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MODELING CITY HALL'S FAÇADE USING LASER SCANNING TECHNOLOGY

Abstract. This paper describes concepts related to facade modeling based on laser scanning. The City Hall of Novi Sad was chosen as object of interest. City Hall's facade scanning was performed using Leica ScanStation scanner. Scans were taken from three different locations to acquire all pieces of the facade. A GPS receiver was used to measure coordinates of three different points on the facade, so that the scans may be georeferenced later in the process. At the end of scanning process there were three point clouds which represented front, the west and east parts of the City Hall's facade. Further, Leica Cyclone 5.7 was used to process point clouds. The point clouds were processed to remove all the points that did not belong to the facade. Refined point clouds were exported in DXF and 3DS formats and visualized in Leica Virtual Explorer Architect.

Key words: facade modeling, laser scanning, visualization

1. Introduction

The technology of terrestrial laser scanning has become popular for the acquisition of architectural scenes, due to the fact that it provides direct, reliable and dense surface measurement in a versatile fashion at independently varying standoff distance and resolution [1].

City Hall, of Novi Sad, is the one of the four monumental buildings on Liberty Square, the main city square. It was built in 1895 and designed by a well-known architect György Molnár. The two-floor building is in the neo-baroque style, so the interior is richly decorated. There are 16 allegorical statues, the works of Julije Anika, along the facade. You can see the town's coat of arms on the upper part of the facade facing the square. The building is also decorated by a high tower with the bell of St. Florian – Matilda. Today, the City Hall is the seat of the local authorities, i.e. the Executive Council of the Assembly of Novi Sad, which is the executive body of the City Assembly [2].

We chose the City Hall, as object of interest for laser scanning, because of its complex facade and cultural heritage.

2. Scanning Process

For scanning the facade of the City Hall the 3D laser scanner Leica ScanStation [7] was used. Tha laser scanner builds a 360 degree point cloud of a scanned surface by sending an infrared beam into the center of a rotating mirror. Using encoders to measure the mirror rotation and the horizontal rotation of the Laser Scanner, the X,Y,Z coordinates of each point can be registered and modeled. A modern laser scanner is able to acquire densely sampled point clouds consisting of several million points. Using state-of-the-art meshing techniques, these

point clouds can be converted into polygonal meshes, immediately suited for graphic rendering.

Because this instrument is integrated by a high resolution digital photocamera with calibrated lens, it takes digital images, in addition to laser scanned data, which are calibrated in the scanning system. Therefore, the geometric contents are supplemented by the descriptive data of the RGB of the points. The combination of digital photography and laser scanning enhances the point cloud data, defining edges and texture [4].

Fig. 1. Three positions of the scanner

Leica ScanStation scanner was rented form “Vekom d.o.o.”. We also hired their operator to operate the scanner.

Scanning of the City Hall was performed from three positions, because it was not posible to scan the whole facade of the building from just one position of the scanner. The positions of the scanner are shown in the Fig 1. The distances from the scanner to the nearest points on the facade in all three cases were, approximately, 15m. Maximum errors of the laser measurements, from that distance, were, according to the scanner specification, less than 6mm for the position measurements and less than 4mm for distance measurements. Because of the complexity of the details on the facade the scanning was performed using a scan density of 30mm at 15m (the distance between neighboring points were 30mm in horizontal and 30mm in vertical direction). We assumed that, such scan density will provide us with enough information to model every element of the facade with high detail. The results of the scanning process were three partially overlapping point clouds with 4.6 millions of points altogether. The scanning process took 6 hours to finish.

The points in each scanned point cloud have coordinates in different coordinate systems which are defined by the scanner position and orientation. Those point clouds have to be registered and georeferenced, which means they have to be merged together and

transformed into real coordinates. We used method of indirect registration and georeferencing to perform that.

Method of indirect registration and georeferencing requires special designed targets to be placed on the facade before scanning process. At least three targets are required in each overlapping area between point clouds. Because those targets are made of special very reflective material and have regular shape, the scanning software can automatically recognize them in scanned point clouds and measure their coordinates with high accuracy and precision. That provide us possibility to register point clouds with an accuracy of 3mm.

The real coordinates of the targets were measured using GPS rover Trimble 5800 and Leica TPS1200 total station. The Real Time Kinematics (RTK) method, that was used for GPS measurements, provides us with very accurate measurements of coordinates with maximum displacement of 10mm from their real coordinates. Such an accuracy was compatibile with the accuracy of the measurements taken by laser scanner so the resulting facade model had an overall accuracy of 10mm.

