illustrated architecture

3D-MODELLING AND VISUALISATION FROM 3D-LASER SCANS AND PANORAMIC IMAGES

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3D-MODELLING AND VISUALISATION FROM 3D-LASER SCANS AND PANORAMIC IMAGES

-Data acquisition
-Scans, Panoramen

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-Calculations
-Calibration, orientation, normalizing, filters

↓

-3D Modelling

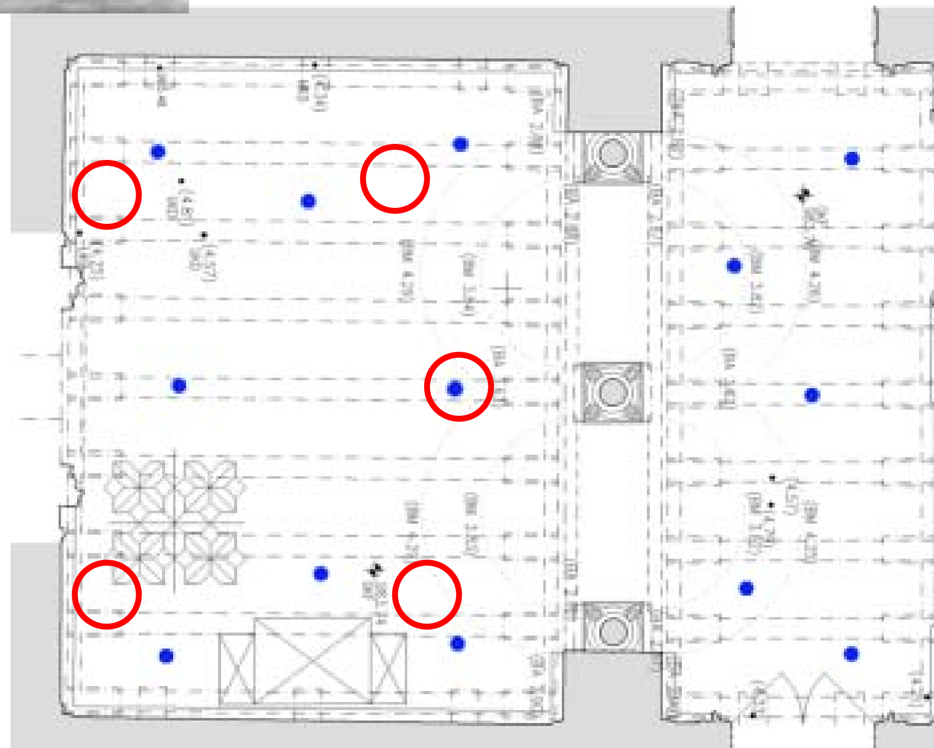
Handmade 3D of models

-3D Triangulation

-3D Modelling from Orthoscans

Data acquisition

Test area:
New swan stone castle
Working room King Ludwig II
→ 13 Scans
→ Recording time 2 hours
→ 5 Panoramaimages
→ Recording time 2 hours



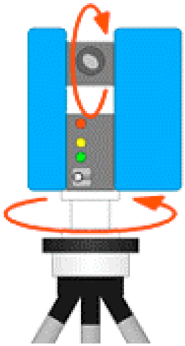
Laser Range Finder

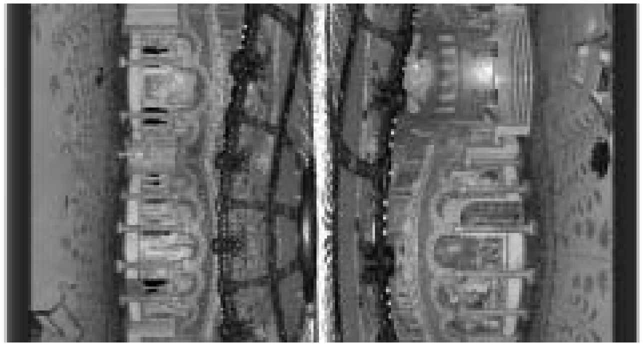
Phase-difference LRFs allow to measure very accurate range values as well as intensity (gray) values. A scene is illuminated point by point, and time-of-flight and phase differences are measured for light that is reflected from surfaces. Combining such an LRF with a (rotating) deflection mirror also allows to measure horizontal and vertical angles.

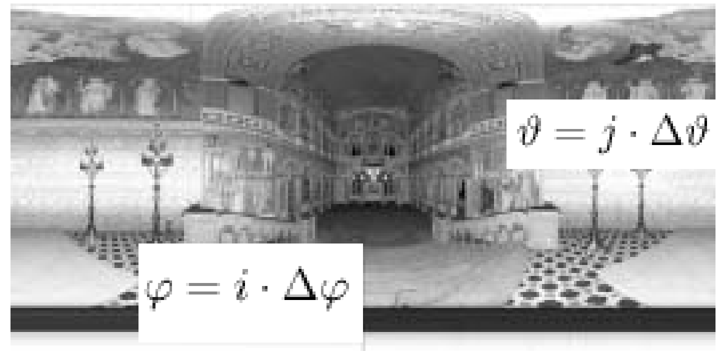
LARA system of
Zoller und Fröhlich GmbH, Wangen

	LARA25200	LARA53500
Distance up to ...	25.2m	53.5m
Error in range data	< 3mm	< 5 mm
Data acquisition rate:	< 625 Mpx/sec.	< 500 Mpx/sec.
Laser output power (CW)	22 mW	32mW
Laser wavelength:	780 nm	
Beam divergence:	0.22 mrad	
Laser safety class:	3R (DIN EN 60825-1)	
Field of view vertical:	310°	
Field of view horizontal:	360°	

Normalizing / Scaner





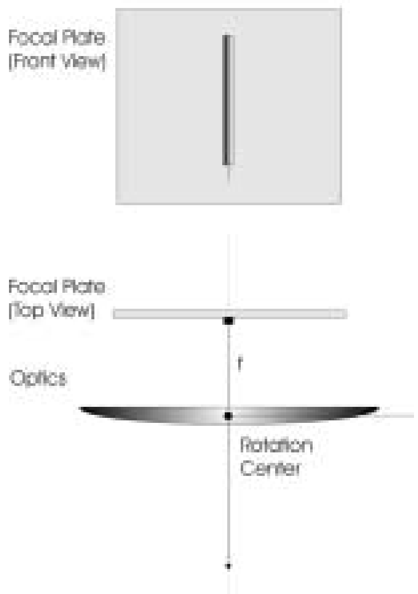


Non calibrated LRF raw data,

Calibrated local polar coord. sys. (360°x180°)

The raw data of the scanner are converted with consideration of internal orientation into equidistant polar coordinates. All errors are out-masked in these data.

