

# **APPLICATION OF MIRRORLESS TOTAL STATIONS FOR SMALL ARCHITECTURAL OBJECTS DOCUMENTATION**

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## **ABSTRACT**

**There are many various methods of construction objects documentation: laser scanning, total station scanning, photogrammetric single- and double-picture methods. Above techniques require special surveying equipment, photogrammetric knowledge and also computers with enough computational power and proper software.**

**The research goal on this paper was to test an application of mirrorless total stations for small architectural objects documentation (churchside shrine). The documentation works were conducted directly in the field. Results elaboration was made using Auto Cad and Topcon software.**

## **1. INTRODUCTION**

**Nowadays there is strong interest in rebuilding and renovation of roadside- and churchside shrines. Specially in the area of Warmia and Mazury where tradition of shrine placing goes back a few ages. Many of shrines are put at monument list and they are a common heritage of inhabitants of that region. Some of them have not been renovated for many years, other have been renewed by inhabitants what deprived those shrines of their primary disposition. Now there are national and European programmes helping stocktaking and renovating such objects. Programme "Save shrines of Warmia" driven by Starostwo Olsztyńskie belongs to this kind of programmes.**

**Authors conducted the test using mirrorless total station for small architectural object (churchside shrine) documentation. Surveying was made by using precise Topcon GPT 7000i total station with digital camera built in it. The taken digital picture was also enclosed to research results. The total station construction enables to make the photogrammetric control without stabilization because surveyed points are marked on photos.**

**The research assumptions put limits as far as objects photos are concerned. Because of that the photo object was the churchside shrine with slight declination from plane (flat object), it was possible to take that photo using digital camera with 2000x2400 resolution. By flat object with non- or small declination from plane, radial deviation can be neglected. By surveyed photopoints and projective transformation of picture used, radial displacement caused by its inclination is eliminated. Photo were taken by total station from tripod set above the control point.**



**Fig. 1. Total Station series GPT 7000i.**



**Fig. 2. Image of fotopoint in Total station.**

## **2. METHODS OF ARCHITECTURAL STOCKTAKING**

**Architectural stocktaking is conducted directly, indirectly or using both way at once. Choosing the surveying manner depend on stocktaking goal, project's requirements and type of objects to survey. (Wytyczne techniczne G- 3.4, 1981)**

**In direct method, surveying is conducted directly at the terrain using available quipment. To these methodes are contained:**

- polar method
- orthogonal method
- line- and angle intersection
- laser scanning (with laser scanner, scanning total station)

**The indirect methods, which are mostly photogrammetric, are:**

- single picture method
- double picture method (based on stereo pair)

**In case of photogrammetric and laser measurements it is necessary to set up a minor and photogrammetric (photopoints) control points. Surveys of these photopoints i.e.**

points recorded on pictures whose location in space is known, are carried out mainly by geodetic methods. Currently mirrorless total stations are used for this purposes.

In a single picture method documentation is conducted basing on one single picture of the object. This approach is used in the case of flat or nearly flat objects. The definition of a flat object can be found in (Wytyczne techniczne G- 3.4, 1981). Double picture method is used in a case of the objects which have several planes that do not have to be parallel to each other. Stereograph (pair) of surveying photos are taken from two positions from the ends of the photogrammetric base. Elaboration of such photos is carried out on photogrammetric digital stations giving vector form matching a classic dash documentation (projections, sections, views).

The alternative for double picture method is laser scanning which allows for faster field and office works conduction. In works like architectural stocktaking, LIDAR scanners finds its application. Those instruments work basing on polar points location measurement (Boehler, Marbs, 2002). For measuring objects in micro scale optical scanners divided on triangulation scanners and structural light scanners are used (Iuliano, Minetola, 2005).

Seeking for alternative for single picture photogrammetric method we tried to use mirrorless total station for stocktaking of small architectural object.

### 3. DIRECT ARCHITECTURAL STOCKTAKING METHOD

#### 3.1 Survey

Researches have been carried out on shrine by St. John the Evangelist's church in Bartąg village near Olsztyn. It is neogothic building made of a red brick in 1897. The survey object was shrine's wall shown at Fig. 3.



Fig. 3. Survey object.

First part of measurements was to set up a minor control. Basing on data from angle and distance survey and conducted leveling, coordinates of control points were calculated.

Shrine's wall measurements was made by aiming at particular bricks edges or defects. Measurement contained total number of 1600 points. Field works lasted 6 hours (without measurement of geodetic control). Most points were measured correctly, what was checked on digital photos. Several times laser beam from mirrorless total station did not hit intentional target located on building edges. Analysis of that problem has been presented in (Klimkowska, Wróbel, 2006). Because of situation described above it was necessary to resurvey missed points by measurement tape in reference to the correctly measured points.

