DIGITAL CLOSE –RANGE PHOTOGRAMMETRY TO USE THE DIGITAL CAMERA AND 3D LASERSCANNING IN ARCHITECTURAL PHOTOGRAMMETRY
DIGITĀLĀ FOTOGRAMMETRIJA IZMANTOJOT DIGITĀLO KAMERU UN 3D LAZERSKANERI ARHITEKTŪRĀ

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Key words: Cultural Heritage Documentation,Photogrammetry

1. Introduction

Documentation of cultural heritage objects are very complicate. Documentation of cultural heritage objects is not an end in itself but serves as a tool to make information accessible to those who cannot investigate the object itself. Cultural heritage objects collect variety of the The kinds of documents. There are the the documents of geometry, landscape, archeology, structure of materials, historical views and other. The one of the documentation is to collect the information of the geometry and the information on the material (structure) facade. Different reasons can be found for necessity of this information:

- the object is not accessible to interested parties
- the object is to large or too complicated to be overlooked and it would be too time-consuming to executive an own investigation
- the object is visible only a short period of time at its original locations
- persons living far from the object cannot afford to visit it
- the object is in danger of slow deterioration or sudden destruction

Among the users of close-range photogrammetry and 3D laser scanner are architects and civil engineers (to supervise buildings, document their current state, deformations or damages), archaeologists, surgeons (plastic surgery) or police departments (documentation of traffic accidents and crime scenes).
The basic idea of architectural photogrammetry is to reconstruct the imaging geometry which was effective during the exposure of photographs in order to derive object coordinates
The digital close range photogrammetry and 3D laser scanner are the most popular methods in architectural photogrammetry for documentation of cultural heritage.
Digital close range photogrammetry offers an easy and economical approach to the metric survey of cultural heritage. The final results to use the digital photogrammetry are fastest then if you use the total station and tradition methods for documentations of cultural objects. The software manage all photogrammetric procedures such as the calibrating the cameras, orientation, digitizing and plotting or modeling the 3D model.
Terrestrial 3D laser scanner are modern geomatic data capture instruments that offer numerous measurement benefits including three-dimensional data capture, remote and non-contact operation, a permanent visual record and dense data acquisition. 3D laser scanner are currently being used in a variety of heritage objects for documentation. The 3D laser scanner has a high cost for using.

2. Digital close-range photogrammetry

The digital close range photogrammetry is similar to analog photogrammetry. The principle how to measure and collect data is same. The main steps are :

- camera calibrating
- make the geodetical network to measure the controlmarks on the object
- make the controlmarks on the object
- measure the controlmarks with total stations
- take the photography
- postprocessing the data
- create the documentation of cultural heritage

The technical instruments and software are:

- hight resolution digital camera
- tripod for digital camera
- reflecting sheets
- total station
- reflecting prizm whith tripod
- close range photogrammetrical sowtware
- geodetical network adjusting sowtware

Camera Calibration is the process of determining the characteristics of a camera such as focal length and lens distortion so it can be used as a measurement device. There are possible to use the self calibrating the camera with software together with data post processing or separate calibrating process. When camera calibrate separate you need to create the calibrating sheet or field and take the pictures from different positions and make the processing the results of parameters of camera. The method to calibrate separate camera is better then self calibrating.
The geodetical network is very important to measure the control marks of the objects and connect all measurements together for 3D modeling. The precision of the all geometrical results is depended the precision of the geodetically network and measuring methods of the control marks. The special reflecting sheets on the white background are the best high precision technical material for putting the controlmarks

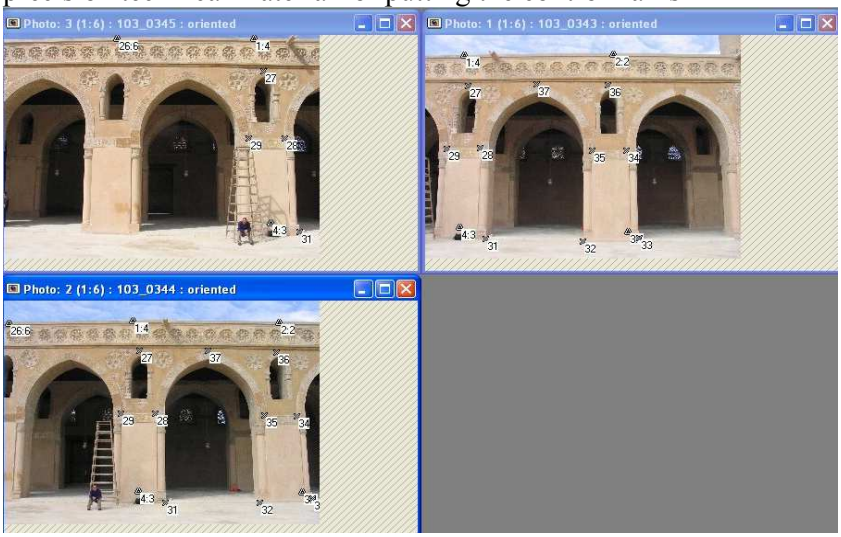

Fig.1 Overlap of the pictures

Taking photographs is, of course, essential for making a photogrammetric measurement. To obtain the high accuracy, reliability and automation the system is capable of, photographs must be of the highest quality.
The camera's field of view defines how much it sees and is a function of the focal length of the lens and the image size (often called the format) or the digital sensor size. For a given lens, a larger image size has a larger field of view. Similarly, for a given size sensor, a shorter focal length lens has a wider field of view. The photography perform from at least two points (image projection centers) to get the image overlap and to create spatial 3D (stereo) model in photogrammetry instrument.
The Terrestrial photogrammetry using the three main photography cases: a) the **normal** case; b) the **one-side divergence** case; c) the **convergent** case:

