Preliminary Study of Scale Effect on Investigating Unknown Object Using Borehole Electrical Resistivity Tomography

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An in-situ experiment for investigating ground improvement using borehole electrical resistivity tomography method, also called BHERT, was performed and proposed at JPGU-2016 as well last year. In the study the simulated results from BHERT presented the roughly three dimensional distributing of the grouted materials of the ground improvement in deep underground soil layers. Despite the clear image being obtained, the operating parameters of BHERT and interpreting method make influence on the result, especially size effect. To clarify more details of the mentioned effect for further adoption, an in-situ with smaller size experiment was performed. A series tests with varies soil materials prepared and objects with different shapes buried inside was performed for setting up a standard reference. The result shows that a correcting factor is existing between object size, field size, and electrical parameters. The factors can be normalized to be unitless.

Keywords: Borehole Electrical Resistivity Tomography, Geophysical Investigating, Scale Effect

Making of a detailed DSM of a partially collapsed road embankment and correlation with 3D GPR data

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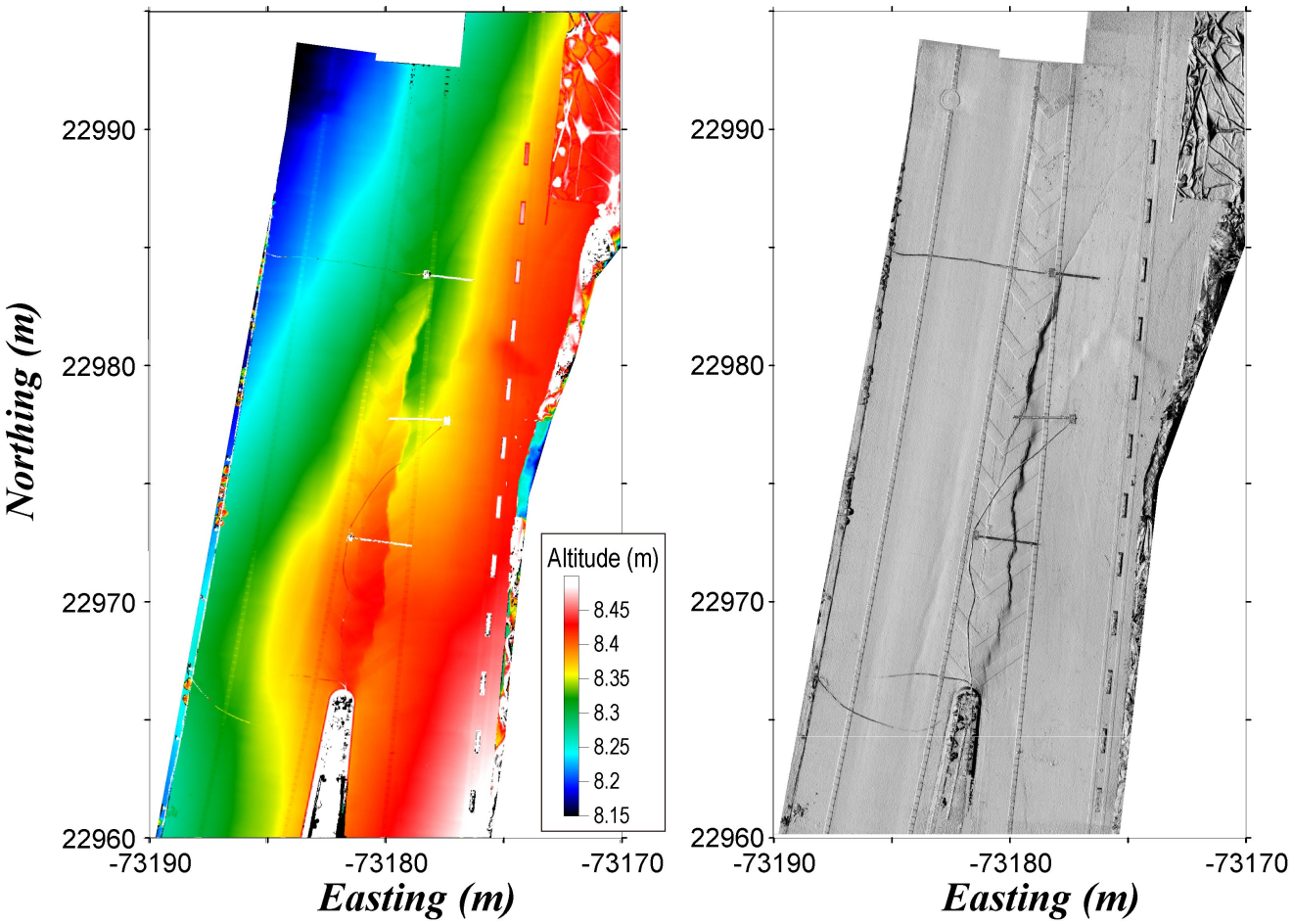
We conducted an urgent but detailed field survey at a site where 8 m high road embankment slope had been partly collapsed by heavy rainfall along with strong motion of 2016 Kumamoto Earthquake 2 months before. The field measurements consisted of high-density surface photogrammetry and near-surface geophysical surveys. We employed a telescopic pole camera system and RICOH GR2 to take digital photographs in the air up to 6 meters. Finally, we made an orthophoto image and a DSM of a road surface which had escaped from collapsing at a spatial resolution of 2.86 mm using a commercial SfM-MVS (structure from motion and multi-view stereo) software package (Agisoft PhotoScan Professional). We used a total of 218 pole camera images and 7 GCPs to create the DSM. In addition, we processed UAV imagery taken on the day after the collapsing to generate a DSM of 2.5 cm spatial resolution of the site. The DSM, which covered 110 m x 90 m area, clearly imaged the embankment collapse and heaving of the ground in front of the failure caused by compression and thrusting. It was helpful to clarify the failure mechanism of road embankment and the role of geotextile-anchored concrete wall set at the foot part of the embankment to avoid entire collapsing of the embankment. Furthermore, we could identify non-tectonic structures from the road surface DSM. Number of cracks and small bulges were traced behind the failure crown, which indicated the co- or post-failure movement of the remained embankment. Then we conducted dense grid GPR survey on the road surface. As a result, cracks extended in the pavement up to 75 cm and the surface pavements were interpreted to be segmented and detached from the underlying road beds. Joint investigation and interpretation of the surface DSM and the near-surface geophysical data was capable to assess the safety conditions of remained road embankment. Namely, which types of restoration works were needed and what extent should be reinforced. In conclusion, combined analysis of surface DSM with the near-surface geophysical survey data is crucial to understand such surface deformation structures as slope failure.