### 3.2. Results elaboration

Coordinates of surveyed points had been entered to Autocad 2009PL, where points had been connected according to the prepared terrain draft. In result stocktaking picture of shrine's wall has been obtained. (Fig. 4.)

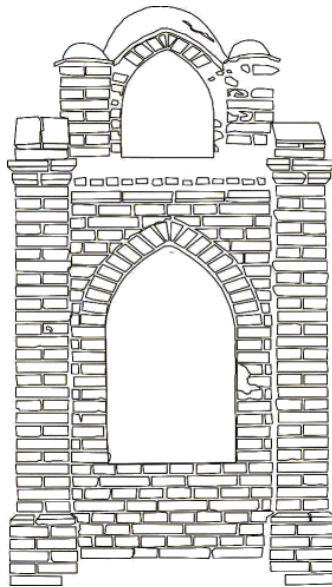


Fig. 4. Façade : bricks configuration.

Chosen elements have been controlled. It consisted of comparing computed values from coordinates with values obtained from tape measurement. Differences were between 0,05cm and 1,5cm.

## 4. COMBINED ARCHITECTURAL STOCKTAKING METHOD

To compare results, authors tried to link surveys conducted with mirrorless total station with digital photo from used total station. Description of similar works can be found in literature (Wiedemann A. at all 2003, Tauch R, Wiedemann A., 2004). To elaborate the results Topcon Company provided and Topcon Image Master software. After calibration of photo in Topcon Image Master Calib, calibrated photo was fitted to survey points.

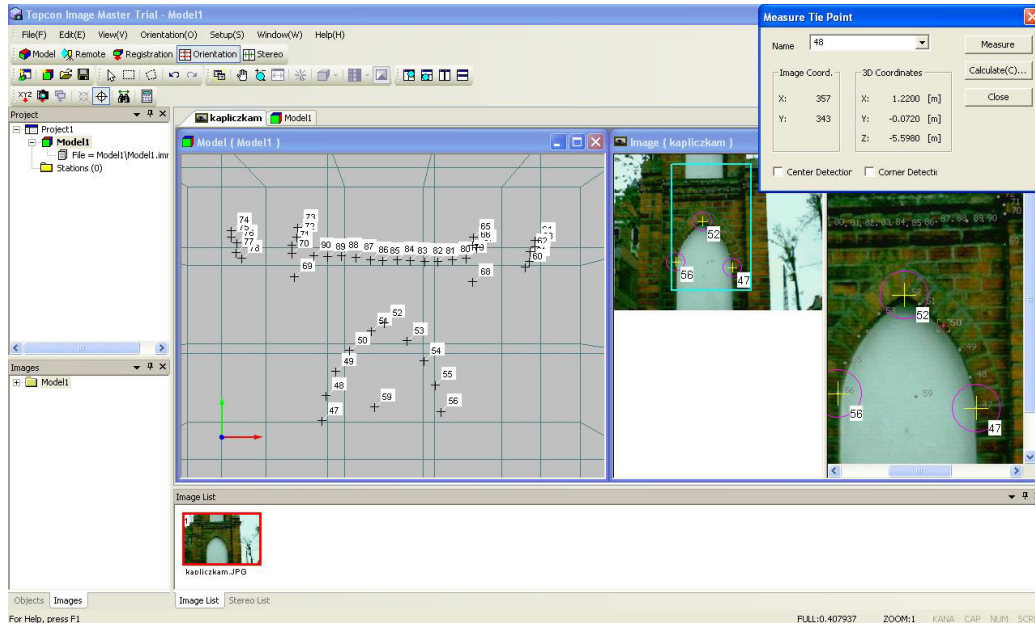


Fig. 5. Fitting a photo.

Basing on fitted photo and TIN model (triangle net), 3D model of measured object was obtained.

