

Webinar: Robots and Drones in Nuclear Decommissioning

Point Clouds and Panorama Captured by TLS (Terrestrial Laser Scanner)

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Online Webinar



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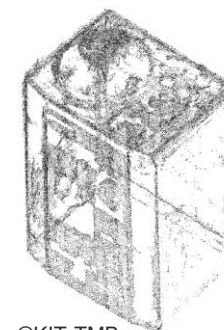
Overview of Point Cloud Data

- What is (raw) point cloud data?
 - Series of points;
 - Each point has a unique value in a coordinate system;
 - Each point can have a RGB value if the point cloud includes color.
 - Data can be visualized in different Software and allows to know the geometry of the real world;
 - Two main steps are needed:
 - Data acquisition;
 - Data processing.
 - Different parameters are to be adjusted in each step.
- Initially, in a raw point cloud data the points don't have any relationship or connection between them.



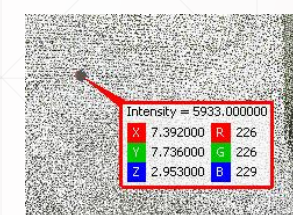
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Real world

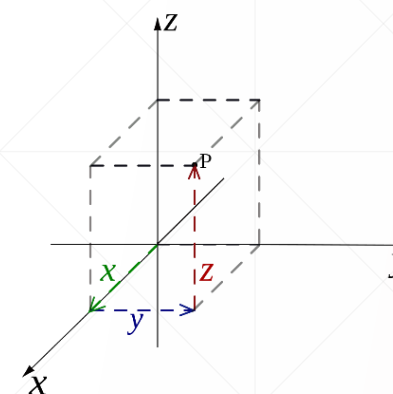


©KIT-TMB

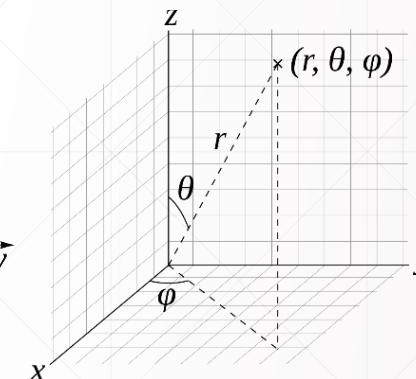
Point cloud



x	y	z
-0.068	0.151	0.038
-0.065	0.150	0.037
-0.059	0.150	0.035
-0.552	0.150	0.029
-0.073	0.152	0.036
-0.072	0.151	0.036
...	...	...
-0.026	0.486	0.130
-0.462	0.106	0.034



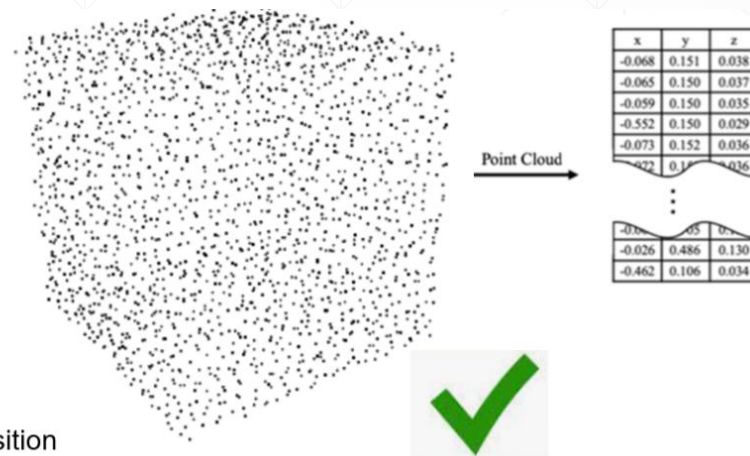
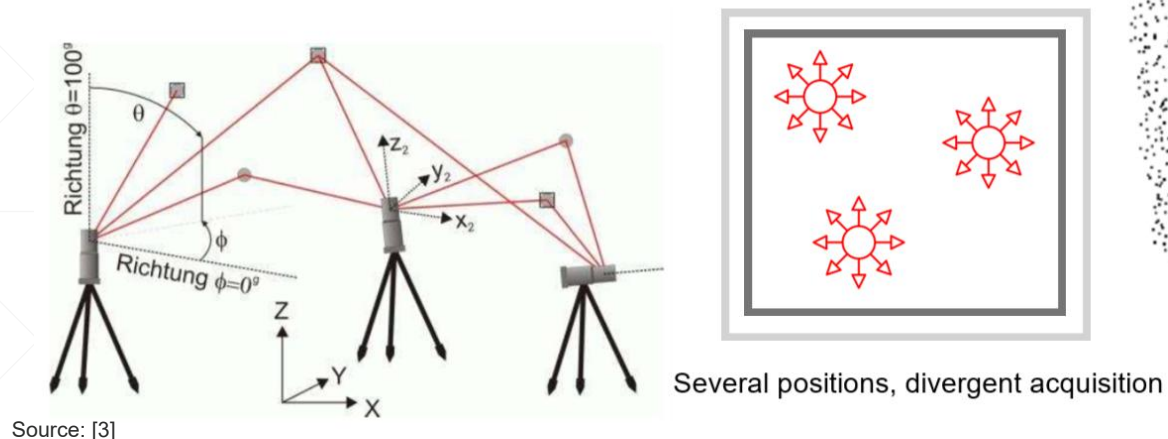
Source: [1]