Keywords: Orthophoto, DSM, UAV, GPR, Near-surface Geophysics



Bathymetry and bottom classification mapping by a remotely controlled watercraft and a high performance fish finder

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Acoustic investigations for small and shallow water areas are significant and high potential value for earth science studies and for disaster prevention researches. For example, estimating water volume for a glacial lake or a landslide dam-created lake is useful to predict outburst flood, and also imaging a bottom of the volcanic crater lake is useful to observing volcanic activities under water. However, such investigations have been difficult due to their cost, mobility and high risk for manned operation. The authors recently are investigating shallow water areas by using modern light-weight and low-cost fish finders. This method enables bathymetric mapping, bottom classification, and high-resolution sonar imaging (Yamasaki and Kamai, 2015). In this presentation, the authors presents an unmanned watercraft survey system equipped with those fish finders to investigate small and shallow water areas.

The developed system is based on Tabusa et al (2013), consists of a commercially available materials, low cost electric devises and a free software. The unmanned watercraft body was constructed with an electric motor and plastic floats to be a form of twin-hulled ship. For this type of small watercraft, the twin-hulled shape was stable in wavy condition by experiments. The electric motor drives with a 12-voltage battery, and had a remote controlling mechanism. Setting radio transmission devices (2.4 GHz ZigBee RF modules) in the mechanism, the communication distance was enlarged as long as 1 km. A GNSS receiver was installed in the watercraft and its positioning data was transmitted through similar radio transmission devise to the operator on land. The position and, calculated speed and heading of the watercraft from GNSS data were shown on a display of PC in real time.

The authors present a case study in Lake Ashinoko, Kanagawa Japan. In the northern part of the lake, a number of submerged trees were found on the lake floor. Some of trees remains to stand on the floor. It has been called “Sakasasugi” in Japanese. Oki et al. (1988) inferred that submerged woods were deposited by a landslide. The authors presumed that the topography and the base materials of the area of submerged woods would differ from other part of lake if a landslide had occurred and investigated the area with the developed system. Then the authors obtained a bathymetric map and distribution maps regarding bottom materials. The bathymetric map shows characteristic rises that differ from other part of lake. The relative surficial hardness values and surficial roughness values of the base of submerged trees defer from most part of the lake. Their results are consistent with that the idea that submerged woods had been transported via a landslide.

