11-19-2019

3D Tunnel Inspection with Photogrammetric and Hybrid Systems

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3D tunnel inspection with photogrammetric and hybrid systems

Dibit measuring technique

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November 19th 2019

Content

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

Dibit Introduction

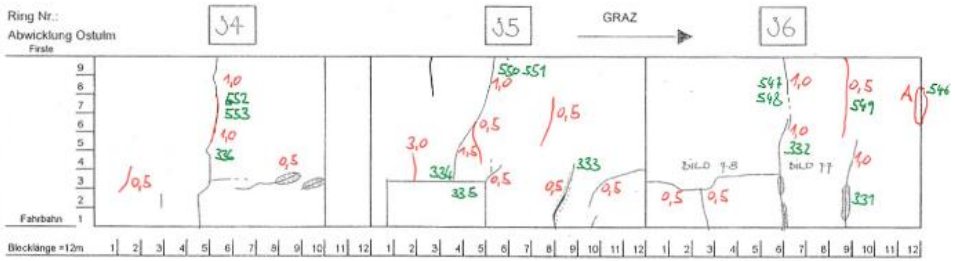
- Established: 2001
- Office Locations: Innsbruck, Austria (Headquarter) and in Bellevue, USA
- Employees: 50 Survey Engineers and Technicians
- Services: Tunnel Surveying, Monitoring and 3D Scanning
- Projects: More than 300 tunnel projects in Europe, North-America, Australia, Africa and Asia
- Scanning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

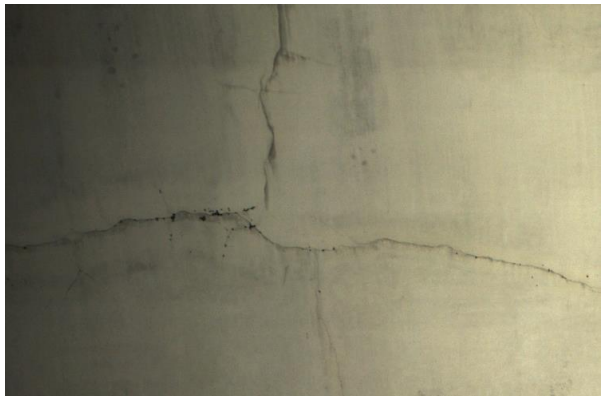
Dibit Highspeed Scanning System

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 ≤ 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

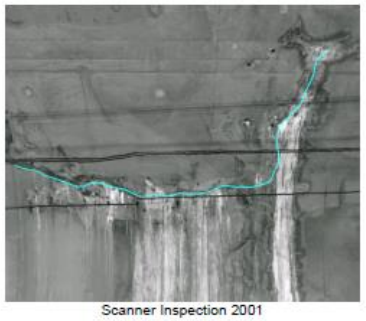
- Inspection
  - Sonnenburghof Tunnel – Highway tunnel – Austria
  - Seattle Railway Tunnel – USA
  - Bochum – Subway tunnel – Germany
- Rehabilitation
  - Alzkanal – Water tunnel – Germany

Semi-automated crack detection

Results - reports

Inspection Photo 2001

Comments Crack in Crown



Scanner Inspection 2001

Scanner Inspection 2011

Condition Analysis Inspector:

