

11-19-2019

3D Tunnel Inspection with Photogrammetric and Hybrid Systems

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Recommended Citation

Michael Mett, Heiner Kontrus, Nina Müller, and Stefan Eder, "3D Tunnel Inspection with Photogrammetric and Hybrid Systems" in "Shotcrete for Underground Support XIV", Matthias Beisler, ILF Consulting Engineers Asia, Ltd., Thailand Preedee Ngamsantikul, Thailand Underground and Tunneling Group (TUTG), Thailand Herbert Klapperich, TU Freiberg, Germany Eds, ECI Symposium Series, (2019).
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3D tunnel inspection with photogrammetric and hybrid systems

Dibit measuring technique

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November 19th 2019



Content



- Dibat Introduction
- Overview on 3D Tunnelscanning
- Tunnelscanning as part of tunnel inspections
- Tunnelscanning as part of geometrical and geological documentation during construction

Dibit Introduction



- Established: 2001
- Office Locations: Innsbruck, Austria (Headquarter) and in Bellevue, USA
- Employees: 50 Survey Engineers and Technicians
- Services: Tunnel Surveying, Monitoring and 3D Scanning
- Projects: More than 300 tunnel projects in Europe, North-America, Australia, Africa and Asia
- Scanning experiences: More than 1000 miles of tunnel scanned world wide



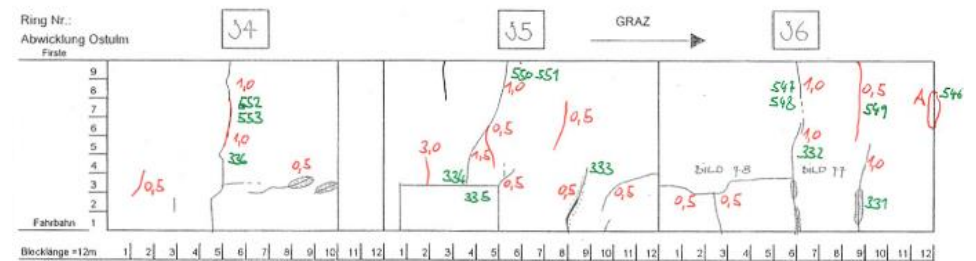
3D Tunnelscanning - Overview



- Sustainable and objective documentation of tunnel conditions
- True-color, high resolution 3D model of the tunnel surface (independant of scanning system)
- Tunnelscans for as-built documentation, inspections and during construction
- Local or global coordinate system for referenced 3D model
- Detection, measurement and mapping of any defects and tunnel components (electrical, geotechnical, geological)
- Data management in TIS (Tunnel Information System)
 - Centralized, structured database for various construction epochs or inspection intervalls
- Comparable results due to open data format (LAS, OBJ, ASCII)

Conventional tunnel inspection

- Manual Crack detection
 - No exact determination of crack location
 - Impossible to map all cracks and defects
- Disadvantages
 - Time consuming (multiple days or weeks)
 - Long tunnel shut downs
 - High personnel expenditures
 - Supporting equipment e.g. manlift



Requirement for modern inspections



- Fast data acquisition
 - Minimized shut down times
 - Minor traffic obstructions
- Objective and reasonable data
- Minimized personnel expenses
- Economic measurement system
- Short inspection intervals (e.g. every 6 months instead of every 6 years)

- Development of the new dibit High Speed Scanning System

Dibit Highspeed Scanning System



- Highspeed industrial cameras
 - Cameras: > 30 fps (frames per second) exposure time
- Special design of high-performance LED technology
- 360° scanning area
- Technical data:
 - Measurement speed: up to 50 miles/h
 - Resolution: 1 x 1 mm (1/25 inch)
- Modular construction (camera, laser-scanner, additional sensors (thermal, multispectral..))



