USE THE 3D LASER SCANNING FOR DOCUMENTATION THE RIGA CATHEDRAL IN LATVIA

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ABSTRACT:

Documentation, analysis and estimate of cultural heritage and historical objects is very complicate and interesting work. The Riga cathedral is one of the oldest building in the Riga city. It is incorporate of cultural heritage register. And of course The Riga Cathedral is included in tourist programms. The Riga Cathedral is very interesting from architectural view. It combines many styles - romanticism, baraque and art nouveau.

The one aim of the documentation is to collect the information of the geometry and the information of the material (structure) faCade and use the information for reconstruction works. Using digital close range photogrammetry and 3D laser scanner data, we can determine this information in very high level.

Work was performed with the one of the most popular laserscanners Leica HDS 3000. In the result of scanning process we got an information about 100 million point. Each of these points determine x, y, z coordinates.

In data analysing and determinating of geometry of the Riga Cathedral facade were used the metods of traditional photogrammetry. Basic step is to make the picture compatibility with most important point coordinates. And then we can draw other elements from facade like bricks, stones, roof or windows.

Main aim was to combine traditional photogrammetry and 3D laser scanner data to get better results than using those methods separately.

The heritage documentation include the documentation of the geometry, documentation of the structure of the object and database for analyze the object to create the surface model of the part of the walls

1. INTRODUCTION

The Riga Cathedral was one of the oldest building in the Riga and was starting built in 1211. During the time from 16 century the Cathedral have a lot of reconstruction. At this time group of the Scientifics' and specialist make the reconstruction of he tower and all church. The project was use together with private surveyor companies and Riga Technical University Department of Geomatic and documentation centre of the Riga Cathedral.

Documentation of cultural heritage and historical objects are very complicate. The Riga Cathedral is very interesting from architectural style. Cathedral has the style of the romanticism, the Baroque taste and art nouveau. 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 kinds of the details. There are the documents of geometry, landscape, archaeology, 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

The digital close range photogrammetry and 3D laser scanner are the most popular methods in architectural photogrammetry for

documentation of cultural heritage. For the documentation of the Riga Cathedral use the documentation with 3D laser scanner and digital photogrammetry. All methods are connected together.

2. DOCUMENTATION

There was possible to use two types of the applications. In one, building are presented by general forms and vector lines , surfaces and planes. This is traditional form to present the results and documentation in 2D plans, facades or section of the building. In this form all plans was possible to connect with orthophotos and individual pictures.

The second possibilities are to present the results in 3D form. The documentation has fully realistic information with maximum details. For example, this kind of the documentation has point cloud from laser scanning, surface model and orthophoto and another individual pictures for representing the some details of the objects. Sometimes the documentation was not complete and there was not possible to see all details. In this case we can use the both methods and another traditional methods for documentation of the details, for example very small drawings on the wall with not possible measure. The another methods are to measure the 1:1 ratio by measuring type or total station. Heritage documentation requires also high quality and resolution imagery. This is not possible to use with built in camera inside the scanner. We must to check the positions of the scanners, light and condition for taking the photos. In some tasks the independent cameras is required and correct the colours of textured models with individual photos.

Figure 1. The photo and point cloud of the prospect of Catedral Organ

3. DATA COLLECTION

3.1. SCANNING PROCESS

For scanning the facade of the Cathedral was use the 3D Leica scanner HDS 3000. Together for scanning use the 11 position of the scanner and the distance between the points in point clouds are 1, 2 – 2 cm. During the scanning the information database had more the 100 millions points in the point clouds. For scanning not use the orthogonal method but convergence method for better results. One place of the church was scanning from different scanner places. The maximum distance for scanning was 90 m . Its dependent the high of the church is ~90 m. This object was

The specifications of the scanner:
-Maximum 360° x 270° field-of-view
-<6 mm spot size @ 50 m
-6 mm positional accuracy @ 50 m

Figure 2. 3D Laser scanner Leica HDS 3000

3.2. POINT CLOUD DATA ANALYZE AND DOCUMENTATION

Data analyze including the process the registration of the point clouds, create the 2D models of the facades and vertical and horizontal sections and 3D model of the Cathedral. For registration of the point cloud was use the Leica Cyclon register. The standard error was 10-50 mm . It was depended the distance from scanner to the object and laser spot size, and laser intensity. The Cathedral was simply to analyze because all geometry contains regular forms, lines, curves. From the point cloud was created the facades plans, vertical and horizontal crossection plans , surface models of the walls. Point cloud database was divided in the separate parts for easy using together with 3D vector data in AutoCad or MicroStation.