Deficiency Name **RF_B/GL1_2001-0004**

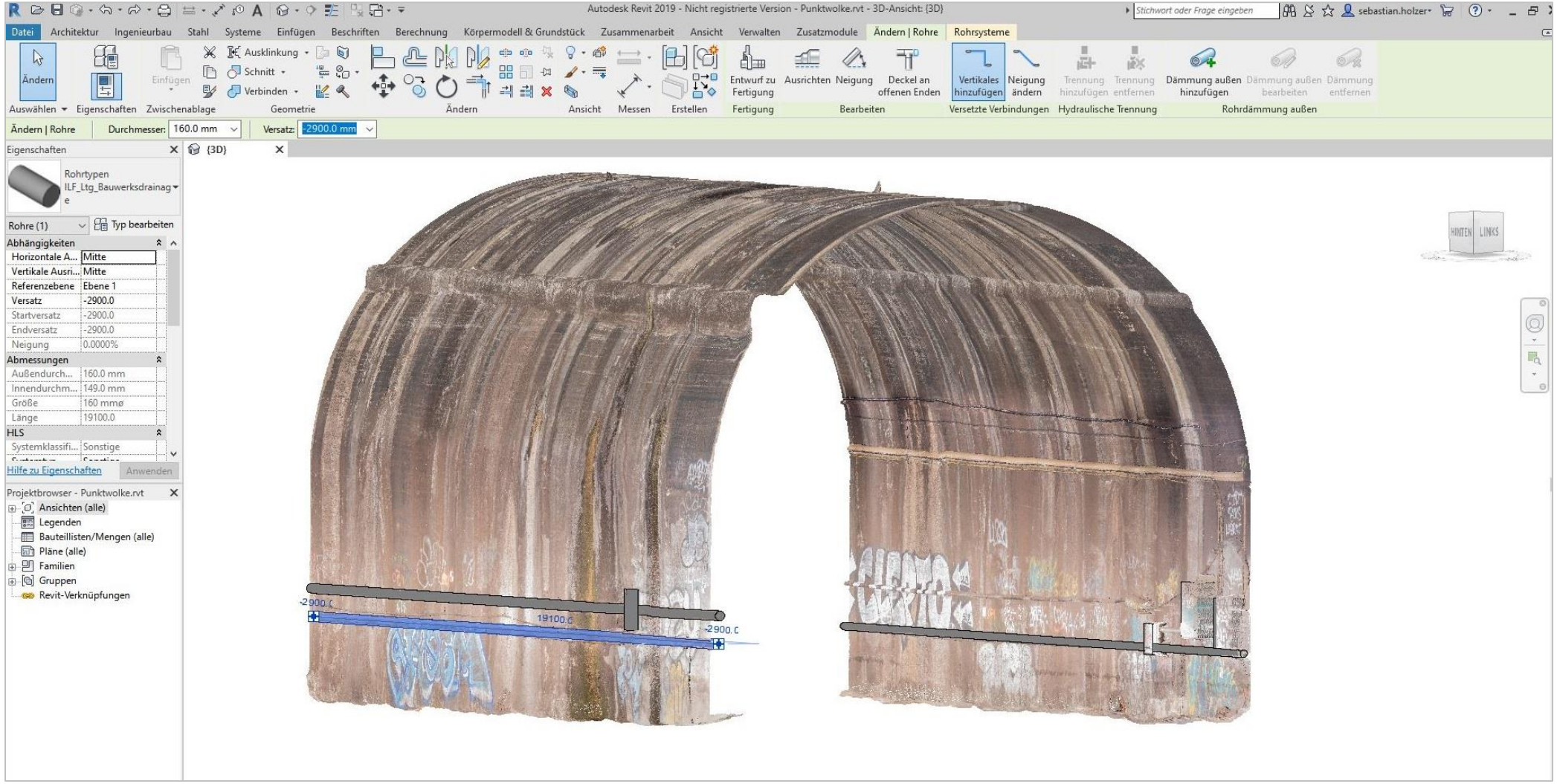
SyncID	T0oen2BbTAapwfAPNCTgvA==
Position 3D	85600,6200; 6547,0960; 101,2970
Station/BL/R	1115,4918; 3,4942; -0,0285
Length	1,5970
Surface Area	0,0000
SSR - Length	0,0000
SSR - Width	0,0000
SSR - Surface Area	0,2380
SSR - Circumference	3,3380
SSR - Rotation	0,0000
Width	0,4000
Depth	0,0000
Degree of Leakage	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

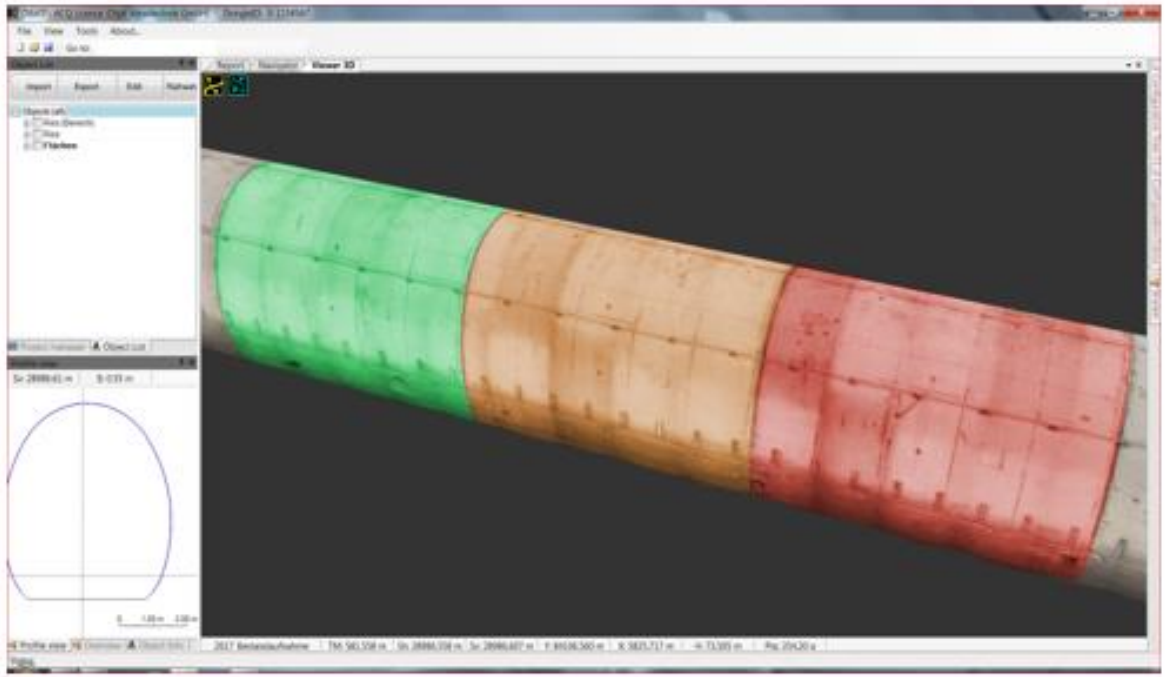


Advantages

- 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 porperties, recognition of material (concrete, steal, asphalt, etc…)
- Interface between TIS (Tunnel Information System) and BIM (Building Information Modeling)



Thank you for your attention