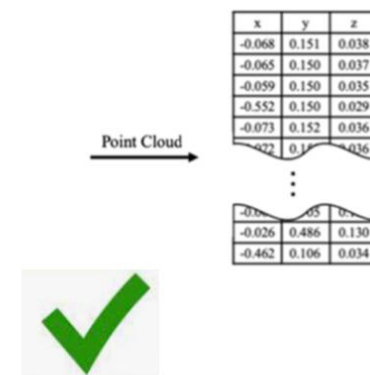
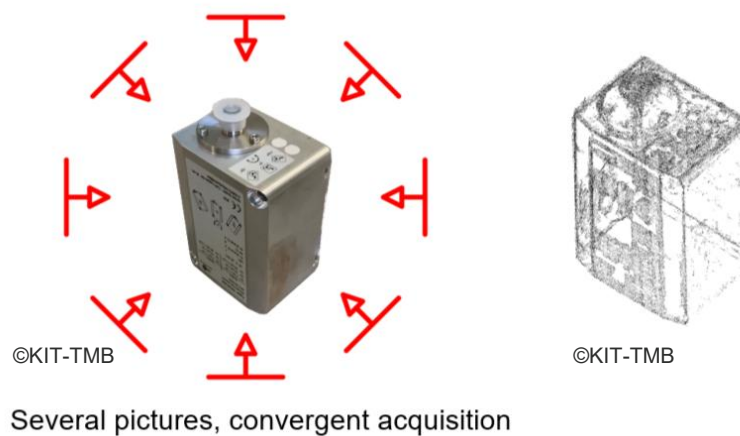
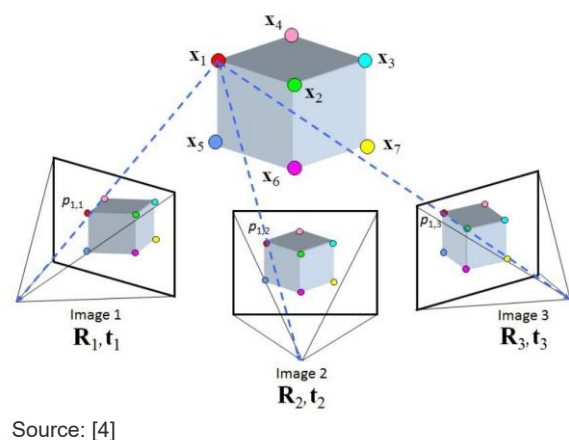
Source: [2]

Overview of Point Cloud Data

- Different methods to generate point cloud data



***LiDAR**
Light
Detection
And Ranging



***SfM**
Structure
from Motion

Data Acquisition

- Different parameters are to be adjusted, case by case depending on the context:
 - Resolution: determining the density of the point cloud;
 - Quality: number of measurements for each point;
 - Filters: removal of specific points – stray points, moving objects, etc. –, maximum range;
 - Color: captures panoramic picture;
 - HDR (High Dynamic Range): captures multiple exposures for vibrant color overlays;
-
- The duration of the scan at each position depend on the parameters → 7 – 10 minutes is acceptable;
 - For an accurate merging, each scan point must overlap with another.

