3D Tunnel Inspection with Photogrammetric and Hybrid Systems

Michael Mett
_Dibit Messtechnik GmbH_

Heiner Kontrus
_Dibit Messtechnik GmbH_, heiner.kontrus@dibit.at

Nina Müller
_Dibit Messtechnik GmbH_

Stefan Eder
_ILF Consulting Engineers_

Follow this and additional works at: https://dc.engconfintl.org/shotcrete_xiv

Part of the Engineering Commons

Recommended Citation

This Abstract and Presentation is brought to you for free and open access by the Proceedings at ECI Digital Archives. It has been accepted for inclusion in Shotcrete for Underground Support XIV by an authorized administrator of ECI Digital Archives. For more information, please contact franco@bepress.com.
3D tunnel inspection with photogrammetric and hybrid systems

Dibit measuring technique

Dr. Michael Mett (Head of Research and Development)
Dipl.-Ing. Heiner Kontrus (CEO)

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 (independent 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 intervals
- 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
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