Single-CCD-Line Panorama Camera



Rotating line camera EyeScan
(KST Dresden and DLR Berlin)

Number of pixels:	3 x 10.200 (RGB)
Radiometric resolution:	14 per channel
Shutter speed:	4ms … infinite
Data rate:	15 Mbyte per second
One 360° picture (scan):	3-6 GigaBytes
Acquisition time (outdoor):	about 4 min

Normalizing / Camera

Non calibrated data

Calibrated zylindrig data

Panoramic Images are also converted with consideration of internal orientation into equidistant cylindrical coordinates

Calibration and orientation

-Scaner

Partial calibration:

1. Virtual north pole →
2. Target axel
3. tilting axle

For each scaner point: yardstick

-Camera

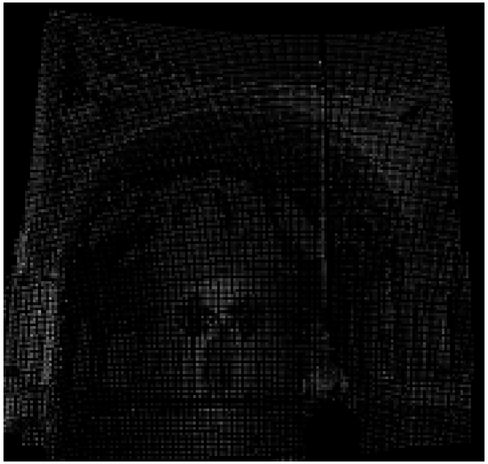
Calibration

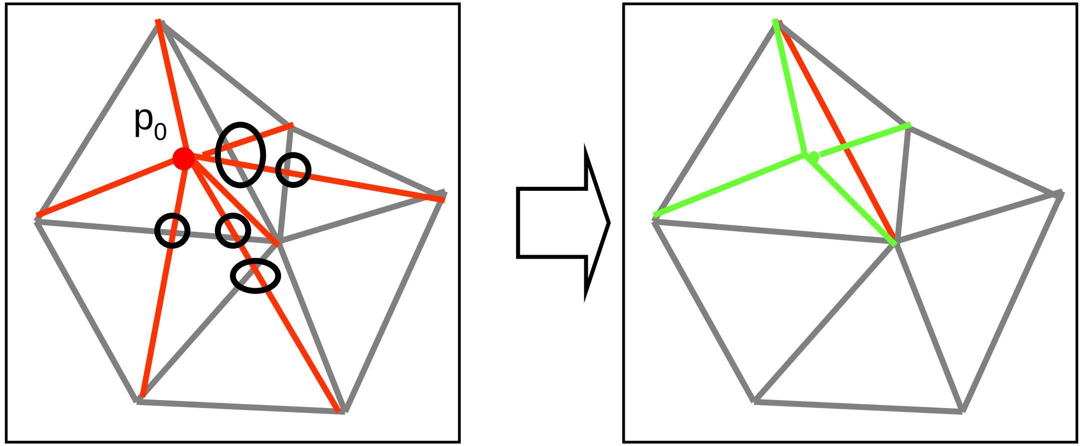
1. Hz. Angles
2. main point
3. Objective
4. affinity of the sensor line
5. Target axel

Orientation

→Orientation by adjustment of all sensor points in one a system with the program complex Neptan.
→The result of the adjustment is about 2mm or 0,5 pixels of the scaner.

Triangulation (meshing)





→ thinning of points ("density check")

→ approximation of normals based on local approximation of the surface

→ point insertion, depending on normals and density around location

→ estimation of Euclidian neighborhoods for 3D points

→ projection of such neighborhoods into a tangential plane
(i.e., from 3D into 2D)

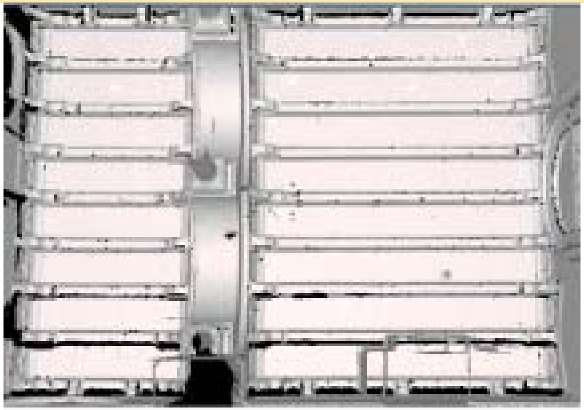
→ new local triangulation (Delaunay) for simplification: creates DSM

