Digital rock mass characterization 2017
Where are we now? - What comes next?

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Digital rock mass characterisation
Conventional tunnelling
In the last century...

Can we improve the way for geological mapping on tunnelling sites?

Issues
- Physical access
- Time constraints
- Number of measurements
- Safety
Technology

- Stereoscopic images
- Surface reconstruction
- Software for assessments
Approach

- Digital images + Software
Approach

- Stereoscopic display
Datenerhebung in der Ingenieurgeologie

Eine Verbesserung der Methodik zur Erfassung von geotechnischen Gebirgsparametern

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„Der Geologe gehört an die Brust!“
2005

ShapeMetriX 3D

Digital rock mass characterisation

Conventional tunnelling
Current practice

- Data acquisition by taking photos
  - Off-the-shelf camera
  - Tripod
  - Lights (instead of flash)
  - Reference elements

- Regular application
- Processing: off site
Current practice

- Documentation

Safe

Comprehensive

Quick
Measurements

- 3D Measurements
- Orientation, Areas, Volumes
Assessment

- Joint Sets
- Spatial variations
Assessment

- Spacing (normal, apparent, set)
Several data base systems
Summary: Current practice

- **3D images and assessments**
  - Used on major tunnelling sites
  - On regular basis

- **Provides**
  - *Objective* documentation
  - Reproducible characterization

- **Important attributes**
  - Does not replace geologists on site
  - Allows spending more attention to other than geometric phenomena
2016

ShapeMetriX TBM

3D images for hard rock TBM tunnelling
Autonomous imaging unit

- LED lights
- Rugged
- Water resistant
- Smartphone controlled
TBM Imaging

- Imaging unit installed at inspection opening (diameter: 60 cm)
Results

**Video** – field of view depends on the location of the cutter head
Video processing

- Extract frames upon optical flow
- Run SfM pipeline
- Add scale & orientation
Results

Ortho-photo
- Sub-mm resolution
- Constant image scale
- Planar measurements
Results

3D image – several camera mountings
Results

- Permanent documentation
Results

- Quantification of overbreak exceeding a specified limit
  - Definition of a cut-off plane (distance from face)

Area behind cut-off plane (exceeding 10 cm overbreak)
Planarity

- Visualisation of overbreak
  - Each interval refers to 10 cm (configurable)
Geological mapping

- Fracture analysis
  - Software from conventional tunnelling
Small scale surface analysis

- Disc penetration

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Extensions

Mapping using a tablet computer
Tablet Mapping

- Instant WIFI transfer from camera to tablet computer
- Mapping on tablet computer

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Tablet Mapping

- 2D structure map generated on site by geologist
structure map imported on 3D image
Tablet Mapping

- Structures grouped into clusters (algorithmically)
Extensions
Automatic analysis
Automatic detection of joint planes

- Analysis of surface normals
- Density plot of surface normals
Automatic detection of joint planes

- Colourisation of similar orientations
Automatic detection of joint planes

- Assignment to areas
- Stereographic projection of joint set orientations
Automatic detection of joint planes

- Rearrangement: fuzzy k-means clustering
Automatic detection of joint traces

Source: A. Buyer, TU Graz
A little glimpse to the future

Videogrammetry
Videogrammetry

- With small rugged off-the-shelf cameras
Videogrammetry
Videogrammetry
A little glimpse to the future
Augmented reality
Using mixed reality devices

- Display artificial contents in context of the real surrounding
- Device contains a complete computer

Source: Microsoft, CNET
Using mixed reality devices

- Display 3D models

Source: Robotic Eyes
Using mixed reality devices

- Tunnel face in the office
- No photomontage but real screenshot from AR smartphone
Using mixed reality devices

- Multiple possibilities for enhanced data display
  - Share characterization data
  - Displacement monitoring
  - Information on built-in components
  - Hazardous blocks
  - Stress data
  - Shotcrete thickness

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Finally

- Different tools

Don’t worry!
Will not replace geologists on site

Questions?
Find us at booth #6