Resolution	Quality	Scan time in minutes							Number of points in million	Point spacing 10m distance (mm)
		Grayscale	RGB	Speed	Night	HDR 2x	HDR 3x	HDR 5x		
1/32	4x	<00:43	<02:40	<02:29	<04:11	<04:11	<05:41	<08:42	0,7	49,1
	6x	<01:03	<03:01	<02:49	<04:31	<04:31	<06:01	<09:02		
	8x	<02:24	<04:21	<04:10	<05:52	<05:52	<07:22	<10:23		
1/20	4x	<00:54	<02:51	<02:40	<04:22	<04:21	<05:52	<08:52	1,7	30,7
	6x	<01:45	<03:42	<03:31	<05:13	<05:13	<06:43	<09:44		
	8x	<05:11	<07:09	<06:57	<08:39	<08:39	<10:09	<13:10		
1/2	1x	<04:11	<06:09	<05:57	<07:39	<07:39	<09:09	<12:10	174,8	3,1
	2x	<07:46	<09:43	<09:32	<11:14	<11:14	<12:44	<15:45		
	3x	<14:56	<16:53	<16:42	<18:23	<18:23	<19:53	<22:54		
	4x	<29:15	<31:12	<31:01	<32:42	<32:42	<34:12	<37:13		
	6x	<115:09	<117:06	<116:55	<118:36	<118:36	<120:06	<123:07		
1/1	2x	<14:56	<16:53	<16:42	<18:23	<18:23	<19:53	<22:54	699,1	1,5
	3x	<29:15	<31:12	<31:01	<32:42	<32:42	<34:12	<37:13		
	4x	<57:53	<59:50	<59:39	<61:20	<61:20	<62:50	<65:51		
	6x	<115:09	<117:06	<116:55	<118:36	<118:36	<120:06	<123:07		

* FARO scan data is not comparable with data from other manufacturers, as the manufacturers specify different parameters for determining the duration. For FARO scanners, the time from pressing the start button to finishing the scan is specified.

Source: [8]



J. Ridao (KIT) during the scan campaign. Source: [5]



Source: [6]

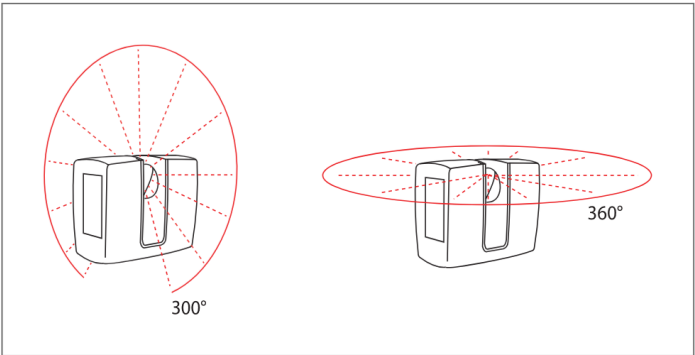
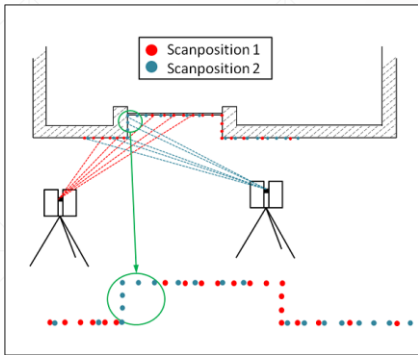
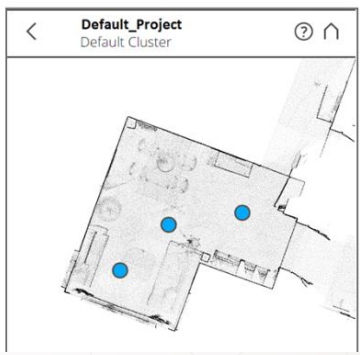


Figure 2-3 Vertical and Horizontal Rotation

Source: [6]



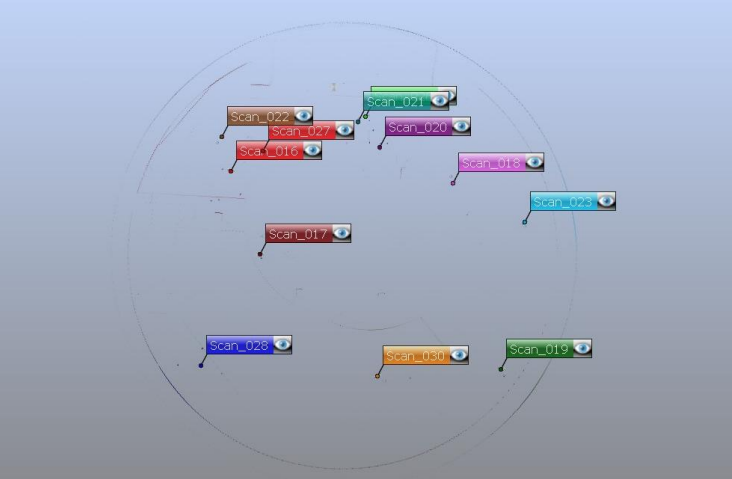
Source: [7]



Source: [6]

Data Processing

- Importing → Processing → Registration → Exporting



Position of the scans at the BR3 (Belgian Reactor 3).