Yamasaki, S., Kamai, T., 2015. A novel method of surveying submerged landslide ruins: Case study of the Nebukawa landslide in Japan. Engineering Geology, 186, 28-33.
Tabusa, T., Sawamura, K., Mukai, T., Kuzume, K., 2013. Development of small scanning Boat by Automatic Cruise and Making of 3-Dmimensional Topography of Mekong River. Navigation, 186, 15-23. (in Japanese, title in translation)
Oki, Y., Hakamada, K., Ito H., 1988. Fossil Cedar Trees of Hakone (Hakone-no-Sakasasugi)–Kanashin Books 23. 180p. Kanashin publishing company. (in Japanese, title in translation)

Keywords: fish finder, sonar, bathymetry, remote investigation, landslide, Lake Ashinoko

Finite Element Modeling of Volcanic Ballistic Impacts in Soft Ash and on Buildings - a Hazard Approach

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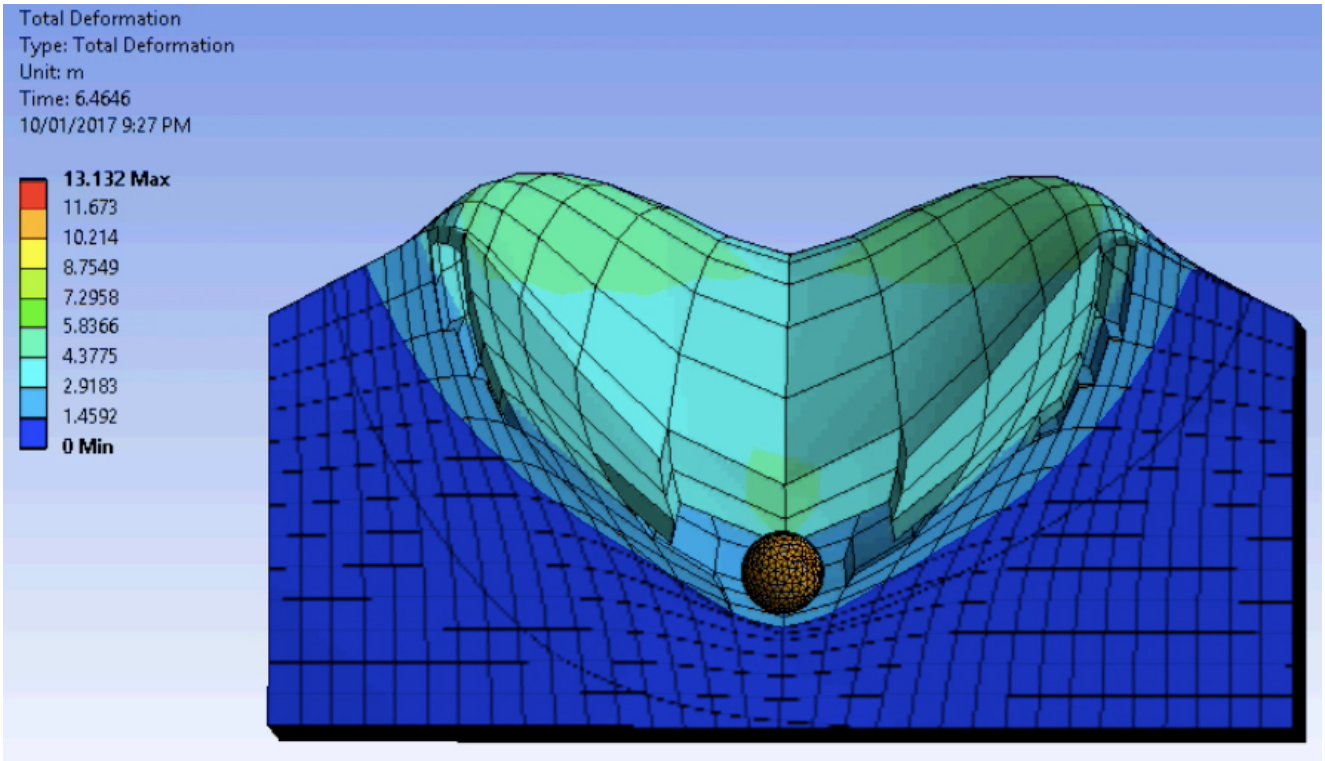
Volcanic eruptions, such as the phreatic eruption of 2014 at Ontake Volcano can produce large number of ballistics, which often turn into craters near the summit of the volcano, and which can have devastating effects on buildings.
In the present contribution, the authors have performed a visual analysis of the ballistic impacts at the summit of the Ontake Volcano on building materials and in soft clastic sediments and reproduced the time of impact between the ballistic and the impacted material.
The simulation was performed with the ANSYS engineering suite using andesite material for the projectile and timber and aluminum sheets to work on the impact on building. The timber planks had a 20 mm thickness and the aluminium sheets 0.5 mm. They were anchored along two parrallel edges to simulate the supporting carpentry. Results reproduced the erosion of the impacted materials as observed in the field, with different effects depending on the penetration angle.
On the ground, the ballistic impacts recreated realistically the craters observed around the summit of the Ontake, showing an interesting feature of plastic decompression at the point of impact, allowing the projectile to slightly rebound.

