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Software used to extract discontinuity sets from point clouds

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Abstract

Slope failure has always been a problem for geotechnical engineers. Rockfall is a widely seen natural disaster in mountainous terrain. Rock slope stability is mainly controlled by fractures. Accurate modelling the rockfall event is crucial to lessen the damage came from the rocks. Traditional compass method is time-consuming and dangerous at steep slopes. Remote sensing techniques such as photogrammetry and laser scanner are new techniques to obtain geotechnical data. Geospatial information of the object can be obtained easily. This data contains 3D coordinates with color and intensity information. In this study, we have revealed the software that can automatically detect and extract geotechnical data from point clouds. Discontinuities in the rock mass can be easily obtained with high accuracy and precision with these software packages.

Introduction

Mass movements contribute to reshape the geomorphology of the Earth surface. They damage the forest area, farm area, transportation corridors, houses and people life. In order to prevent harmful effects of mass movements, engineering geologists need to model the terrain with high accuracy and resolution.

Steep slopes are prone to failure with a small change on forces acting on them. Therefore, these areas need to be analyzed carefully. Detached rock fragments may fall extremely fast. Potential energy will transform into kinetic energy during falling.

Traditional geomechanical surveys are often carried out on limited sectors of the rock mass. Therefore, they do not provide enough data for a complete reconstruction of the rock mass [1]. Most of the steep slopes are inaccessible. Traditional geological surveys are not possible in steep terrain or heavily fractured rock masses [2]. Recent advances in remote sensing technologies allow automatically detect the discontinuity sets (DS) and minimize survey time in dangerous environments.

In order to examine the rockfall event, factors, models, software and DEMs are critical in rockfall modelling as they are related with each other [3]. Topographic maps were popular sources from time immemorial to produce Digital Elevation Maps (DEM). However, they have low accuracy and are not actual. Nowadays, remote sensing techniques are used to generate DEM.

Unmanned aerial vehicle (UAV) and Light Detection and Ranging (LiDAR) are very popular remote sensing equipment that have been used in engineering projects since last decade. Data obtained from UAV and LiDAR are 3D coordinates that include intensity and color information of the object. Small details can be monitored in 3D model. Direct access to the rocks does not need in remote sensing techniques. Rock mass characterization can be performed with high-precision.

International Society for Rock Mechanics and Rock Engineering (ISRM) selected the following ten parameters orientation, spacing, persistence, roughness, wall strength, aperture, filling, seepage, number of sets, and block size [1].

This study focused on the collection of scientific papers related with discontinuity set extractor programs. DS is crucial in rock engineering applications [4].

Discontinuity sets

In rock mass classification, two popular methods, Q and RMR classifications, have been used. Discontinuity set properties are important input parameters for these classification systems. Intact rock is rarely seen, most of the rocks contain one or more discontinuity.

Discontinuities are used in rock engineering projects such as rockfall studies, mining and tunneling. Rockfall event is prevalent on rocky terrain and it threatens people life and structures. Discontinuities play a significant role in strength, permeability and stability of rock masses. Therefore, precise measurement of discontinuities (dip and dip direction) is vital in rock engineering applications [4].

In recent years, collection geotechnical data on-site has evolved to collect data using remote sensing [5]. Remote sensing provides several possibilities for landform analyses. Structural and geological features can be extracted from 3D point clouds. High density 3D point cloud export more detailed outcomes for capturing morphology and extracting discontinuity sets.

Kinematic analysis using dip and dip direction information of discontinuities, which were obtained from 3D point clouds, may be performed more beneficial than classical compass methods.

Software packages

Today, there are many software packages that can extract dip and dip direction properties from point clouds (Table 1). These software packages can easily detect DS in rocks using three-dimensional (3D) point clouds obtained from UAV and LiDAR.

Using dip and dip direction, rockfall type (wedge, planar and toppling) can be determined. Therefore, the area that can be affected from rockfall disaster will be identified and the precautions can be taken.

Table 1. Software used to extract discontinuity sets

Software	Reference
Matterocking	[6]
DSE	[7]
ShapeMetrix 3D (3GSM GmbH	[8]
Sirovision (Datamine and CSIRO)	[9]
Split-FX	[10]
Coltop-3D	[11]
Plane Detect	[12]
RockScan	[13]
3DM Analyst	[14]
CloudCompare	[15]
DiAna	[1]

Conclusion

Discontinuities such as joints, bedding planes and fractures play vital role in rock engineering. Geo-structural analysis of rock mass discontinuities is vital to propose a solution. Discontinuity orientation determines the falling type and the consequences of rockfall. Traditional methods require direct access to the rockmass. Remote sensing technology solves the problem of reaching inaccessible areas. Classical compass method requires skilled geoscientist and it has error-prone. The automatic discontinuity extractor software eliminates this need. High density of point clouds can enable the reconstruction of the rocky surface. Characterization of rockfall dynamics can be easily performed via using point clouds.

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