



Introduction to Coltop3D

Client presentation by Thierry Oppikofer, Clément Michoud & Richard Metzger, © 2021

Coltop3D is a powerful software to measure the orientation of discontinuities related to highresolution 3D point clouds



- Full featured software for structural geological analysis of 3D point clouds
- Designed for the interactive and expert-based analysis of geological structures at local and regional scale
- Can handle high-resolution LiDAR or photogrammetric 3D point clouds and digital elevation models
- Optimized for data visualization and processing of huge point clouds
- Structural analysis and various applications in different domains:
 - Structural geology
 - Natural hazards
 - Mines and quarries
 - Civil engineering
- Main assumptions for remote structural analysis:
 - Rock surfaces are shaped by discontinuities in the rock mass (bedding, schistosity, joints, fractures, faults...)
 - The orientation of rock surfaces equals the orientation of discontinuities

- High-resolution LiDAR or photogrammetric 3D point clouds and digital elevation models as input data:
 - Coltop3D can import plain ASCII text files as point cloud datasets, which contain at least the X, Y and Z coordinates of each point (vertex) and possibly additional information such as the signal intensity or color information.
 - The point cloud importation is very flexible, and there are no constraints on the way data should be organized in the input file.
 - Coltop3D can also import regular grids, such as digital elevation models (ESRI grids, ASCII grids and other formats are supported).
- Export of point clouds to third party software can also be completely customized
- Runs on Windows OS



• The point cloud can be displayed with many different coloring schemes





Example of color rendering modes currently implemented in Coltop3D.

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Coltop3D principles and concepts

- The main feature of Coltop3D is the unique orientation-specific coloring of point clouds. Indeed, Coltop is the acronyme for COLor TOPography.
- Coltop3D computes the spatial orientation (i.e. dip direction and dip angle) of each point with respect to its neighboring points.
- Display using a unique color for each spatial orientation:





Classical representation of slope angle OR slope aspect vs. the Coltop3D representation combining slope angle AND slope aspect (figures: M. Jaboyedoff)

Coltop3D principles and concepts

- Efficient data management for huge 3D datasets
- Spatial indexing based on octrees:
 - Spatial index based successive division of the overall bounding box into 8 equal subregions until only a minimum number of points is contained in each subregion
- Advantages of octrees:
 - Allows for fast localization of points within a given region
 - Low consumption of RAM
 - Minimization of hard drive access



Illustration of the spatial indexing using octrees: a) first order octree; b) second order octree; c) original TLS point cloud (Jaboyedoff et al. 2007).

Example 1: structural analysis

• Remote characterization of discontinuities in inaccessible rock walls





Structural analysis of discontinuities in a rockfall-prone and inaccessible cliff using Coltop3D with a TLS point cloud (after Derron et al. 2011)

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Example 2: structural-geological mapping

• Structural-geological mapping in Coltop3D: example of the Dents-du-Midi limestone massif in the Swiss Alps.





Matasci, B. et al. (2015) Geological mapping and fold modeling using Terrestrial Laser Scanning point clouds: application to the Dents-du-Midi limestone massif (Switzerland). European Journal of Remote Sensing, 48, 569-591.

Example 2: structural-geological mapping

• Structural analysis of folds in Coltop3D: example of a fold hinge in the Dents-du-Midi limestone massif in the Swiss Alps.





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Example 3: natural hazards & rock slope engineering

 Engineering geological analysis of a large rockfall (Ia) and an unstable wedge (II) in an active quarry: Arvel limestone quarry, Switzerland





Example 3: natural hazards & rock slope engineering

 Engineering geological analysis of a large rockfall (1a) and an unstable wedge (II) in an active quarry: Arvel limestone quarry, Switzerland



Pedrazzini, A. et al. (2010) Assessment of rockslide and rockfall problems in an active quarry: case study of the Arvel quarry (Western Switzerland). ISRM International Symposium - EUROCK 2010, 15-18 June 2010, Lausanne, Switzerland

Example 3: natural hazards & rock slope engineering

- Measuring the orientation of major discontinuities on the point cloud in Coltop3D provides the required input data for kinematic analysis
- The slope aspect and slope angle of the topography can also be measured in Coltop3D
- Remote measurements in Coltop3D are more cost-efficient and safer than field measurements
- Good match between Coltop3D and field measurements
- Supports assessment of stability (safety factor)
- → Future versions of Coltop3D will include advanced stereonets that allow for kinematic feasibility tests directly in Coltop3D.





Pedrazzini, A. et al. (2010) Assessment of rockslide and rockfall problems in an active quarry: case study of the Arvel quarry (Western Switzerland). ISRM International Symposium - EUROCK 2010, 15-18 June 2010, Lausanne, Switzerland

Example 4: regional digital elevation model analysis

Once imported, a digital elevation model will be treated as a point cloud within Coltop3D.
→ Visualize in 3D → Zoom, rotate, translate
→ Change color scheme

 \rightarrow Make selections



Example 4: regional digital elevation model analysis

• Major structures shaping entire slopes often match discontinuity sets





Summary

- Full featured software for structural geological analysis of 3D point clouds.
- Optimized for 3D visualization of huge point clouds from high-resolution LiDAR or photogrammetric 3D point clouds and digital elevation models.
- Various color schemes, including the unique orientation-specific coloring combining slope aspect and slope angle.
- Local slope orientation computed for each point with respect to its neighboring points.
- Designed for the interactive analysis of geological structures at local and regional scale.
- Structural analysis and various applications in different domains:
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