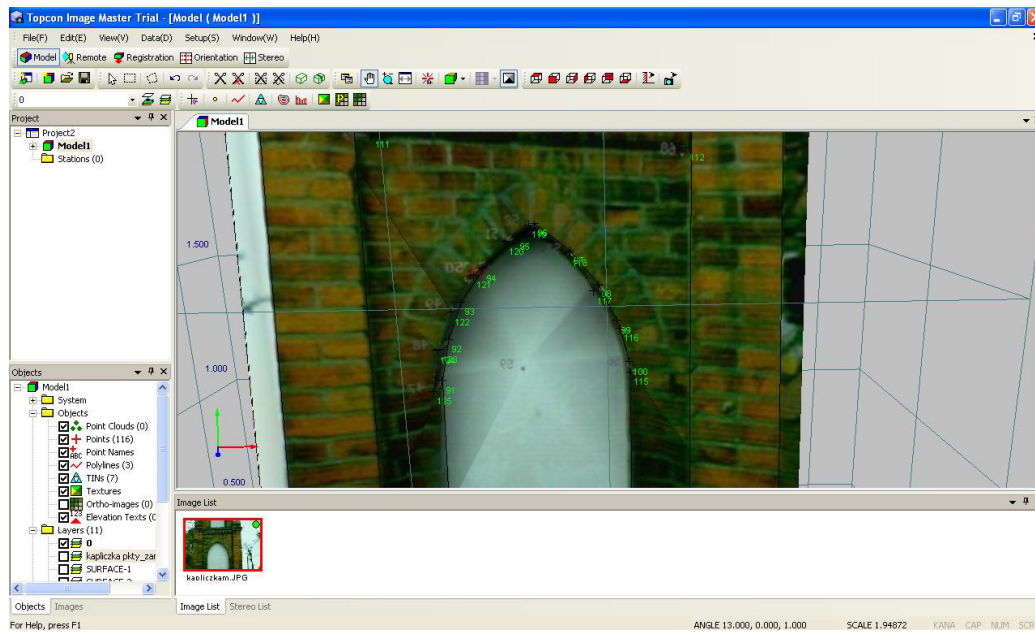
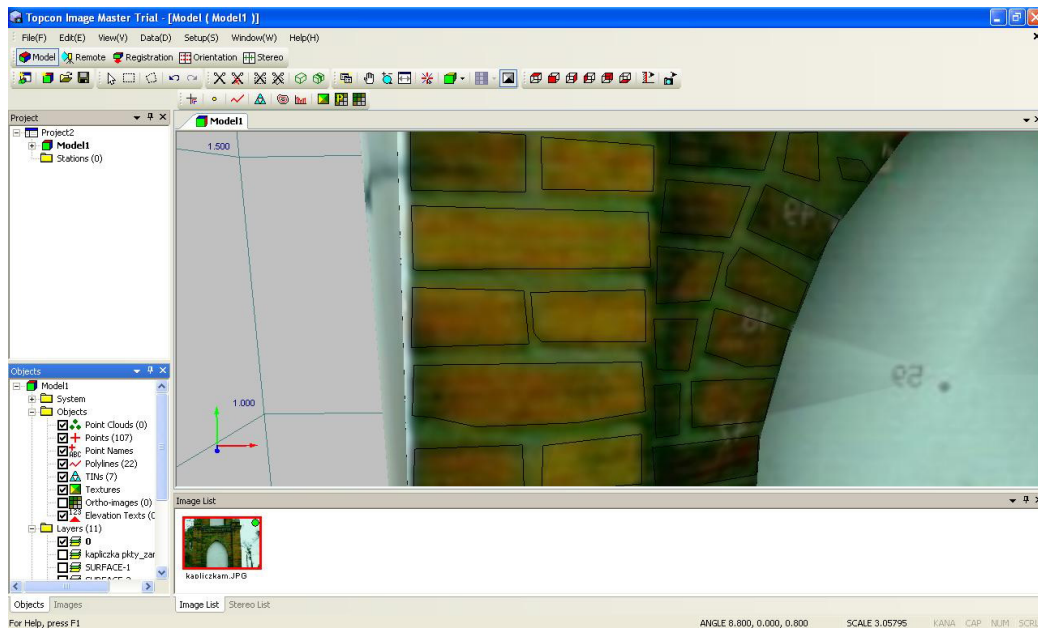


Fig. 6. 3D model of object's wall.

This method, just like the one from direct survey, enables to work out walls façade. (Fig. 7.). The results obtained from this elaboration are comparable to those got from field measurement.



**Fig. 7. Façade measurement.**

## **5. SUMMARY**

**In the research stocktaking survey, conducted by mirrorless total station, and elaboration of façadeation picture, have been described. There was also a test of stocktaking consisted in combining field survey with survey on digital photo taken by total station. Elaboration concerned one wall of object. It is possible to make such measurement from each object side and to get additionally its 3D model.**

**Basing on carried out researches it is likely to draw following conclusions:**

- **mirrorless total station can be used to small architectural objects stocktaking,**
- **it is not necessary to mark points if total station has digital camera built in,**
- **time of measurement is quite short,**
- **survey provides sufficient accuracy,**
- **total station measurement can be also a supplementary survey with relation to survey on photo and vice versa,**
- **it is possible to use mirrorless total station for surveying control elements,**
- **in case of direct measurement it is not necessary to use photogrammetric software and to have deep photogrammetric knowledge,**
- **combination of mirrorless totalstation survey and digital photo measurement gives a possibility to conduct stocktaking of small architectural objects,**
- **mirrorless totalstation can be used for stocktaking of fragments façade located high, without necessity of using elevators for placing photopoints.**

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