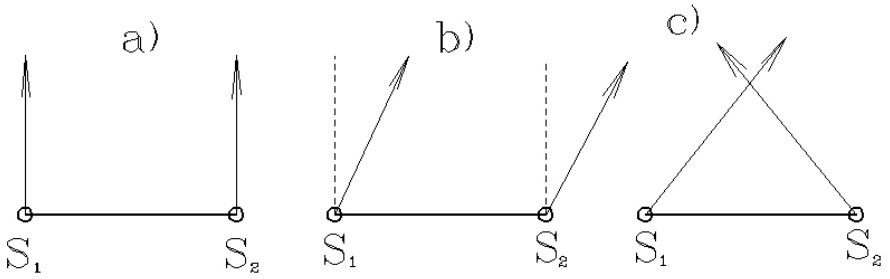

Fig. 2 Three main photography cases

In photogrammetry most frequently used the normal photography case. In normal case the main camera rays are parallel and perpendicular to object plane.

3. 3D laser scanner

3D laser scanner is the one of the new technologies for documentation of cultural heritage. There are different kinds of 3D laser scanner: for terrestrial, land and optical scanning. 3D laser scanner is one of digital terrestrial fotogrammetry method. To use the laser beam , is possible take a lot of the information of the geometry and structure such as color. The results of the using the laser scanner are point cloud and RGB color for each point.Laser scanning has become a standart tool for 3D data collection for generation of the high quality 3D models of cultural heritage. These systems allow for the fast and reliable generation of millions of 3D points based on the run-time of reflected light pulses. This results in a very effective and dense measurement of surface geometry. The results show the 3D model with real colors.
The main purposes of the using the 3D laser scanner are :

- Manage the 3D coordinates
- A lot of points on the surface
- Precise define the surface of the irregular structure
- The results acquire short time
- The results possible to use in historical database

The scanning process steps are:

- Planning process Scanner position, suns shadows, distance
- Define the coordinate system
- Creation of the subsidiary buildings
- Scanning process

4. Create the documentation of cultural heritage

There are many various of the documentation:

- orthofoto of the parts of objects
- 3D model with pictures
- 2D model of the object geometry in CAD programs

The traditional way to merge the results of geodetic and photogrammetric survey, scanner data and the manual measurements of architects at the site is to put them on common plans. These products are of a high value but they lack flexibility. If other views, other intersections or graphical presentations are required, a time consuming new drawing starts, and in some cases additional measurements are required. If no photogrammetric images are available this means, that a new campaign may become necessary.

A better way seems to merge the measurements during the post-processing of the campaign, when even all photogrammetric products or scanner data are available, all results to a CAD model, covering the whole object in an homogeneous accuracy. Available images may solve the discrepancies between the results of the different data acquisition techniques and used to determine better parameters on reliability and accuracy of the different approaches.

The software have the possibilities to make the orthophoto and 3D models with texture in one software. To make the orthofhoto and 3D models from surfaces is fully automatically.

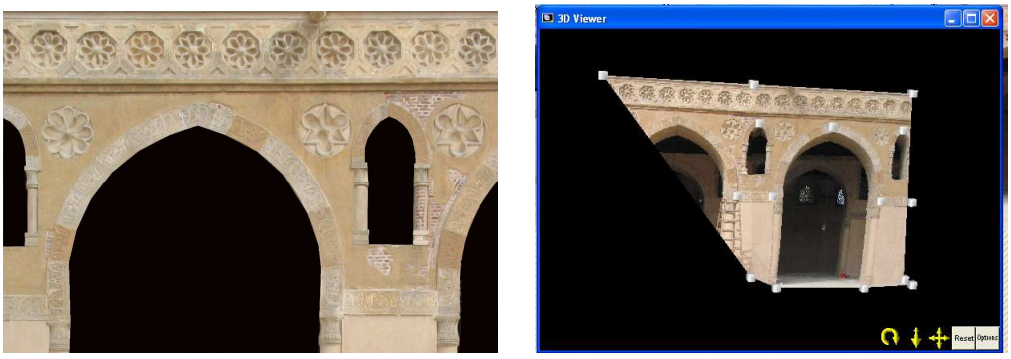

Fig.3 Orthophoto and 3D models of the part of the walls in Egypt to use the Photomodeler

To works with 3D laser scanner data the software main produce:

