Course: TERRA Summer School – Module II – Remote Rock Mass Characterization

Exercise: Remote Rock Mass Mapping Exercise

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Computer assisted mapping of planar fractures

Background

CloudCompare (CC) is an open-source 3D point cloud computing software. It can process files from laser scans as well as from photogrammetry. The 3D models created in RealityCapture are then post-processed in CC. There are many different algorithms in CC which can be used for various purposes.

1. Projections
2. Registration
3. Distance computation
4. Geometric features estimation
5. Segmentation etc.

CloudCompare can support the following formats e.g.,

- BIN
- ASCII
- PLY
- OBJ
- LAS and LAZ clouds
- FBX

The scanned photogrammetric 3D models of the rock face are processed in CC to analyze the planar structures with compass plugin. This provides a simple way to extract the discontinuity sets and their orientation.

Objectives

1. Understand the basic GUI of CC.
2. Perform simple measurements on point cloud like point picking and distance measurement.
3. Learn the use of the segmentation tool to crop a certain part of the rock face.
4. Use the compass plugin tool to map the planar structures.
5. Perform cross sections of the rock face and other geometric features estimation.

Dataset

3D model (textured mesh + point cloud) of the tunnel wall section 30-40 from tunnel 8. Download the ‘E04. Dataset.bin’ dataset from Aalto OpenLearning.

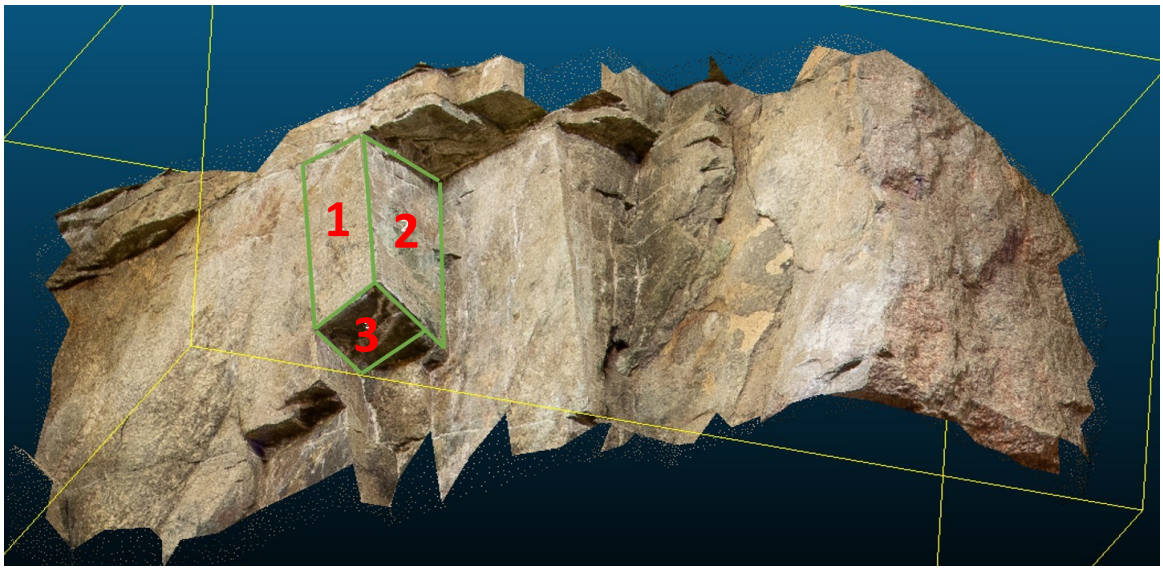
Instructions

1. Open CC and load the dataset. Open CC and then import the BIN file (‘E04. Dataset.bin’) from the Aalto OpenLearning. File -> Open or click on the folder icon and import the file.
1. Once the BIN file is loaded. There will be two separate files in CC. One will be the point cloud and the other will be the mesh. The actual measurements are made on the point cloud while the mesh provides visuals.
2. You can rotate the model by holding LMB and rotating the mouse. Pan the view with RMB. Zooming is done by scrolling.
3. Clone the source files by clicking on the icon. Do all the analysis on the cloned files and keep the source files intact.
4. Segment the model to create a mapping window. Since the point cloud itself can be a large file and there are many fracture surfaces, so it’s important to segment (crop) the scene of interest from the cloned model and perform analysis on that small point cloud.