Verarbeitung

13 Scans

Alle Scans in diesem Projekt wurden verarbeitet.

Scans verarbeiten

Registrierung

1 Cluster 7.7 mm

Alle Cluster sind registriert.

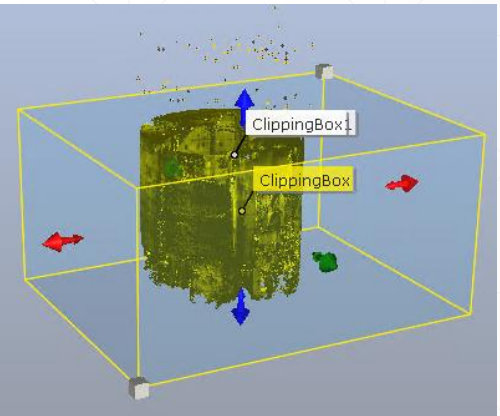
Bericht anzeigen

Projektpunktwolke

1,820,867,336 Punkte

Es wurde eine Projektpunktwolke erstellt.

Erkunden

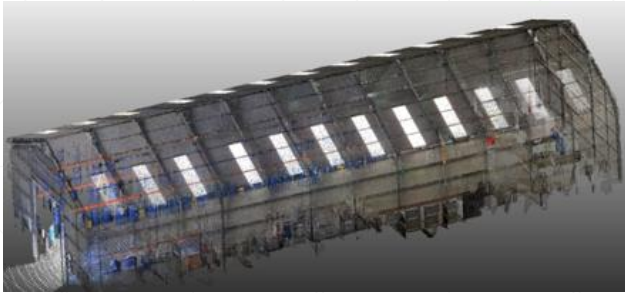


This data was acquired by KIT (Karlsruhe Institute of Technology) within the Framework of the European Project DORADO (Digital Twins and Ontology for Robot Assisted Decommissioning Operations), funded from the Nuclear Research and Training (HORIZON-EURATOM-2023-NRT-01), project #101165990. This Content must be treated as confidential, used exclusively within this Project implementation. For any Question or request, please go to the project's contact page: <https://dorado-project.eu/>

Processing of data collected at the BR3 (Belgian Reactor 3) using the dedicated software SCENE. Source [9] (<https://www.faro.com/de-DE/Products/Software/SCENE-Software>)

