Terrestrial laser scanning applied for reverse engineering and monitoring of historical buildings

I. Milev & L. Gründig
Technet GmbH

SiRailScan

Overview

- Laser data processing
  - Pontcloud registartion
  - General Spline Definition
  - Interpolation function
- Rehabilitation works and reverse engineering
  - Represent on several projects
- Conclusions

3D Laser scanning technology to aquire spatial data

- 3D model
- Construction drawings
- Orthoimages
- Especially for historical architecture objects without construction records

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Laser data processing

- Automated plane detection based Registration
  - Detect planes in the image matrices of the scans (scanner system)
  - Finding identical planes for the registration
  - Calculate the interconected transformation with reability and quality values

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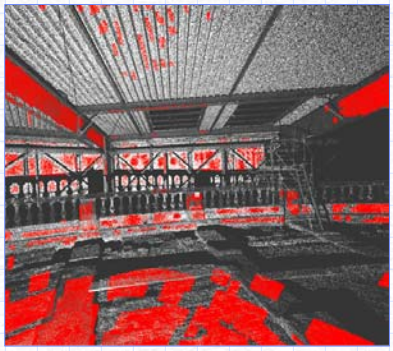
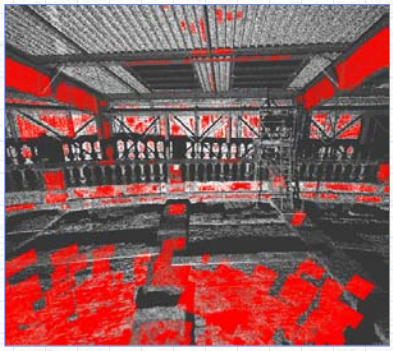
Plane segmentation

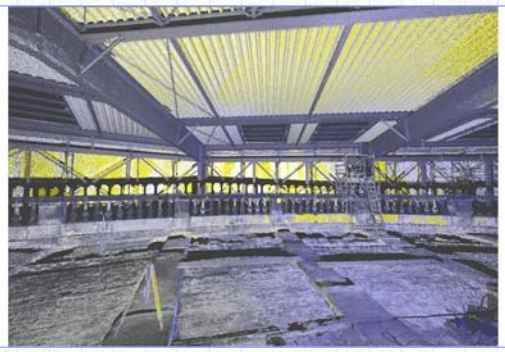
- Detected planes





Fitting control

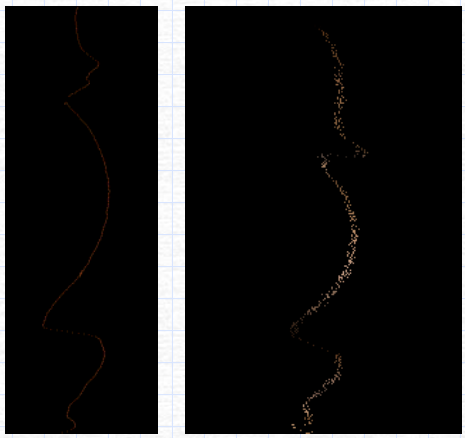
- Orientated Scans



Laser data processing

- Depending on the accuracy requirements the processing work can be accomplish:
  - On the basis of the raw point cloud
  - On the basis of the surface model

Surface model and raw point cloud



Interpolation function

- General Spline Definition
  - Searching for a spline function
    - Base $g : I \to \Re$

$$\partial^{\#j} L_k(u_j) = \delta_{jk}, \qquad j = 1 : m \tag{3}$$

$$|L_k(t)| \le \alpha \exp(-\beta |t - u_k|), \tag{1}$$

$$f = \sum_j L_j g_j \tag{2}$$

Spline

- Surface modelling
  - Find the shape for a accurate model

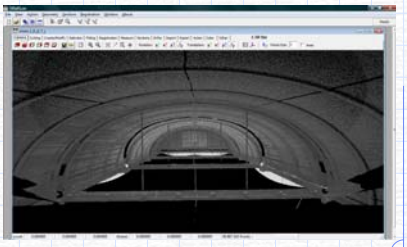
Rehabilitation works and Reverse Engineering