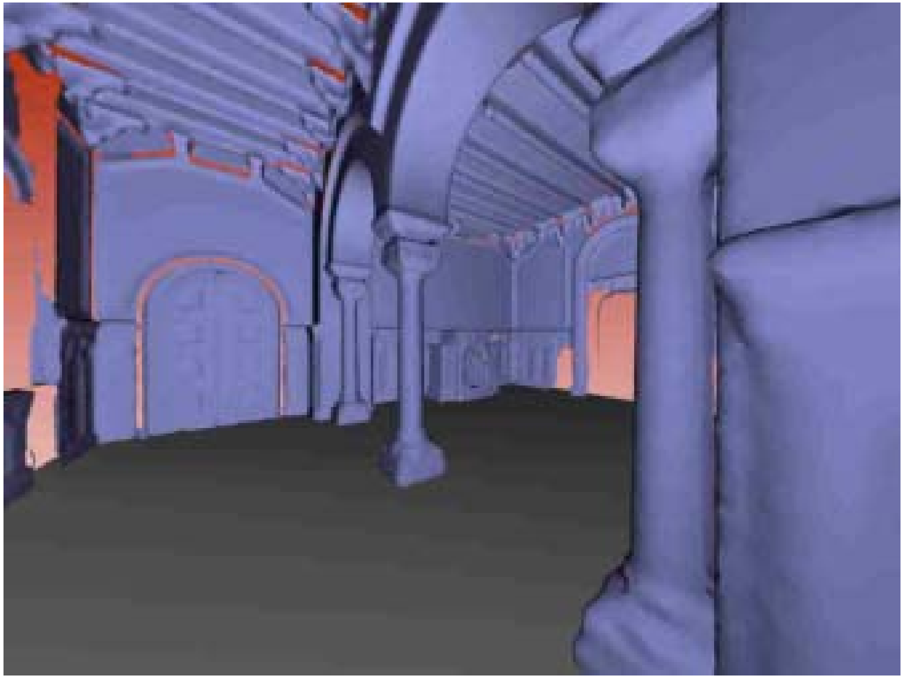
Triangulation Rework

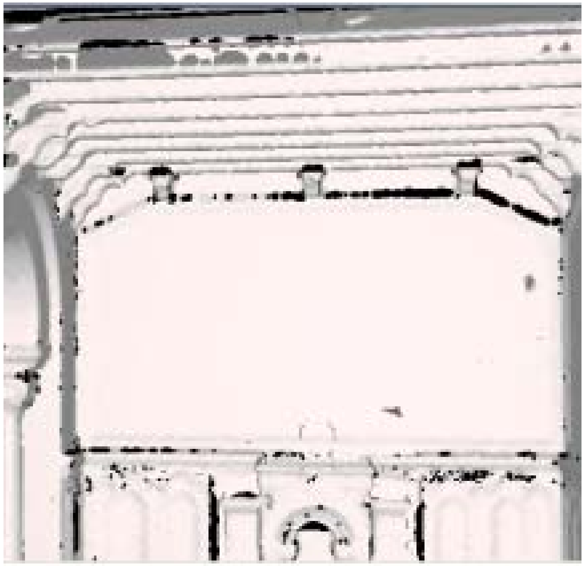
→ delete islands

→ close holes

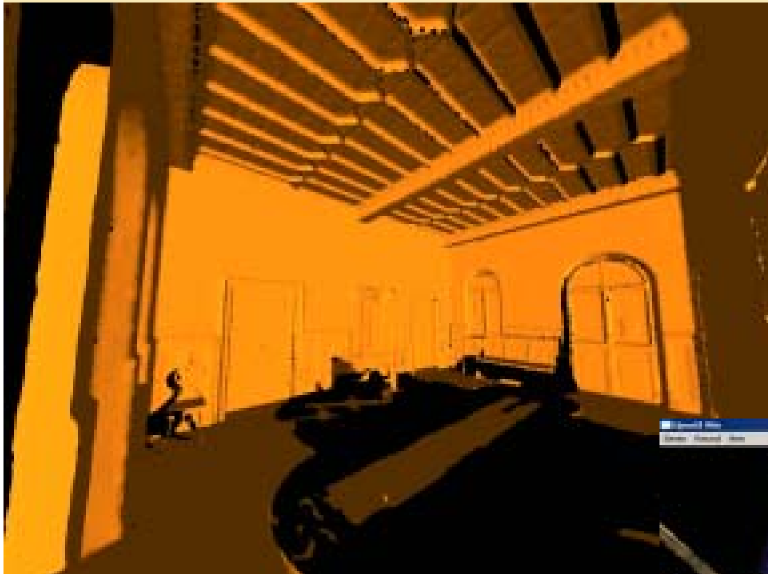
→ thinning of points

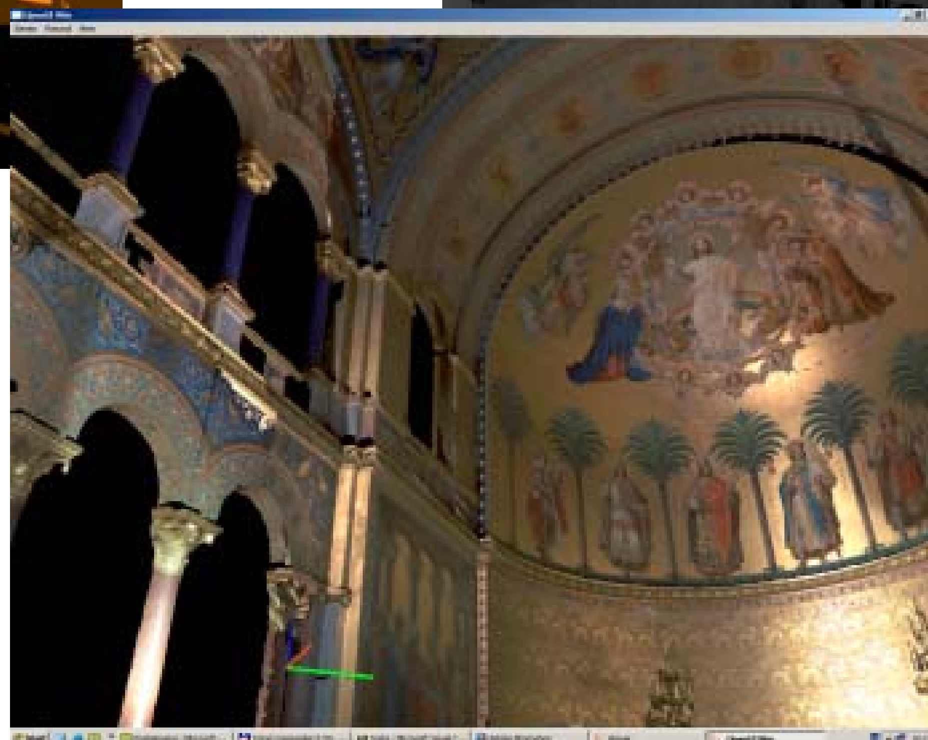






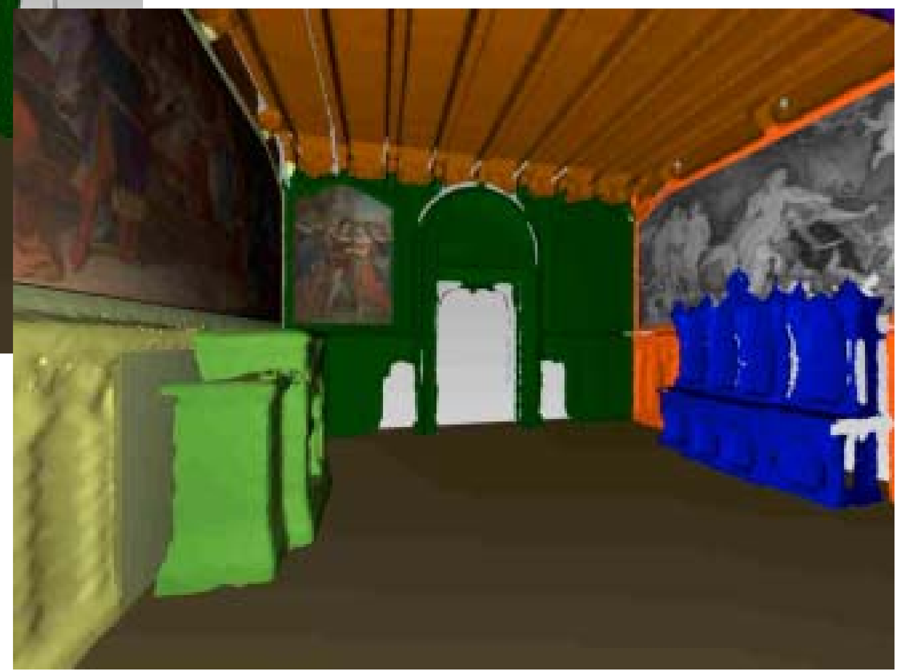
Triangulation





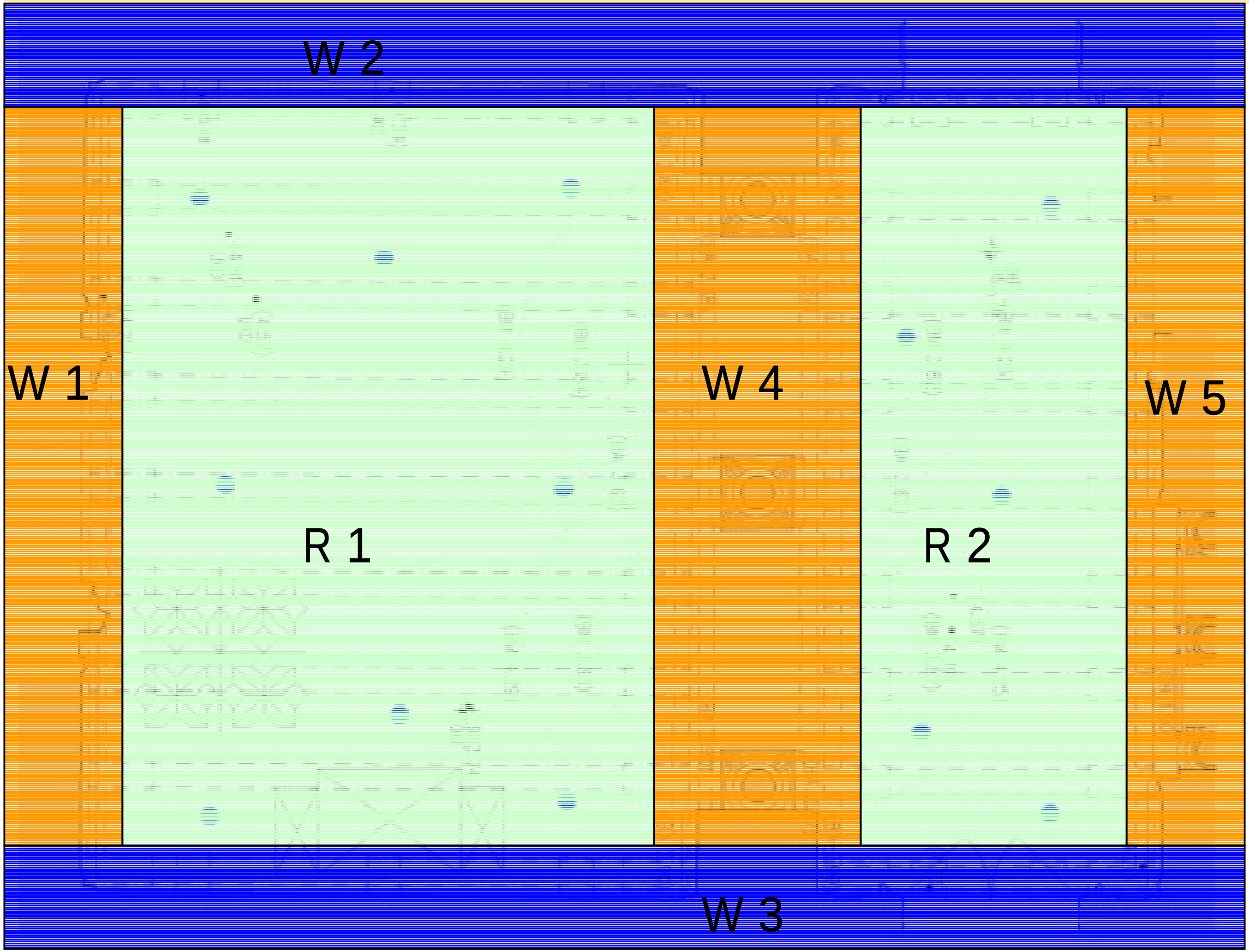