Some Results

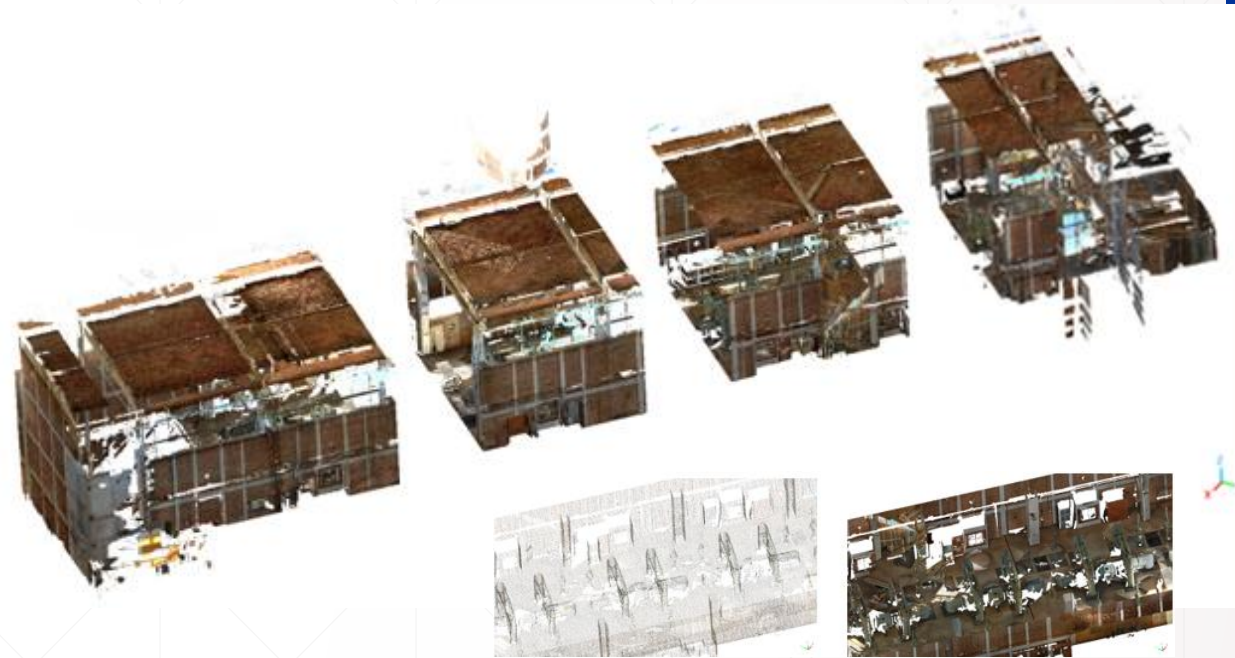
- Point Clouds



3D scan of a waste storage facility. Source: [10]



3D scan of the BR3 during a scan campaign. Source: [10]



3D scan of the BR1 (Belgian Reactor 1) during a scan campaign. Source: [10]

- Panorama Views



Panorama views in the BR3 (Belgian Reactor 3) during a scan campaign. Source: KIT-TMB [10]

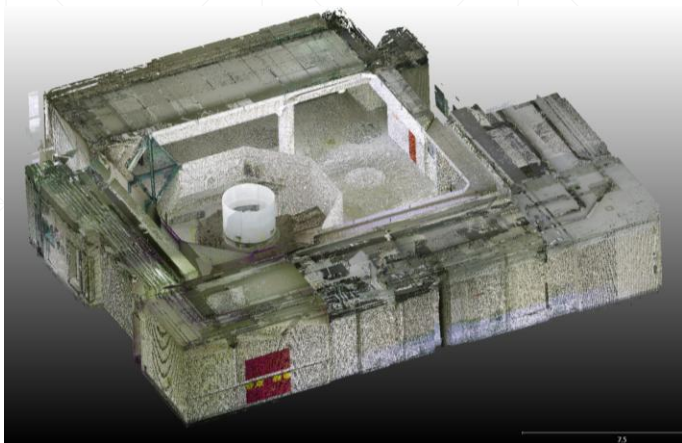


This data was acquired by KIT (Karlsruhe Institute of Technology) within the Framework of the European Project DORADO (Digital Twins and Ontology for Robot Assisted Decommissioning Operations), funded from the Nuclear Research and Training (HORIZON-EURATOM-2023-NRT-01), project #101165990. This Content must be treated as confidential, used exclusively within this Project implementation. For any Question or request, please go to the project's contact page: <https://dorado-project.eu/>

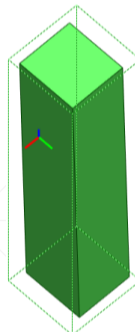
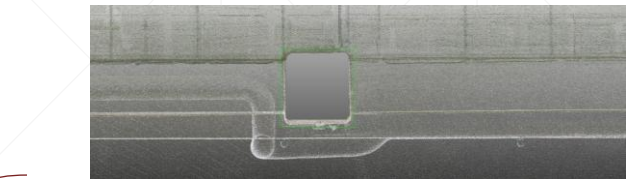
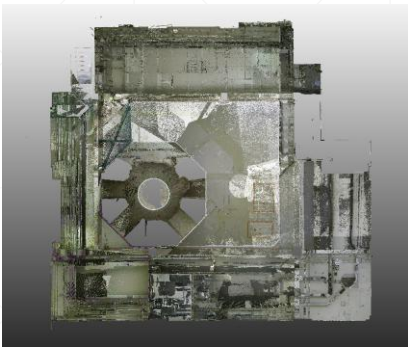
Further Steps

- Scan-to-BIM

From point cloud ...

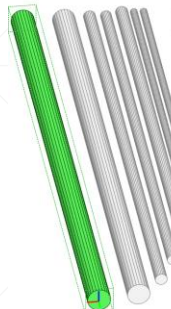
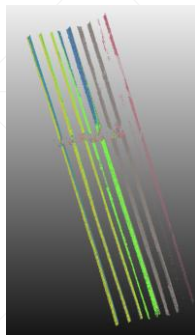
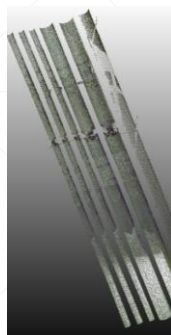


Point cloud of the Finland Reactor 1 (FiR1) provided by VTT.