Dibit Highspeed Scanning System



Dibit Highspeed Scanning System



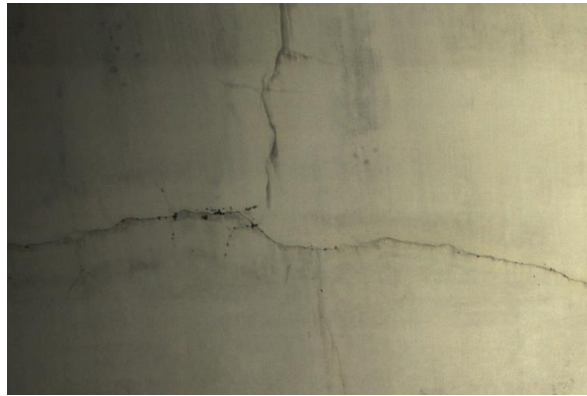
- Measurement system can be mounted on various vehicles



Dibit Highspeed Scanning System



- Up to 30 frames per second for each camera (300 fps in total)



Results



- True color 3D model
- Sub-millimeter resolution of the surface (cracks $\leq 0,3$ mm are visible)
- Tunnel inspection in a virtual surrounding
 - Manual categorization of deficiencies (cracks, spallings, etc.)
 - Referencing: locally or globally georeferenced 3D model
 - 3D-Polyline: length, area, location
 - Detection of changes from previous measurement epochs
- Semi-automated crack detection

Dibit 7 Software



■ Inspection

- Sonnenburghof Tunnel – Highway tunnel – Austria
- Seattle Railway Tunnel – USA
- Bochum – Subway tunnel – Germany

■ Rehabilitation

- Alzkanal – Water tunnel – Germany

Semi-automated crack detection



The screenshot displays a software interface for tunnel inspection. The main window shows a photograph of a tunnel wall with a vertical red line indicating a detected crack. The crack is labeled 'R-24'. A small white tag with the number '423' is visible on the wall to the right of the crack. The interface includes a menu bar at the top with options like 'Datei', 'Bearbeiten', 'Ansicht', 'Extras', and 'Fenster'. Below the menu is a toolbar with various icons. A status bar at the bottom shows coordinates: TM: 108.338 m, Abw.: -0.017 m, Prof: (SV,B,R), SV: 1447.480 m, B: 09.120 m, R: -0.017 m. A 'TD6 Navigator' panel on the right shows a tree view with 'Fenster\Tunnel\Interface\La' and 'R-24' selected. Below the tree is a table with the following data:

Name	
Tunnel-Abdruck	Pejerku
Tunnel	
Tunnel-Datenbank-Interface	
Objektmodell-Version	2011.0
Objektmodell-Udatum	2011.10

Below the table is an 'Attributgruppe' field. At the bottom right, a cross-section diagram of a tunnel is shown, with a green line indicating the position of the crack. The diagram has a vertical axis and a horizontal axis. The text 'Bereich von 000107 bis 000112' is visible at the bottom right of the interface.

Results - reports



Bochum Metro A/B Line

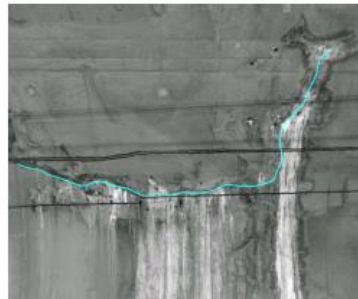
Follow up Inspection 2011

Inspection Photo 2001



Comments

Crack in Crown



Scanner Inspection 2001



Scanner Inspection 2011

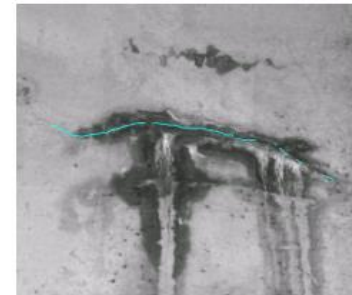
Condition Analysis Inspector:

Bochum Metro A/B Line

Follow up Inspection 2011

Deficiency Name **RF_B/GL1_2001-0004**

SyncID T0cen2BbTAapwfAPNCTgvA==
Position 3D 85800,8200; 6547,0960; 101,2970
Station/BL/R 1115,4918; 3,4942; -0,0285
Length 1,5970
Surface Area 0,0000
SSR - Length 0,0000
SSR - Width 0,0000
SSR - Surface Area 0,2380
SSR - Circumference 3,3380
SSR - Rotation 0,0000
Width 0,4000
Depth 0,0000
Degree of Leakage Damp
Sediment Heavy
Identified 0
Inspector Kuno, Dipl.-Ing. Norbert
Inspection Date 20001001
Comments Crack on Wall



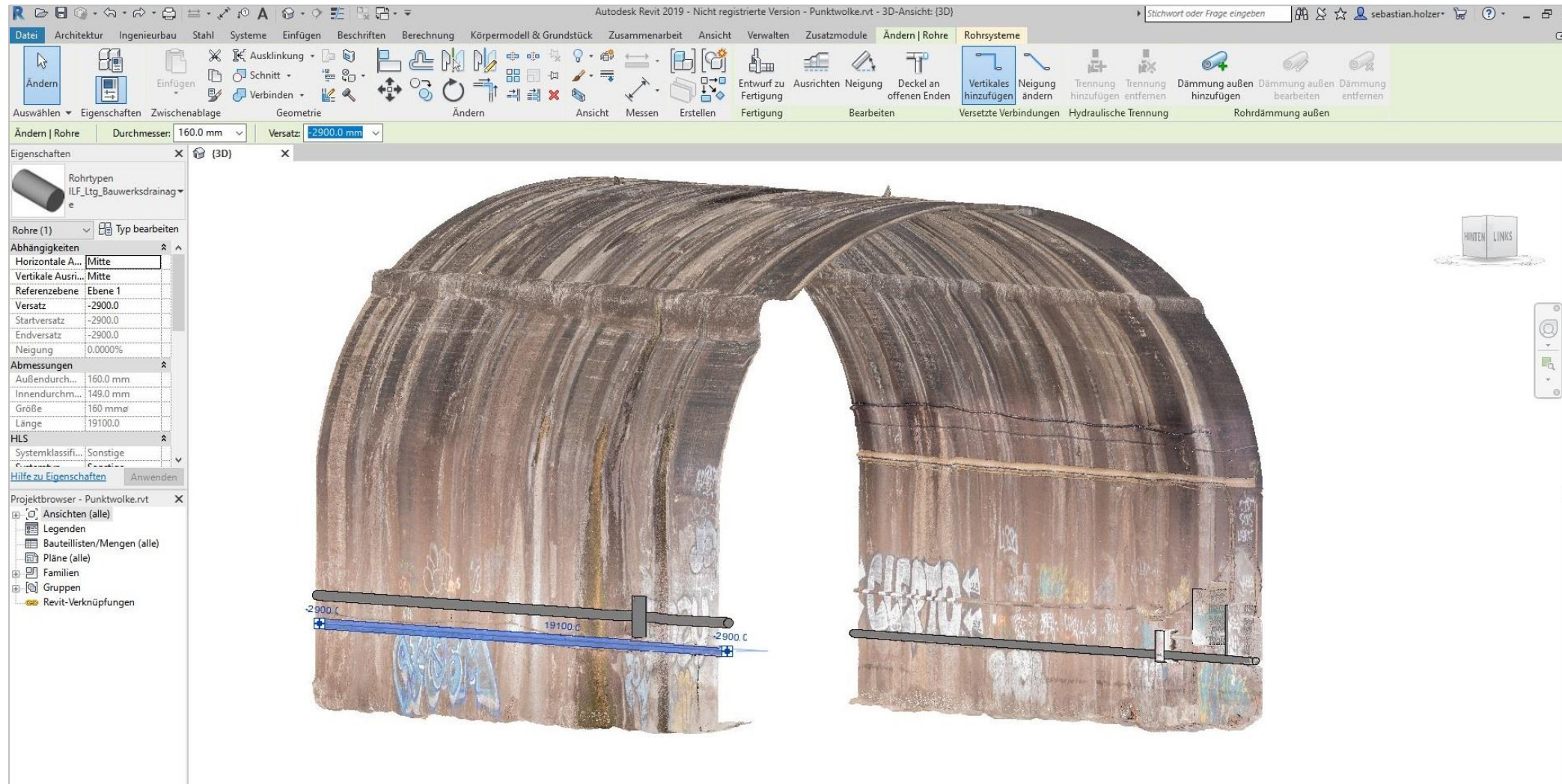
Scanner Inspection 2001



Scanner Inspection 2011

Condition Analysis Inspector:

BIM for Tunnels



Advantages

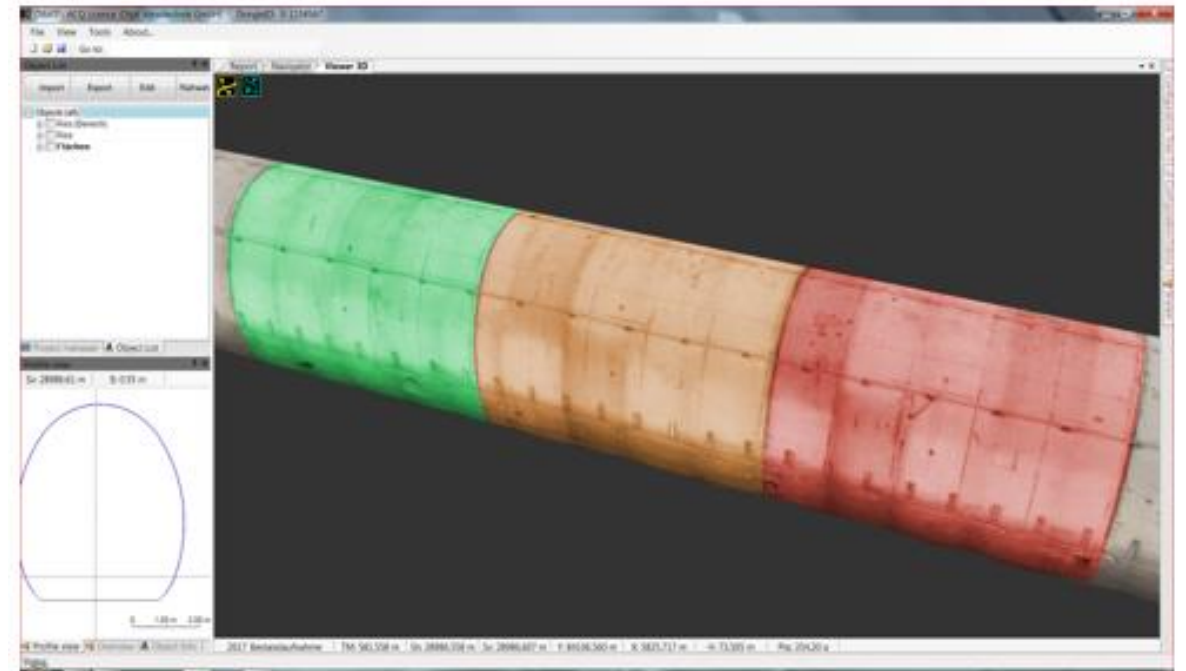


- Short shut down times of tunnels
- Compliance with safety standards due to periodically monitoring of tunnel constructions
- Monitoring and comparison of surface-changes over time
- Inspection and mapping of defects with categorisation in a TIS-Database
- Semi-automated crack detection up to 0,3 mm
- Automated generation of reports and plots

Outlook



- Fully automated detection of defects, e.g. cracks
- Statistical analysis of tunnel parameters over time
- Implementation of multi / hyperspectral sensors (thermal properties, recognition of material (concrete, steel, asphalt, etc...))
- Interface between TIS (Tunnel Information System) and BIM (Building Information Modeling)



Thank you for your attention