Mapping Intensity data from Scanner or color data from the camera onto the mesh

Triangulation / CAD System



For the further treatment in a CAD system must be divided the Mesh into objects.

CAD System objects

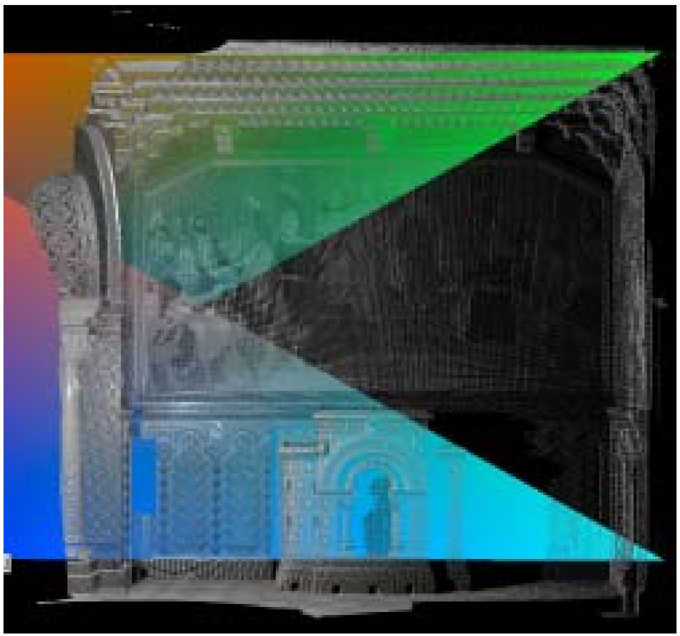


In the CAD System we can divide the test area in 5 walls and 2 roofs.