Keywords: Ballistic, Impact Hazards, Ontake Volcano, Disaster Risk



Rockfall Simulation from DSM Data generated by SfM from UAV-based imagery: Analysing the rockfall hazards in the touristic Fox Valley.

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The Fox Valley, on the West Coast of the South Island of New Zealand, is a highly praised destination for tourists wanting to come up close to an alpine glacier and a majestic landscape. It is popular sightseeing spot and one of the main tourist resources, but such a dynamic environment can present several hazards, such as rockfalls. These events in the Fox valley are the results of some incidents, for instance valley deglaciation during the Quaternary and historic oscillation, eventually liberating multi-metric blocks. And one of the most active area where the tourists are concentrated is the Gunbarrel tributary, which threatens the carpark and the walking track.
In order to better understand the rockfall hazards and eventually reduce tourists' vulnerability, the present contribution proposes rockfall modelling using a Digital Surface Model (DSM) acquired by Structure-from-Motion (SfM) photogrammetry using a commercial quadcopter UAV and Terrestrial Laser Scanning (TLS). The model results were then analysed to assess the hazards and potentially the risk of rockfalls by using a GIS software and Flow-R which has been developed at the University of Lausann, Switzerland.
Results have shown that most of the rockfalls are meant to stop in the vicinity of the apron of the Gunbarrel tributary, being less of a threat to the walking track. But as the walking track cannot be placed too low due to potential river surges, which can be generated by glacier terminus collapse, the management remains a delicate issue. A talus formed by a large amount of rockfalls can become debris flow when it contains abundant water because due to rainfall. The model did not account for blocks that jump out of the present catchment and towards the carpark, although recent events in 2016 have shown that such rockfalls had happen. This limitation can be imputed to the model, but most certainly to the limitation of UAV-based DSM, which are difficult to acquire in terrain where the altitude change is ~1000 m, as it is at Gunbarrel. Another limitation to this analysis is the progressive change of the apron, where the accumulation of loose material has been increasing in 2016, due to a large number of debris-flows. The debris-flow fan deposits tend to reduce the slope break at the bottom in the apron, pushing the blocks further in the valley. Regular monitoring and repeats of the modelling are therefore essentials.

Keywords: rockfall, UAV, SfM, tourism, TLS

Comparison of measurement accuracy for DSM and orthomosaic between 2013 and 2016 UAV flights at Midori fault scarp, Neodani fault

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Purpose of this study is to compare measurement accuracy of digital surface model (DSM) and orthomosaic taken in 2013 and 2016, which are measured at Midori fault scarp in Neodani fault by Unmanned Aerial Vehicle (UAV). Resolution of aerial photograph was 3cm (in 2013) and 1cm (in 2016), and the number of aerial photographs covering the study area was 109 (in 2013) and 498 (in 2016), respectively. DSM and orthomosaic were produced from a dense point cloud, processed by Structure from Motion (SfM). Since real time kinematic-Global Navigation Satellite System (RTK-GNSS) survey gave 3-D coordinates (easting, northing, elevation) on 4 ground control points (GCPs) and evaluation points (EPs), the both productions were geo-referenced using GCPs. Then, horizontal coordinates and elevation of the EPs were measured on the orthomosaic and DSM, and finally, difference was calculated by subtracting GNSS-surveyed result from measurement result. It was found that horizontal root mean square error (RMSE) was 0.45m (in 2013) and 0.05m (in 2016), and vertical RMSE was 0.32m (in 2013) and 0.02m (in 2016), respectively. This result shows that 2016 observation gives 9 times (horizontal) and 16 times (vertical) better accuracy than 2013 observation.

Keywords: UAV, SfM, accuracy

Detection of surface changes in sandstone blocks by weathering in a coastal environment using TLS

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Compared to the traditional measurement method, i.e., point to point, or cross-sectional measurements using scale bars, recent advantageous measurements using terrestrial laser scanning (TLS) enables more efficient and accurate measurements of the amount of weathering on the surface of vulnerable materials in coastal areas. We carried out multi-temporal TLS measurements to monitor the changes in the surficial morphology of sandstone blocks used for masonry piers of a bridge on a shore platform at Aoshima, Miyazaki Prefecture in western Japan. While the blocks have suffered from salt weathering above the sea level since the construction of the bridge in 1951, the weathering-induced depressions are still developing in the spray zone. The multiple measurements of the detailed morphology reveal the contemporary weathering rates.

Keywords: weathering, sandstone, terrestrial laser scanning, rock strength