- The point cloud with original colors
- Surface
- Plans
- Profile
- Othophoto

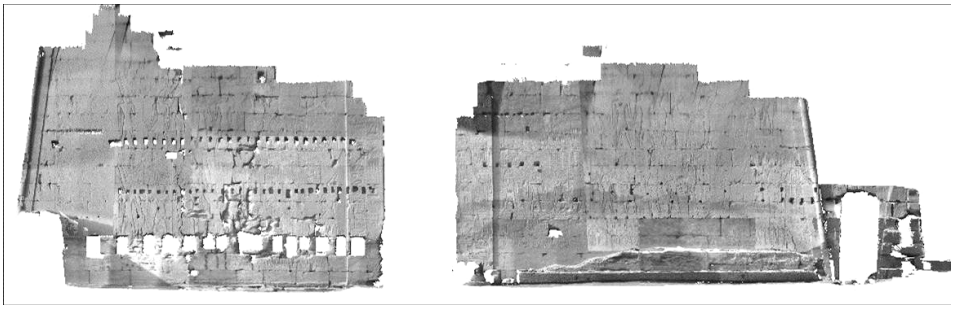

Fig.4 Ortophoto projection of the 8.pylon North facade

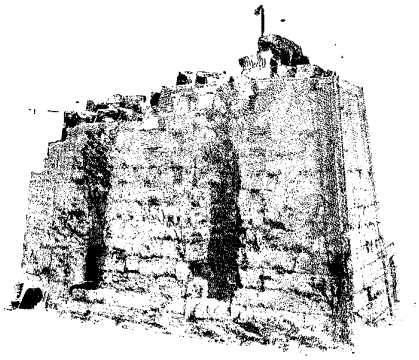

Fig.5 The 3D point cloud model of the part 8.pylon in the Karnak temple in Egypt

5. Main errors of the production documentation with digital photogrammetry and 3D laser scanner

Digital photogrammetry and 3D laser scanner are the technical science who use the various of the technical instruments. There are :

- electronically tachiametr for taking the coordinates of the controlmarks
- digital camera
- leveling instruments for controlling the levels
- 3D scanners
- Global Position Systems

All technical instruments and methods used for documentation have the errors.
The main errors to use the digital photogrammetry are:

- measuring errors (distance and angles)
- precision of the instruments (distance and angle measuring errors)
- centering the electronical tachiometr
- network errors (precision of the geodetical network)
- calibrating errors of the digital camera
- resolutions of the digital camera
- fix the positions of digital camera to take the pictures (different distances from objects, convergence case errors)
- post processing errors-fix the positions of the controlpoints and referencpoints
- subjective errors
- climate problems – sun, warm

3D laser scanner is the technical instrument who results depends on the:

- measuring errors (distance and angles)
- to define the coordinate system
- network errors (precision of the geodetical network)
- calibrating errors
- resolutions of the digital camera
- fix the positions of digital camera to take the pictures (different distances from objects, convergence case errors)
- post processing errors-fix the positions of the controlpoints and referencpoints
- subjective errors
- climate problems – sun, warm
- the positions of the 3D laser scanner
- edges problems of the objects

6.Conclusion

The paper was developed as part of the projects, which purpose are to analyze the documentation process to use the traditional photogrammetry and 3D laser scanner for documentation the cultural object in Egypt. By the combination the both methods or data sources the results will better.

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Kaļinka M., Rutkovska E. Digitālā fotogrammetrija izmantojot digitālo kameru un 3D lazerskaneri.
Rakstā tiek apskatītas galvenās kultūrbjektu ģeometrijas dokumentēšanas metodes mūsdienās, izmantojot tradicionālo fotogrammetriju, kas tiek aizvietota ar digitālo fotogrammetriju un 3D lāzerskaneri. Rakstā aprakstītas galvenās priekšrocības, trūkumi un kļūdu avoti, izmantojot digitālo kameru un 3D lāzerskaneri. Pielietojot pie dažādiem objektiem ir dažādas iespējas pielietot vienu vai vairākas metodes, kas palīdz palielināt rezultāta kvalitāti un galvenokārt iegūšanas ātrumu

Kaļinka M., Rutkovska E.Digital close – range photogrammetry to use the digital camera and 3D laser scanner in architectural photogrammetry
The paper consider the main methods for documentation of the geometry in the cultural heritage nowdays to change the traditional photogrammetry with digital photogrammetry and 3D laser scanner. The paper describe the main problems, errors and possibilities to use the digital camera and 3D laser scanner. To use the one or more methods for documentation the object, the results will be with hight precision and the main the faster.

Калинка.М, Рутковска. Е. Дигитальная фотограмметрия изпользов дигитальную камеру и 3Д лазер сканер.
Встатье расматривается главние методы для документаций историтеских обектов замени традитионал фотограмметрий за дигитальнуй камеры и 3Д лазер сканер. Встатье расматривается главние проблемыбб ошибки и возможнасти использований дигитальнуй камеры и 3Д лазер сканерю Точное и быстре результат будет если изпользовает оба методы