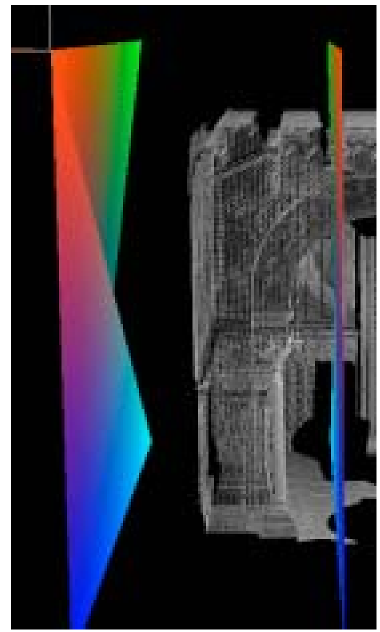
If this structure is well-known, we can also compute one or more Orthoscans for each object.

Orthoscans

Orthoscans can be calculated without triangulation directly from the normalizing Scans and provided with texture information.

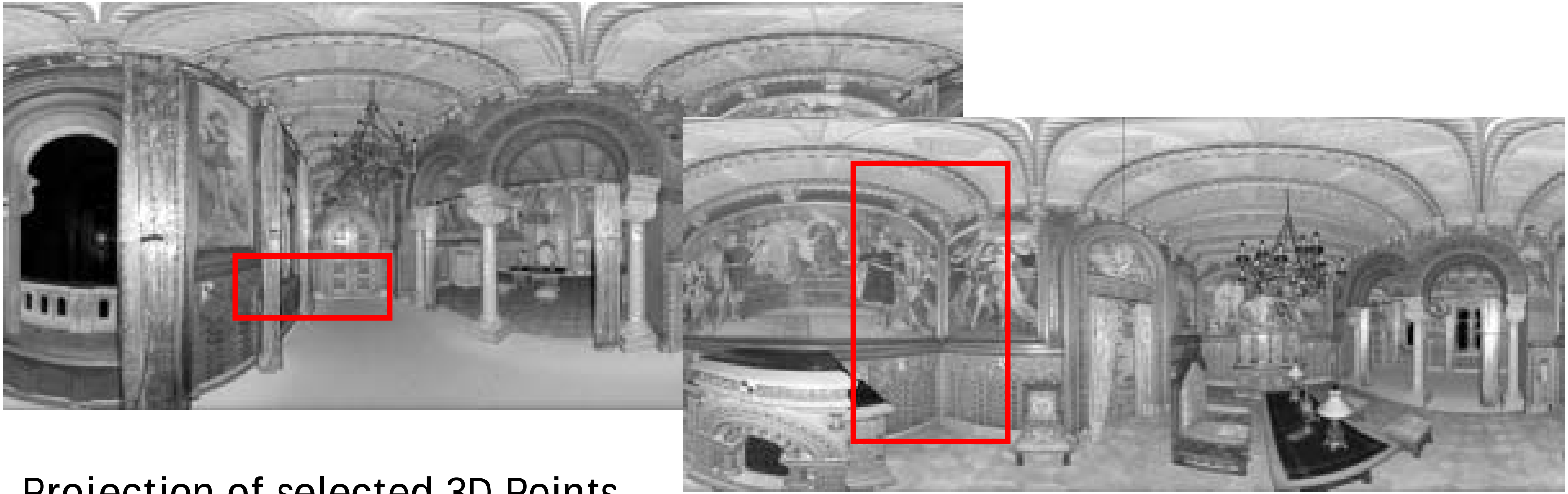


Orthoplane “behind” the 3D pointcloud

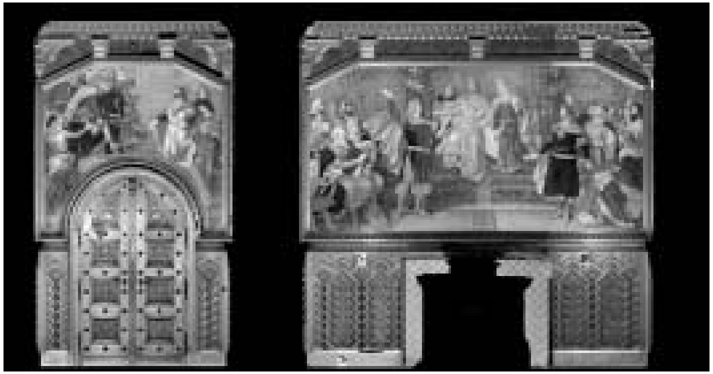


Orthospace “in” the 3D pointcloud

Orthoscans



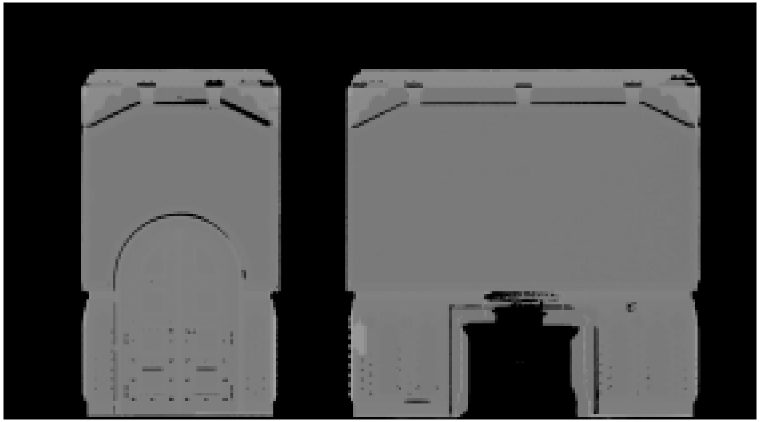
Projection of selected 3D Points
into a orthoplane