5. Rotate the model to see the area of interest.
6. Select both the cloned mesh and the cloned point cloud in the DB Tree (left) so their names are highlighted in blue.
7. Use the interactive segmentation tool to crop the following section from the rock face. While in this mode, use rectangular selection tool and Segment In the selected area. You should now see additional files in the DB Tree on the left. The

remaining geometry that was cropped out, and the segmented geometry that should be currently selected. Investigate the files and make sure you segmented correctly. Enable only the mapping window mesh (.part) and point cloud (.segmented).

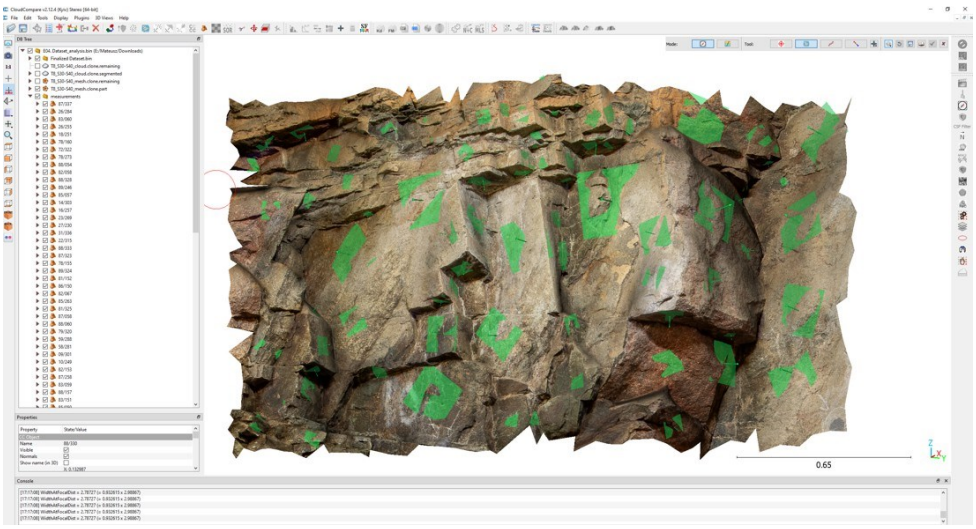
8. Fracture orientation measurements. With the segmented mapping window ready, let's first start by measuring the 3 fracture planes indicated in the image below:



9. Set the view mode to centered perspective (F3 or Display -> Toggle centered perspective)
10. Select the point cloud.
11. Use the compass plugin (Plugins -> Compass or click on the compass icon from the right side of the screen)
12. The compass mode will turn on and then select plane tool .
13. Rotate the model so that the planes are clearly visible in the center. Measure the three fracture planes. It's vital to adjust the size of the circle according to the fracture plane, so that every point inside the circle lie on the plane and not outside of it. Use ctrl + mouse wheel to increase or decrease the size of compass circle.
14. Let's verify that you have measured correctly. Check if your results are close to the following results:
    - Fracture 1: 87/337
    - Fracture 2: 83/60
    - Fracture 3: 26/285

15. If measured correctly, you can proceed to measure each planar feature in the cropped segment of the tunnel wall. Remember to use a structured approach, for example start from top left and moving right measure each surface and then repeat for all areas below. Try not to miss the small surfaces (remember you can adjust the sampling circle size by ctrl+scroll)

16. Finally, your results should look somewhat like this:



17. After completing all measurements, save the results into .csv file (compass plugin -> Export interpretation and measurements)
18. Also take a screenshot of the results (Display -> Render to file)
19. You can also compute the surface density of the point cloud (select the point cloud -> Tools -> Other -> Compute geometric features). Check surface density and use 0.03 m local neighborhood radius.