



ACCURACY OF 3D BUILDING MODELS CREATED USING TERRESTRIAL AND AIRBORNE LASER SCANNING DATA

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Introduction

Data

3D Modelling

Error sources

Accuracy
assessment

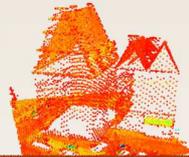
Conclusions

AGENDA

- **Introduction**
- **Data Used**
 - Terrestrial Laser Scanning Data
 - Airborne Laser Scanning Data
 - Point clouds integration
- **3D Modelling**
- **Error sources**
- **Accuracy assessment**
 - Reference data
 - Results
- **Conclusions**

MOTIVATION

- Airborne Laser Scanning Data
- Digital photo



3D Model



What is the accuracy of the model ?

Does the model meet accuracy standards of professional applications ?

- Terrestrial Laser Scanning Data
- Digital photo



Professional Applications



TERRESTRIAL LASER SCANNING DATA

- Performed by *Leica ScanStation C10*
 - Scan resolution: $\pm 2\text{cm}$ on the object
- Network points were used for georeferencing and connecting single scans
 - *Trimble R6* receiver was used
 - Coordinate precision: $< 3\text{cm}$
 - Coordinate system: *EPSG:2180*
 - Polish system of normal heights
- Registration and transformation was made in *Cyclone Register 8.1* software
 - Registration accuracy: $< 1\text{ cm}$

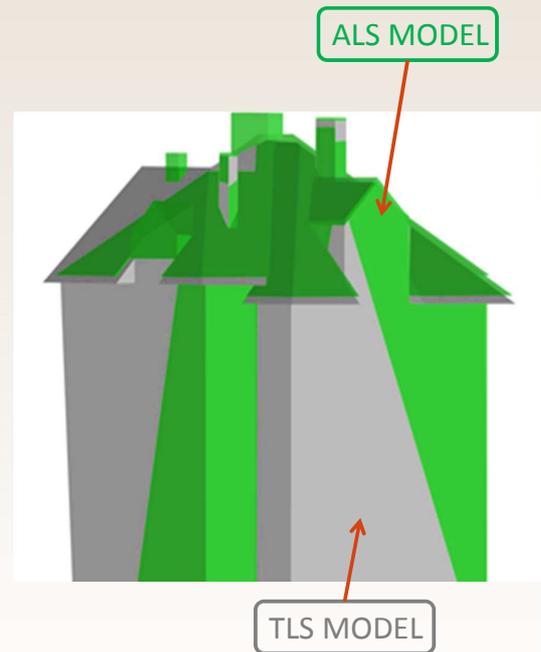
AIRBORNE LASER SCANNING DATA

- Performed by *Lite Mapper* system (*Full Waveform Riegl LMS-Q680i* scanner)
 - Scan resolution: *12 points per square meter*
- Polish system of normal heights and *EPSG:2180* coordinate system was defined



DATA INTEGRATION

- Due to the differing precision of the TLS and ALS sensors the point clouds, derived from both sensors had a horizontal and height offset
- *Iterative Closest Point* (ICP) algorithm was used for co-registration of TLS and ALS data
 - The co-registration of the data was performed separately for each building
 - TLS clouds were treated as a reference
 - the scale factor was fixed (equal to 1)



3D MODELLING

Use planes to approximate scanning data

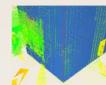
Model the edges of the buildings

Check and correct the topology

Extend buildings walls to DTM

Create final 3D vector model

Texturing



Semiautomatic process using Cyclone software and home developed software

3D MODELLING

Error budget

- Terrestrial laser scanning data errors
- Airborne laser scanning data errors
- Data integration errors
- Generalization of the model and the surface roughness (detail of the modeling)
- Topology correction
- Textures errors

REFERENCE DATA

- **Measurement was performed using a Leica TCR407 power reflectorless total station**
- **Tachymetric measured points are highly accurate and can be treated as error-free**
- **Coordinates of 80 reference points there were determined**
 - 55 points for vector elements (corners of vector model)
 - 25 points for texture elements (corners not present in vector model but on textures)
- **For the corresponding control points, differences between coordinates, heights and distances, (both horizontal and spatial) were calculated**



REFERENCE DATA



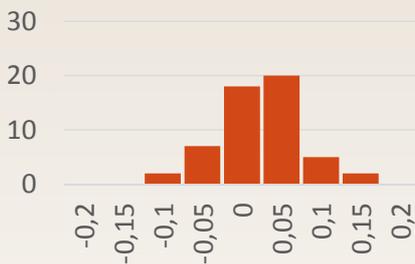
Location of control points

- vector
- texture

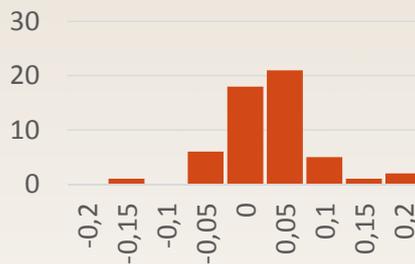
RESULTS

Building 1

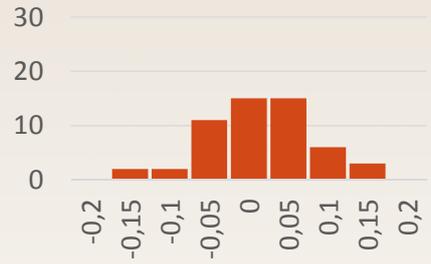
$\Delta x[m]$



$\Delta y[m]$

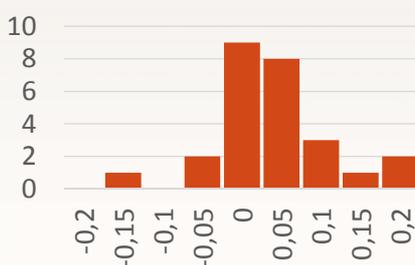


$\Delta z[m]$

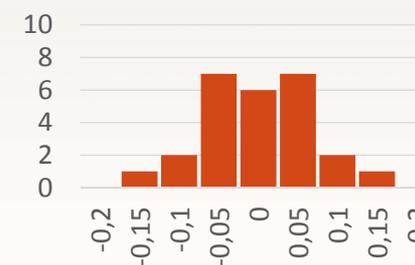


Building 2

$\Delta x[m]$



$\Delta y[m]$



$\Delta z[m]$