- Parish hall
- Church ruin Betanien
- New Palace Sanssouci
- Public library of Berlin

Parish hall

- Cottbus
- 15 years unused
- Complete renovation for councillor
- No drawings for inner cylindrical roof
- Now generate data of the actual state for the architectural planning needs

Scanning Stations	Points [Million]
Front	25
Back	25
Left	20
Right	20
Corner 1	22
Corner 3	22



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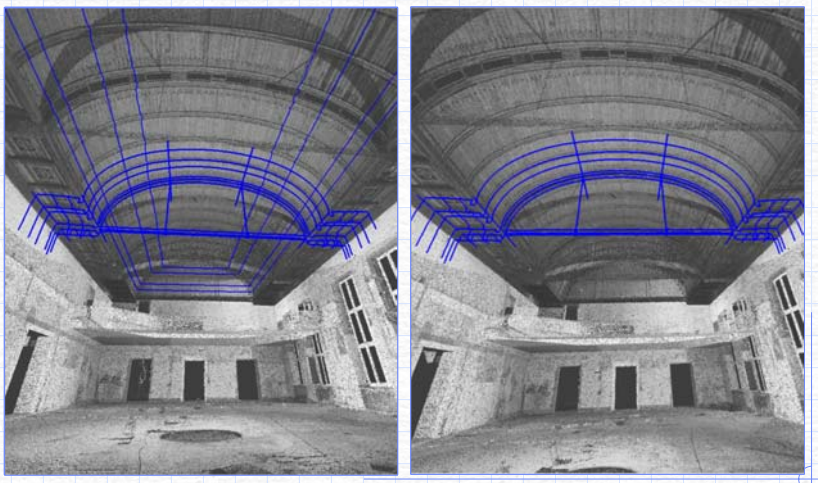

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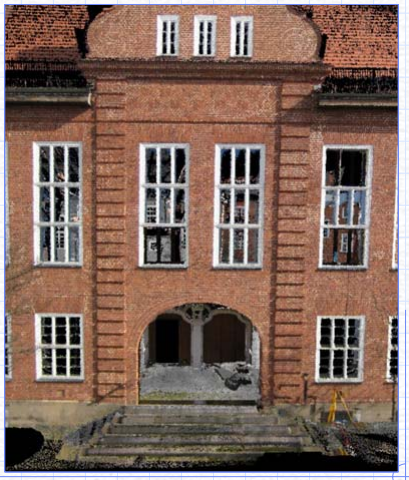
Objectives

- Create sections
- Develop a colour model with free hand fotos
- Orthophotos



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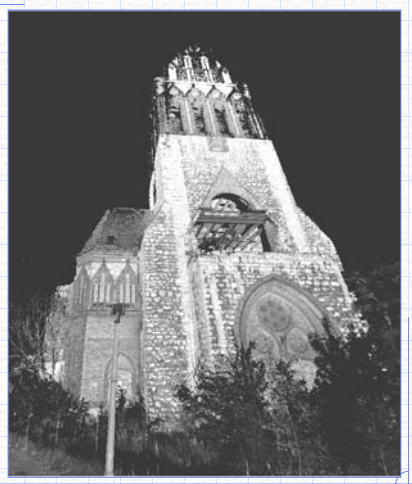
Church ruin Betanien

- Berlin Weissensee
- Built 1900-1902
- Destroyed WW2
- 65m high
- Obtain actual dimensions and shapes