Intensity data of orthoscan 8 bit
3mm Footprint

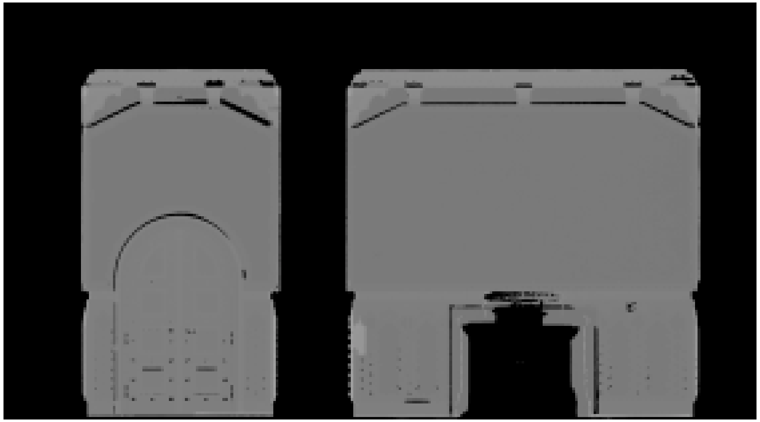
Range data of orthoscan 16 bit
1mm resolution

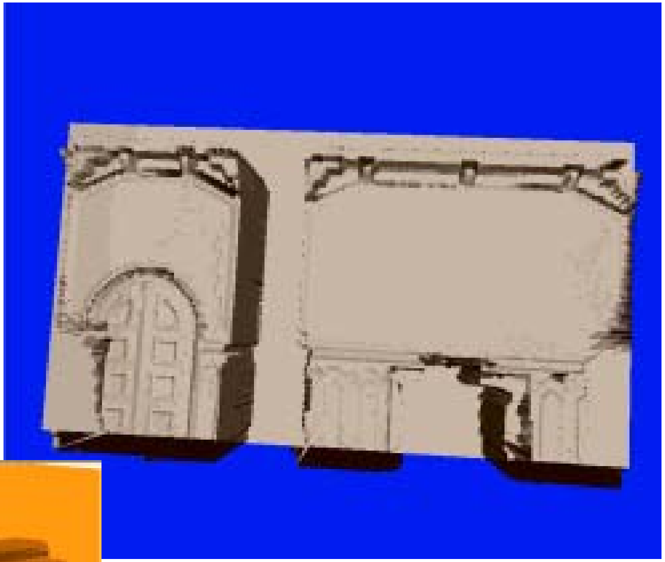
Orthoscans

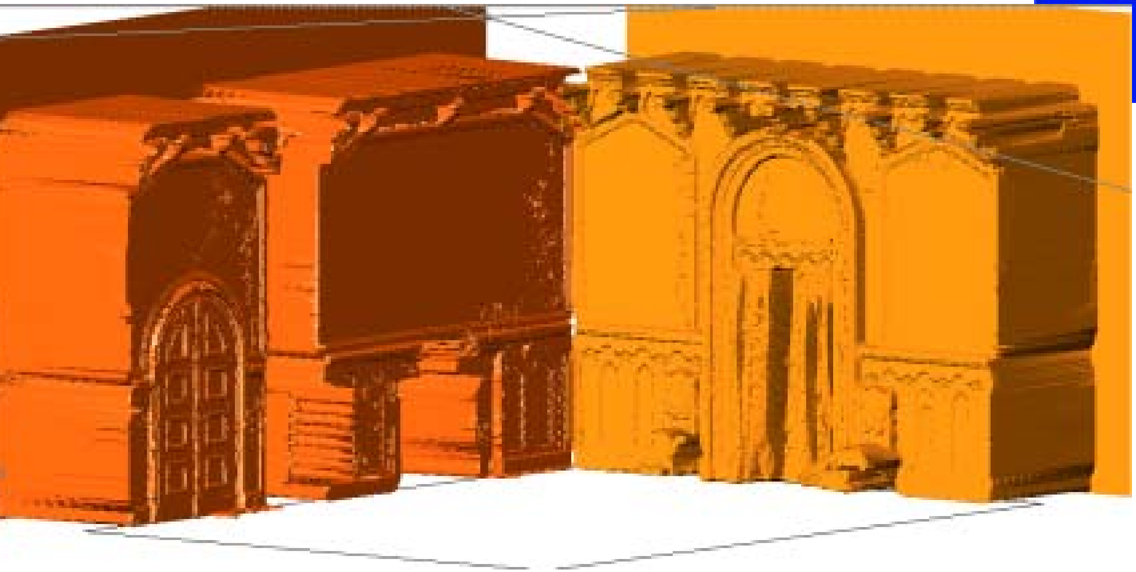


Mapping of corresponding camera data in an Orthoscan

Orthoscans / 3D Darstellung





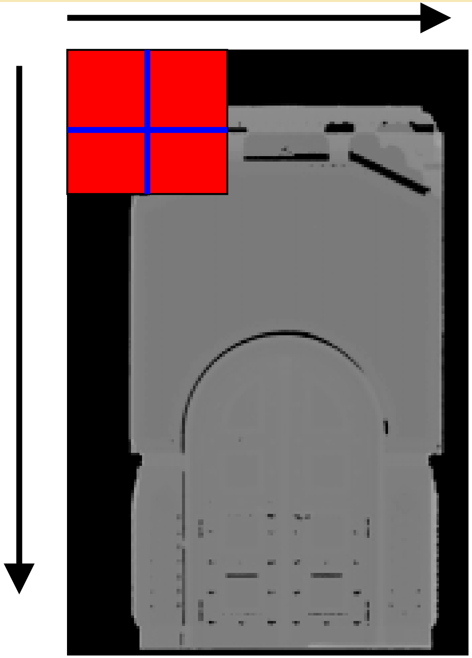


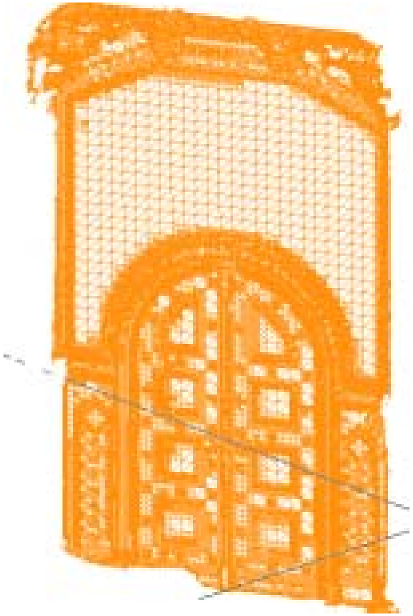
1. Range Data

2. Range Data as 3D Bitmap

3. Range Data as Mesh in a CAD System (Subsample 4)

Orthoscans Data reduction 1

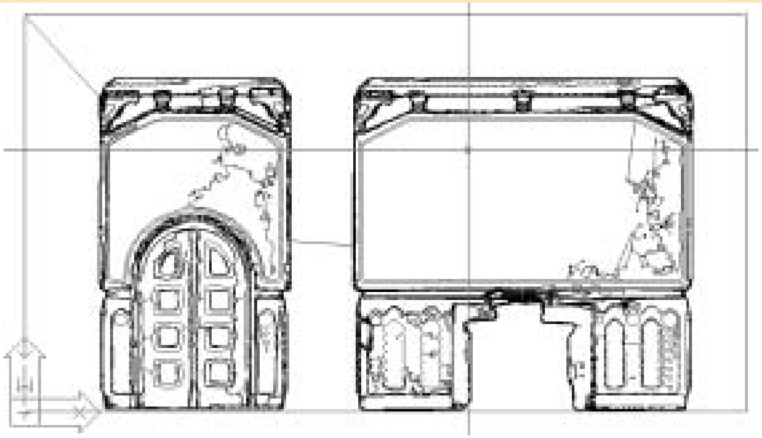