IfcEntity	IfcColumn
Name	Column 1
PredefinedType	COLUMN

Columns



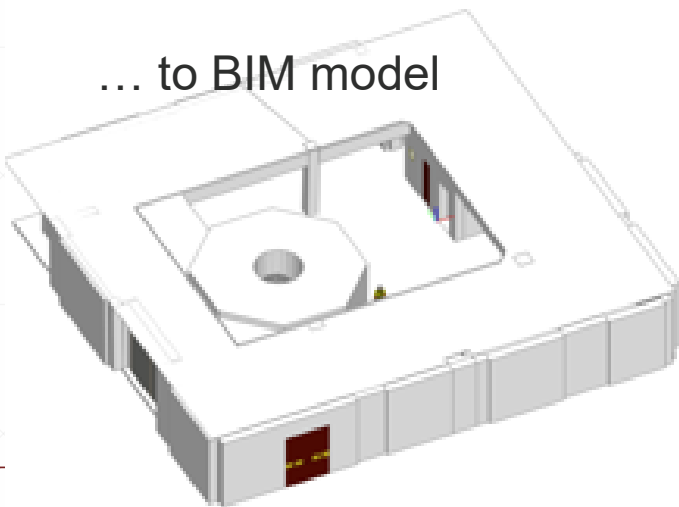
Self	Isa:EXTRUSION
Identy	Isa:EXTRUSION
Name	Part 1.2
ShapeType	Column
MaterialType	CONCRETE

Pipes

[...]

Other primitives

... to BIM model



IFC model created with 3DScanPF, KIT. Source: [10]

☒	☐ Wände
☒	☐ Bauelement Proxies
☒	☐ Rohrleitungen
☒	☐ Träger
☒	☐ Stützen
☒	☐ Andere
☒	☐ Decken
☒	☐ Elektrizität
☒	☐ Treppe
☒	☐ Bewehrung

Conclusions and Lessons Learned

- Results of the Laser scanner are quite satisfactory;
- Information is being analyzed and used to implement the tasks in the DORADO project:
 - Scan-to-BIM;
 - Change detection;
 - ...
- It can be combined with data coming from other sensors;
- Lessons learned from this site are being taken into account for future scan campaigns;
- There is always something to improve!



Members of DORADO and XS-Ability during the scan campaign. Source: [12]



Members of DORADO and XS-Ability during the scan campaign. Source: [5]



J. Ridao (KIT) during the scan campaign. Source: [5]

Sources

- [1] <https://www.wikiwand.com/de/Koordinatensystem>
- [2] <https://de.wikiversity.org/wiki/Kugelkoordinaten/Diffeomorphismus/Einf%C3%BChrung/Beispiel>
- [3] https://fgg-web.fgg.uni-lj.si/~alisc/WG5/wg5_documents/ISPRS2007_proceedings/doc/Lectures/ISPRS2007_Pfeifer-Overview_of_TLS_Systems.pdf
- [4] Ozgur YILMAZ, Fatih KARAKUS, Stereo and Kinect fusion for continuous 3D reconstruction and visual odometry.
https://www.researchgate.net/publication/269327935_Stereo_and_kinect_fusion_for_continuous_3D_reconstruction_and_visual_odometry/figures?lo=1
- [5] DORADO Project, Scan campaign, 2026. <https://www.dorado-project.eu/>
- [6] FARO FOCUS User Manual, <https://download.faro.com/ui/core/index.html?mode=public&referrer=%2Furl%2Fnnuewywdynawx2n#expl-tabl./SHARED/%211nsvFf8NQ7xMh/dua8W8UkYVZQ6oU9>
- [7] <https://www.laserscanning-europe.com/en/case-study/correctly-positioning-laser-scanner>
- [8] <https://www.laserscanning-europe.com/de/case-study/scandauer-faro-focus-s-serie>
- [9] <https://www.faro.com/de-DE/Products/Software/SCENE-Software>
- [10] KIT-TMB (3DScanPF), Scan campaign, April 2026.
- [11] Task 4.1 of the DORADO project, <https://www.dorado-project.eu/>
- [12] https://www.linkedin.com/posts/xs-ability-project_xsability-robotics-groundrobots-activity-7470044387830325248-k-77?utm_source=share&utm_medium=member_desktop&rcm=ACoAABfO8z0BhwFi3Ark7loH4vPd89aEDOat9gw

Thank you for your attention!



Questionnaire for stakeholders



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