Application of analysis method using S-DEM data for landslide measurement

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1. Introduction
In recent years, disasters associated with abnormal weather such as “guerrilla rainstorms” have occurred. In particular, in Japan there is an increasing risk of occurrence of various slope failures such as slope collapses of shallow depth and debris slides, but it is difficult to predict the occurrence of slope failures and take preventive measures because it is difficult to capture phenomena that are prognostic of slope failure. Observation methods for wide-area slopes using ground-installed equipment such as extensometers have not been in widespread use because of the cost and labor involved. Therefore, the development of a new slope monitoring approach is needed. In this paper, we propose a measurement and analysis method for computing the movement of slopes, using point cloud data, with a high degree of accuracy. We discuss the results of an experiment in an actual slide debris field and report the applicability of our proposed method.

2. Method for analysis of slope displacement
In general ,a ground data filtered from original data of LiDAR survey system becomes relatively monotonous Digital Elevation Model(DEM) which removes the influence of vegetation (Mukouyama ,2011). We developed a method that can extract the minute topography from the original laser data by using only the laser data from below a certain height from the ground surface. The result from the method developed here has a resolution of 10 cm. This analysis were used "MIERRE" that was developed Nakanihon Air Services. Its experimental trials were performed to verify the applicability of our proposed method, and the results show that more than approximately 0.4 m changes in the displacement of the slope could be detected in the area where a debris slide occurred (Kikuchi et al,2017).

3. Application of our method
The Location is located two area of slope displacement on reservoir of dam. We measured the minute displacement of landslides between the first and second surveys. The laser point clouds data density of the laser scanner on the airplane in the specification was in the range of 100 to 120 m2, and 5 to 10% of them reached the ground surface. The amount of displacement at the measurement point in Non-moved block indicates the accuracy of our measurement technique.

3.1 Test field A
Test field A is a debris slide site facing the reservoir. From the results of minute topography and field work, it was presumed to be a slope on which surface collapse will proceed. In the case of the measurement of the two times LiDAR-data, the maximum displacement amount of 4.6 m was confirmed within the range of the altitude difference from the reservoir altitude to the upper end of the surface collapse of about 100 m (show in the left-hand fig.2). This result estimates processing of debris slide on the surface layer confirmed in the field work. In addition, since 0.3-1 meter deformation in the reservoir direction is recognized in the upper rock block of the surface collapse.

3.2 Test field B

Test field B is a landslide due to heavy rain of typhoon 12 which occurred in September 2012. The landslide is not observed on the landslide map by the National Research Institute for Earth Science and Disaster Resilience. It is presumed a Primary landslide. As a result, the fluctuation vector quantity is a detection quantity of about ±0.3 m which is a range of almost error inside and outside the landslide block (show in the right-hand fig.2), and there is no tendency for the direction of the vector to be collected, so that a significant fluctuation exceeding the error. It is judged that it will not be accepted, and we will continue to measure regularly in the future.

4. Conclusions

In this study, we developed a technique for measuring slope displacements using three dimensional laser point group data, or LiDAR data. In this technique, we used only the laser data that is reflected from objects at heights of 2–5 m from the ground surface. Moreover, we developed a matching method for images created from the limited laser point group data in order to compute displacements using time series laser data. Experimental trials were performed to verify the applicability of our proposed method, and the results show that more than approximately 0.3 m changes in the displacement of the slope could be detected in the area where a debris slide occurred as shown in Fig. 2. We have demonstrated that it is possible to expand the applicability of airborne laser surveying to monitor slope failure by using the method proposed here.

Keywords: Landslide, Digital Elevation Model, Point cloud data, Monitoring of slope movement

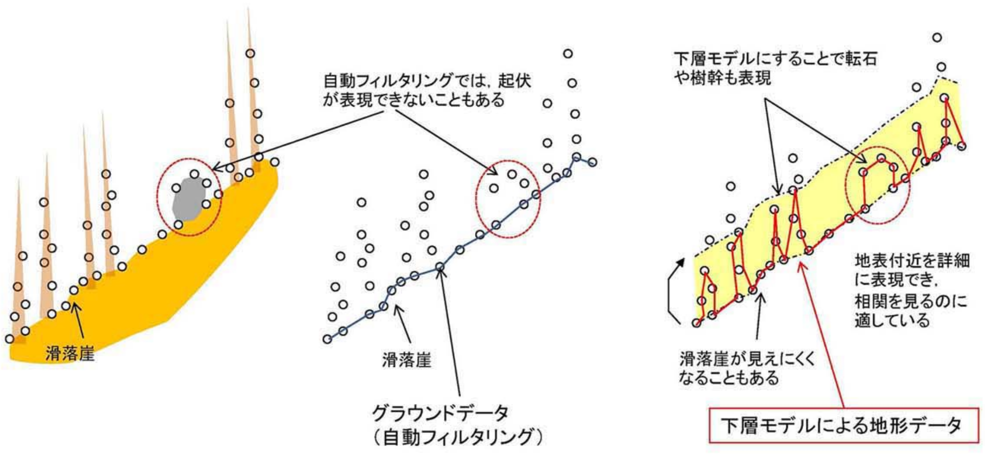

図-1 グランドデータと下層モデルを使用することによる得られる点群の違い

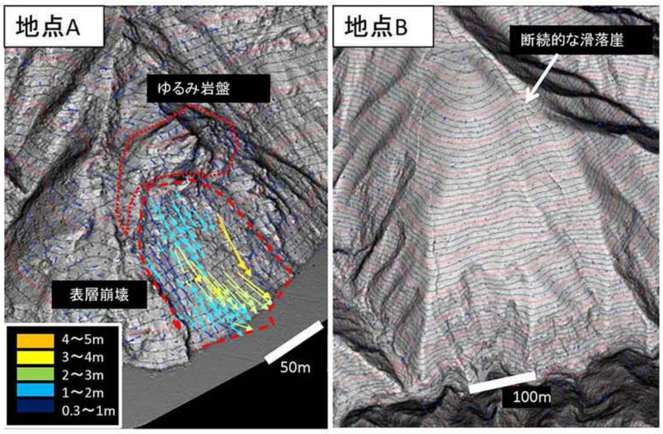

図-2 各地点の変動ベクトル解析結果