Figure 3. Cathedral 3D Model from point cloud and mesh

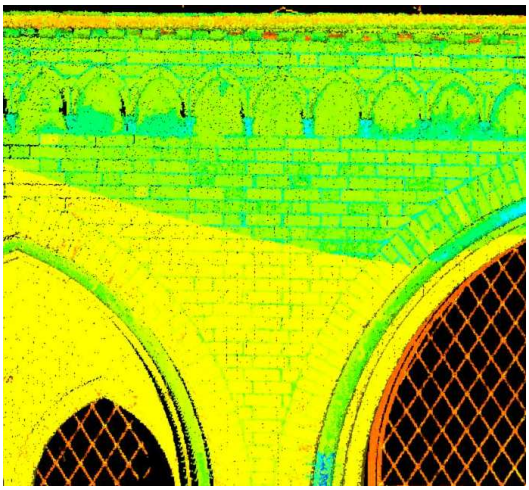

Figure 4. The part of the entrance of the Cathedral in point cloud

To process the laserscanning data one can meat with difficulties, like precision, software compatibility and individual factor. This process is very complicated. Depending of preferable results, it is neccesary to notice fixed precision. For analyzing the facade data for documentation of the facade of the church use the point cloud and combined together with photogrammetry . Because the complicated details not easy to coloured from point clouds and and also not possible some places very good to see the seams of the bricks.Its depended from precision and accurate of point clouds. If the higer accurate of point cloud , the better to see the seams and cracks of the bricks. For this task we take the high quality picture and oriented on the point cloud for creation the high quality orthophoto of the plane facades. For modelling and documentation was used following software:

- Leica Cyclon – for reading the coordinates and modeling the 3D model
- Bentley MicroStation V8 with Leica CloudWorx 3.2 – use for create the vector data and analyze the geometry of facades, arcs and etc.

Key steps in processing the laser scanner data:

- Inspection the model in Leica Cyclon –There need to change the settings, like color, point frequency or density.
- Most important element drawing in MicroStation file with Cyclon CloudWorx 3.2. Work in MicroStation – find the most important line, point, which are like reference point – marked sign; windows or doors edge, roof comb.
- Photography – Take a picture with Canon EOS Rebel Digital/EOS 300D Digital camera and wide objective Canon Ultrasonic. The Picture need to take more orthogonal, in order to avoid distortions.
- Processing with foto in Photomodeler or MicroStation Descartes for transformation the picture and to create the facade orthophoto.

Factors of precision:

- Shading in starting data (Point cloud).
- Shading in photography.
- Obstruction, which affect visibility.
- The angle of focus.
- The sun.

The geometrical accurate for finding the best point in point cloud are 3 – 5 mm, but in the relative precision of the part of the facade are 3 mm.

Figure 5. Fragment of Pilaster P6 inside at Riga Cathedral pictures and vector data

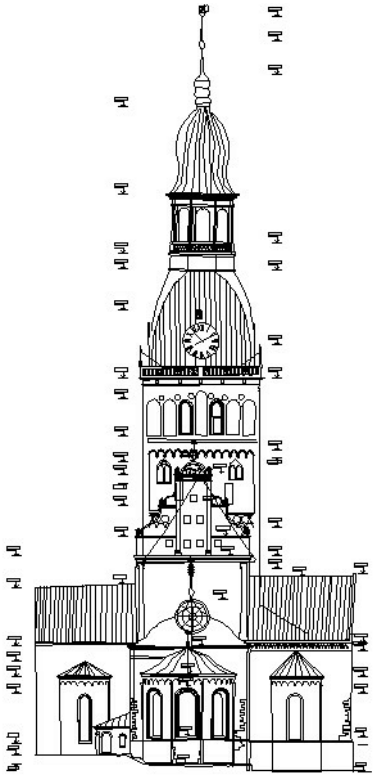

Figure 6. Fragment of south wall at Riga Cathedral with vector data.

4. THE PRECISIONS OF THE RESULTS

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

All technical instruments and methods used for documentation have the errors.

The main errors to use the digital photogrammetry and scanner are:

- measuring errors (distances and angles)
- precision of the instruments (distance and angle measuring errors)
- centering the geodetical instrument
- network errors (precision of the geodetical network)
- calibrating errors of the digital camera
- fix the positions (different distances from objects,
- convergence case errors)
- post processing errors-fix the positions of the controlpoints and referencpoints
- subjective errors
- interpretation
- climate problems – sun, warm,wind
- edges problems of the objects

5. 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 historical objects in Latvia. By the combination the both methods or data sources the results will better and possible to take a lot of the informations. The main accurate is to accurate find the coonected point in the point cloud and digital picture for creation of the orthophoto. This method was better to work with plane object like the facade, floor but to work with no plane object the better is to use 3D point clouds.

All data and information its possible to divide in the two parts and create the documentation databases. These parts are:

1) Analytical information which include the textual information of the historical view of the Cathedral and its interesting objects

2) Geometrical information - including the

- vector plans
- point cloud model
- orthophotos of the facades or walls, columns ,
- 3D model from mesh and virtual video model generated by point clouds,
- different colour intensity interpretation from point clouds pictures another information where possible to analyze and see the

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