Study of ICP analysis of LiDAR using UAV laser measurement of surface slope collapse

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1. Introduce

In slope disasters that increase in recent years, rock falls from steep slopes are reported to occur even if they are not extracted to the inspection site.There are many places and it is extracted to a hazardous place. The monitoring the real time by extensometer or tilt sensor to measure directly is high expensive. And, it is difficult to observe the rock falls and surface slope collapse with the conventional equipment such extensometer in terms of cost and labor, and therefore the development of new slope monitoring approaches has been expected.This paper also presents the applicability of our proposed method with an actual example of measurements for surface slope collapse.

2. Outline of study area

Study area is located in the western part of Shizuoka Prefecture in Japan. The maximum size of the mass is 200 meters in width, 250 meters in length, 70 meters in height. The average slope angle is 40 degrees. There is a steep cliff of the pelitic schist at the top, and the talus deposits is partially found bottom part of the slope. From the results of micro topographical interpretation and field survey, the gravel size is mainly composed of 10 ~ 50 cm in diameter, but it is big ones and it reaches 2 m and falls from the upper steep cliff rock part and deposited. The gravel didn't stick the moss and a talus deposits does not cover of vegetation and that collapse is still progressing. The measurement of surface of talus deposits is difficult, because it cannot accurately capture shapes and compare. UAV laser measurement was carried out by Nakanihon Airservice Co., Ltd. twice in June and December in 2016. The specifications are shown in Table 1, and the accuracy of measurement data is shown in Table 2.

3. Method

In laser measurement, ground data filtered from original data is a DEM (Digital Elevation Model) which removes influences such as vegetation. However, the DEM meshes from the data of only the last shot by filtering. Therefore, it is not possible to describe in detail the state of the detailed ground surface rich in irregularities such as a rolling stone and an overhang topography. Therefore, we decided to analyze by directly using the point cloud data on the ground and its vicinity so as not to impair the original information amount of measurement data. In the analysis, ICP (Iterative Closest Point) analysis was adopted because it is necessary to appropriately match the planarly complex distribution shape in order to target the rocky stone on the ground surface among the talus deposits. In this study, processing of point cloud data was performed using free software CloudCompare, and ICP analysis was analyzed using MathWorks numerical analysis software MATLAB free library.

4. Result

From the calculation results of the two periods, the maximum displacement amount of 0.42 m was confirmed within the range of an altitude difference of about 50 m from the terminal end to the top end of the debris. It was 0.2 to 0.4 m especially in the active area and 0.02 to 0.10 m in the stable area, and it was confirmed that the amount of variation varies depending on the place. The reason for this is

consistent with the area where large gravels are active, consistent with the phenomenon which can be said to be unstable as the diameter of the debris is larger if the inclination is the same. In addition, the trend of the variation in the quiet area shows a vector coincident with the maximum inclination direction, and consistent results were obtained compared with the phenomenon. However, in the field survey, the verification was carried out since the specific stone was confirmed to be displaced by 1 m or more. It was confirmed that sometimes it was not possible to follow the characteristic shape (feature)
5. Conclusions

In this study, we measured using LiDAR date of UAV and analysis three-dimension vector displacement at talus deposits, and the fluctuation amount according to the property of the site was measured. However, we couldnot measure the amount of displacement of large gravel recognizable by field survey, because we calculated it as an average value of square block. This displacement result will underestimate the variation. Although it is sufficient to identify such characteristic shapes (features) individually and grasp the displacement, we think that it is necessary to improve it as a problem of fluctuation analysis by ICP in the future.

Keywords: ICP analysis, point cloud group, steep slope

表-1　計測機材の仕様 Table 1 Measurement Parameters

使用機器	Riegl VUX-1
測定方式	タイムオブフライト オンライン波形
測定レート	500,000 点/秒
対地高度	約 80m
スキャン角	±120 度
計測精度	±30mm

表-2　計測結果と精度一覧 Table 2　Measurement Times

データ名	実施日	経過日数	グラウンド到達率（%）	密度(点/1m^2)
第 1 回目	2016/6/1	-	8.7	83
第 2 回目	2016/12/7	189	11.5	143