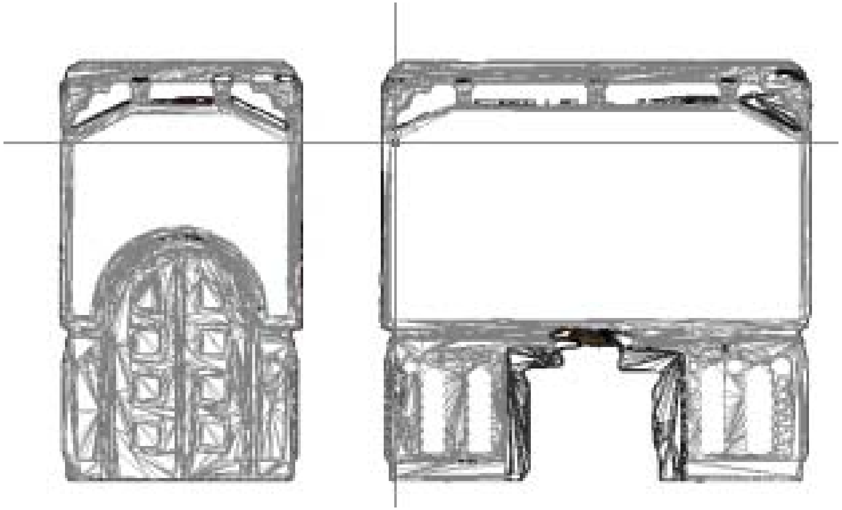


Filters with adjusted levels

In a segment is to calculate whether all points are on an adjusted level.
If that is tru the segment will replaced by two triangles
if that is wrong the segment will be divided into 4 parts and again examined.
The original data can be reduced in this way by 99%.

Orthoscans Data reduction 2





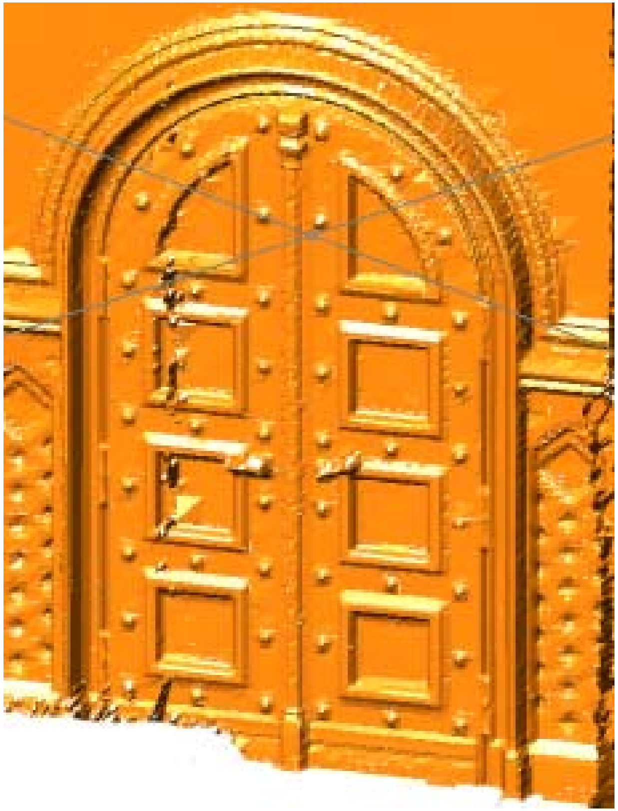
Analysis of the greyscale

1. The distance values of the Orthoscans are converted into an outline map.

2. The outline map can meshed.

The original data can be reduced in this way by 99%.