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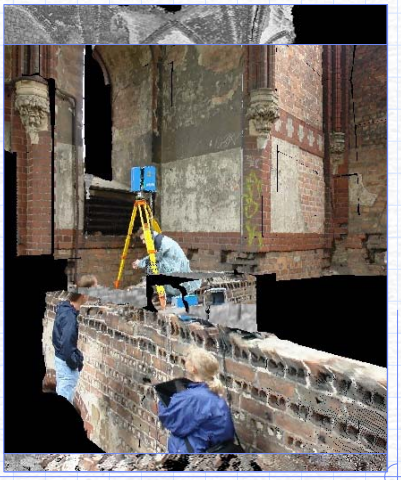
- link point cloud and free hand photo
- Also for historical photos
- Animation



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- Line drawings
- Automated sections with step of 50 cm

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New Palace in Sanssouci

- Castle, park Sanssouci in Potsdam
- Built between 1763 and 1769

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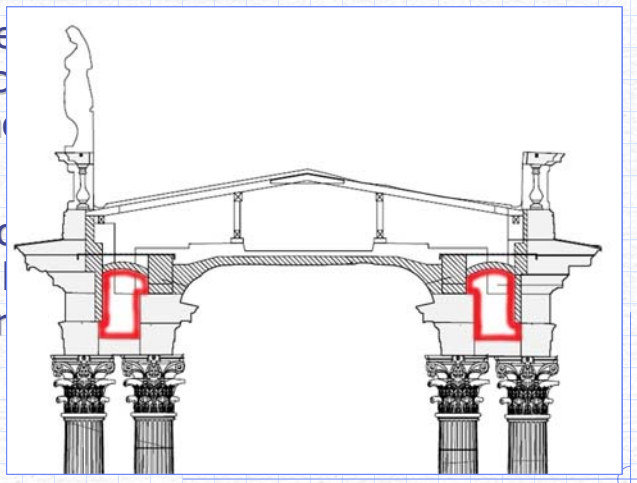
- Old anke construc he repla
- Prefabric handed inside ar



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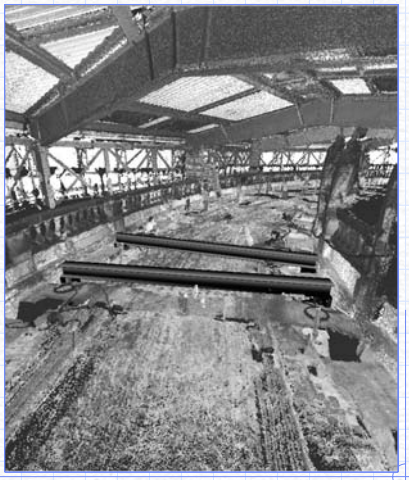
- Determine actual geometrical shape of architraves
- Horizontal and vertical cuts



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Prussian Cultural Heritage

- Ortho images
  - Roof structure
  - Facade
  - brickwork from fundament

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Staatsbibliothek zu Berlin

- Since 1661 (house Unter den Linden since 1914)
- New building of central reading hall will be finished till 2009

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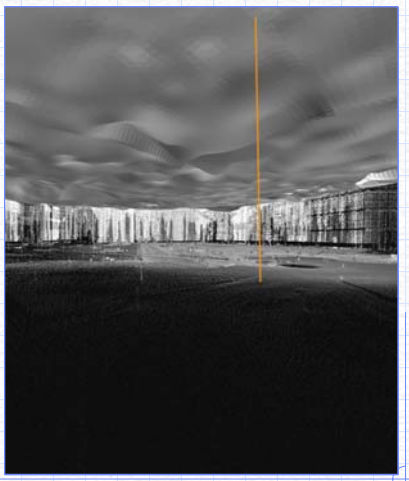
Time stamp based data acquisition

- Two epoches are captured
- Volume caculation for the building pit-excavation volume



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Conclusion

- construction drawings based on new reverse engineering techniques
- Different modeling strategies for different accuracy levels
- 3D models for precise volume determination, acoustic calculations and epoch based documentation of the object conditions – preserving evidence

Thank you