Method of Documenting the Cultural Heritage (in English and Slovenian). Minist. of Culture, Ljubljana, Slovenia.

Kasser M., Egels Y. (eds) 2000. Photogrammétrie numérique (in French). Contains chapter on architectural photogrammetry, contributed by P. Grussenmeyer, K. Hanke, A. Streilein. Hermes Science Publishing, Paris.

Kasser M., Egels Y. (eds) 2001. Digital Photogrammetry (in English). Contains chapter on architectural photogrammetry, contributed by P. Grussenmeyer, K. Hanke, A. Streilein. Taylor & Francis, New York – London.

Lerma García J.L. 2002. Fotogrametría Moderna: Analítica y Digital (in Spanish). Universidad Politéchnica de Valencia, Valencia.

Patias P., Karras G.E. 1995. Contemporary Photogrammetric Applications in Architecture and Archaeology. Thessaloniki.

Dr inż. Bogusława Kwoczyńska
Uniwersytet Rolniczy w Krakowie
Katedra Geodezji Rolnej, Katastru i Fotogrametrii
30-198 Kraków, ul. Balicka 253 a
e-mail: rmkwoczy@cyf-kr.edu.pl