Orthoscans / Triangulation



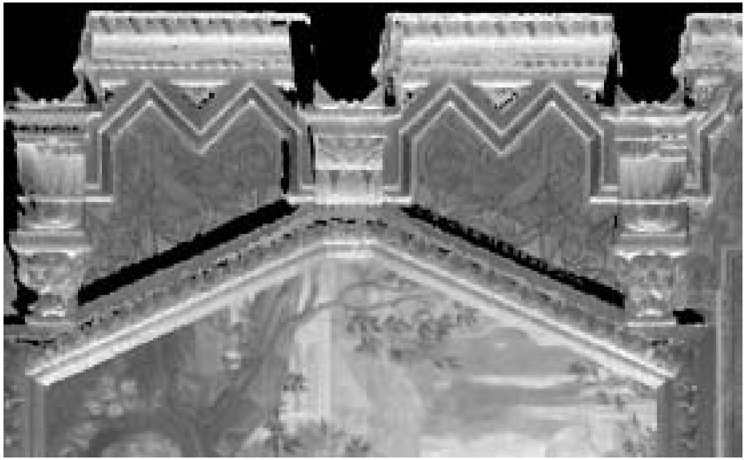
Detail from triangulation

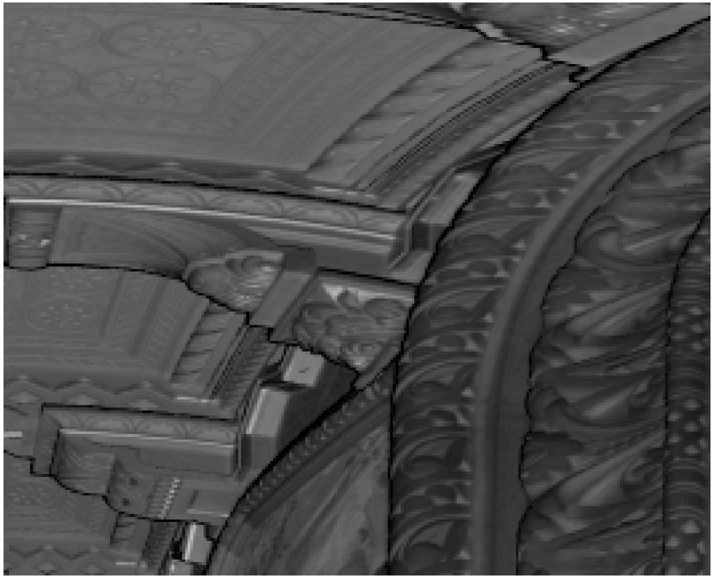
→ Smallest triangle side 20mm
→ Smallest possible triangel side 10mm

Detail from Orthoscan

→ Smallest triangle side 3mm
→ Smallest possible triangel side 3mm

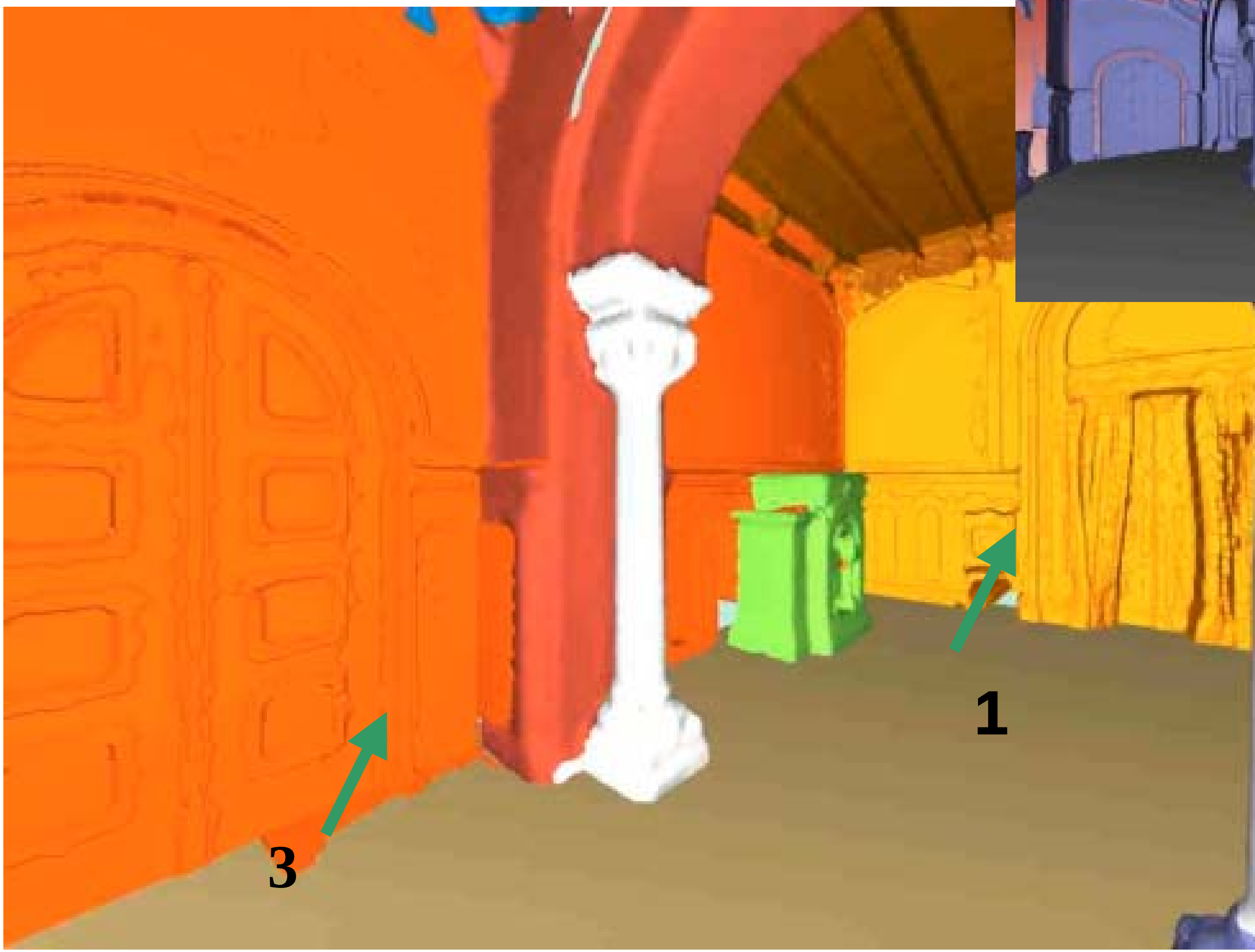
Orthoscans Restrictions





1. Orthoscans show an object only from the front.
2. At the sides therefore error in the Mesh and in the texture.
3. However the data of the sides are present in the Scans and could be insert into the Mesh later.

Orthoscans Results



The walls one and three from Orthoscans can be integrated into the Mesh.

Orthoscans Results

The Orthoscans can be texturiert with the Intensity data of the scanner or the colors of the panorami camera.

The other objects objects can be testuriert with materials in the CAD system.