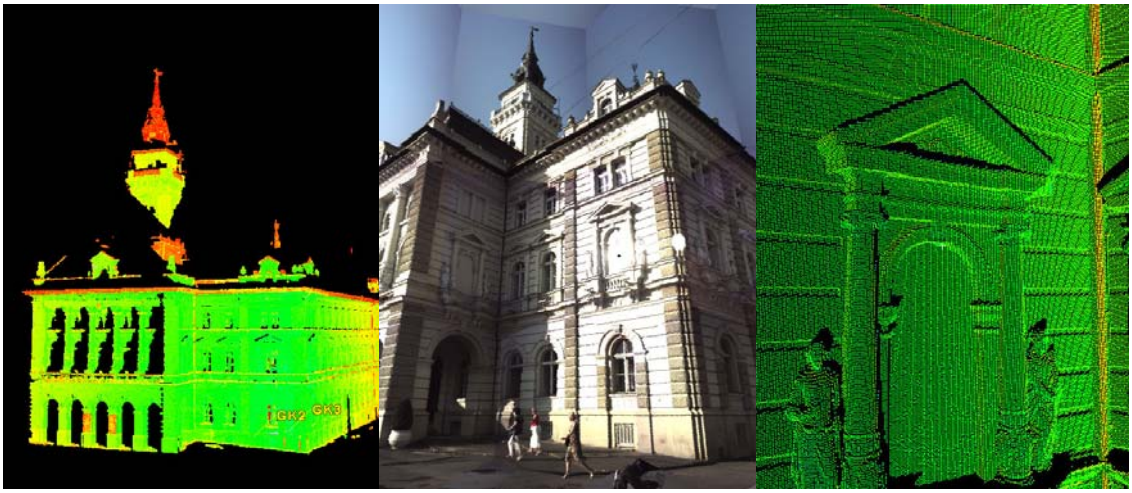

Fig. 2. Point cloud and multimage of the west facade; detail view of facade

3. Processing The Data

The results of laser scanning process were three point clouds which contained points that belong to the facade as well as points that belong to other objects, fixed or mobile, and errouneous measurements. We processed the scaned data using Leica Cyclone 5.7. which has tools to analyze and extract information from the point cloud data and convert point clouds into object-based line and surface models [6].

Processing of the scan data was performed through series of well defined steps, which included:

- registration and georeferencing
- filtering errouneous data
- modeling of the data

We performed registration and georeferencing using specialy designed targets that were scanned and measured during the scanning process. The coordinates of those targets were represented using the Gauss–Krueger 7 coordinate system and they were used to define a new reference system. After that each point cloud was registered to that reference system. The result was a unified point cloud, georeferenced in the Gauss–Krueger 7 coordinate system.

Before entering the modeling phase it is recommended to remove all the data that did not belong to the object of interest to reduce the computational time. We followed that recomendation and removed all points that do not belonged to the facade from our data set using Cyclone's tools for manual selection and deletion.

The third step was the creation of the mesh model. Because of complexity of the facade, we estimated that building of a model for the whole facade would be a very difficult task which largely exceeds our resources. Therefore, we decided to build a model for a part of the facade. We chose to build a model for the central area of the front facade, which was 10 meters wide and 8 meters high. Complex meshing algorithm was found to be the most appropriate for creating mesh model, network of triangles which represents surface, for the chosen part of the facade. That algorithm creates a mesh consisting of triangles using trios of adjacent points that are likely to lie on the same surface.

Fig. 3. Mesh for the part of the facade without and with applied texture

To produce a realistic model of the facade a proper texture had to be applied to the mesh. Images that were taken by the scanner, during the scanning process, were applied to the mesh as a texture using Cyclone's Image TextureMap tool.

At the end, refined point clouds and created model were exported to DXF and 3DS formats and visualised in Leica Virtual Explorer Architect.

4. Conclusions

A terrestrial laser scanning is used to collect building facades at a large amount of geometric detail. This paper presented application of laser scanning technology for modeling of the facade of the City Hall in Novi Sad. Leica HDS 6000 laser scanner was used for the scanning process and Leica Cyclone 5.7 was used to process scanned data. The result of that approach was a large amount of detailed data for the whole facade and a very accurate and realistic model for the part of the facade. The future work will include building of the model for the whole facade using mesh and geometric primitives.

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