Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

HTT30-P01 Room:Convention Hall Time:May 25 18:15-19:30

Dose rate mapping by UAV and application to radioactive contamination area

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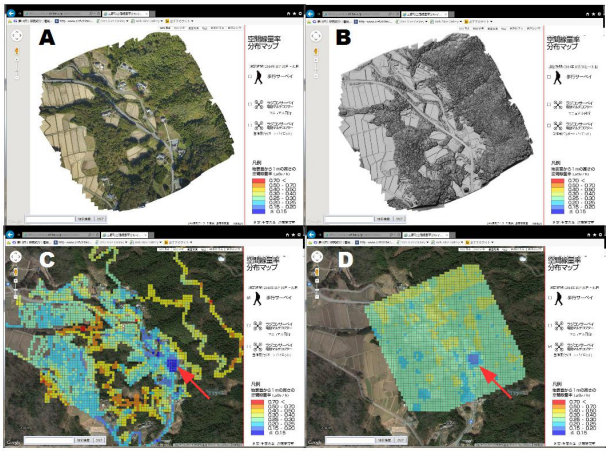
Dose rate mapping in radioactively contaminated area is inevitable to make acknowledgement to live in the land, and to monitor external dose continuously. As convenient tool to measure dose rate especially in mountain area, we develop the system to measure dose rate by UAV (Unmanned Aerial Vehicle). The system is applied to two regions in Fukushima Prefecture. At the JpGU meeting, examples of practical use of UAV system will be presented.

Keywords: dose rate, unmanned aerial vehicle, nuclear disaster, Fukushima, Structure from Motion, Digital Surface Model



Japan Geoscience Union Meeting 2015
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HTT30-P02 Room:Convention Hall Time:May 25 18:15-19:30

A method for measuring surface rupture displacement by using UAV - Application to the 2014 Kamishiro fault earthquake

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The surface ruptures associated with the 2014 Kamishiro fault earthquake (Mj 6.7), central Japan was photographed by digital cameras mounted on an unmanned aerial vehicle (UAV) and a high pole. The resulting Digital Surface Model (DSM) generated using the Structure from Motion (SfM) -Multi-View Stereo (MVS) software enabled accurate measurement of the terrain section, as well as variations in directions and amounts of three-dimensional surface displacements. Imaging technology mounted on a UAV is used to obtain widespread surface measurements, while the pole camera is used for the detailed photography of important locations. The accuracy of the DSM will be confirmed by the comparison of our findings with the measurements by other methods, such as auto-level, Total Station, and terrestrial LiDAR.

As a result, we were able to create a DSM of a resolution of a few centimeters. The shaded diagram of the DSM indicates the following: 1) Surface rupture has propagated in an intricately bent and branched manner. 2) Small-scale deformation and deformation along several meters of width have taken place. Subsequently, this DSM was compared with the cross-sectional survey and measurements carried out by the auto-level and LiDAR, and it was confirmed that the DSM is characterized by fine topographic changes. However, an error of about 10 cm could have been present depending on the location.

Keywords: The 2014 Kamishiro fault earthquake, surface rupture, UAV, SfM-MVS, Ultra-high-resolution DSM

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HTT30-P03 Room:Convention Hall Time:May 25 18:15-19:30

Accuracy validation of DSM that has been generated by UAV and SfM-MVS, Part3

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Preface

Nowadays, more and more people are drawing attention to a measuring technique using UAV and SfM-MVS(Structure from Motion). Using this technique enable us to obtain the topographical information of the spatio-temporal resolution. This technique has applied to information acquisition of the initial stage of the disaster, measurement of the amount of displayment of landslide configuratio and active fault terrain, and utilizes to generate ultra high quality resolution DSM which only has a few cm resolution images. On the other hand, any of the research has tried to take a shot of a micro object, such as gravel of the riverbed, from sky and then turn it to DSM. Verification of accuracy has not yet done sufficiently as well.

This essay is going to write about the best way to take picture from sky and analyzing method on SfM-MVS, in order to turn a few cm micro objects into DSM, through various experimental set-up.

Experiment technique

Set acrylic plate as a criteria surface, and place three bricks (height respectively 6, 12, 18cm), then photographed them from the air by UAV. These bricks intrinsic merit is fixed. After, process captured images with SfM-MVS software, and produced the DSM. Display DSM on GIS, extracts their DSM of each center of the brick and the criteria plane and tried to calculate individual value. Average, maximum, minimum, and standard deviation of the extracted individual values were compared with other experimental data and intrinsic merit. I used DJI Phantom2 Vision+ as UAV, Agisoft PhotoScan Professional 1.1.2 as SfM-MVS, and ArcGIS 10.2 as GIS.

There are 6 experimental set-ups, for taking pictures from sky.

Exp.1 Take pictures from different height; 5m, 10m and 20m.

Exp.2 Change the number of photo to analyze; 10, 20, 50, 100 and 150.

Exp.3 Change the position of GCP in 4 ways, on the criteria plane and on the bricks, only on the criteria plane, only on the bricks, only on top of the bricks and the criteria plane.

Exp.4. Manually compensate the GCP which is automatically granted by SfM-MVS.

Exp.5. Change the setting of the Camera calibration on SfM-MVS, using the new faculty of PhotoScan1.1.1.

Exp.6 Change the tile angle of the camera.

Setting for Exp.5 and Exp.6 are provided on the day of experiment.

Result

The result of Exp.1 shows that DSM resolution differed by the heights; 0.6cm in ground advanced 5m, 1cm in ground altitude 10m, 2cm in ground elevation 20m. As the flight altitude got higher, the advance height of DSM on bricks and standard deviation became smaller. Also, higher the flight altitude

Keywords: UAV, SfM-MVS, Super high-resolution DSM, Accuracy validation

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HTT30-P04 Room:Convention Hall Time:May 25 18:15-19:30

The development of ultra-high resolution 3D measurement system by a multicopter using the latest laser scanner

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In recent years, unmanned helicopters, especially multicopters which have multiple rotors, have been developed rapidly and the compact laser scanner which can load on them have been also developed. RIEGL VUX-1, ultra-lightweight compact laser scanner, was released in 2014. This scanner is assumed to load on unmanned aerial vehicles. The specifications of the scanner are as follows: weight 3.6kg, size 227∗180∗125mm, a large field of view (330 degrees) and a high measurement rate of 500,000 points / seconds. The scanner also corresponds to multiple targets processing by the waveform analysis.

In this study, at first a multicopter that can be loaded with this latest laser scanner was newly developed. In the second, attempts to ultra-high-definition 3D measurement will be done by the new multicopter with the scanner.

The accuracy verification test was done by the unmanned helicopter YAMAHA RMAX L18 with a gasoline engine. This test was done by Nakanihon Air Service CO.,LTD, RIEGL JAPAN LTD and KoHaTa Inc. in Oct. 2014. As a result of horizontal direction verification, vertical direction verification and small object identification verification, it was revealed that the system can grasp the small step of the relative height 1cm unit as Fig.1.

The influence of the vibration of the engine was concerned, but the effect of vibration was relatively small comparing with the actual aircraft. This may be because the high frequency vibration was dominant. The newly developed multicopter moved by the motors for reducing the vibration, it is considered to be able to ensure the accuracy with the smaller and lighter IMU.

The new multicopter is designed to be able to exert maximum performance of the sensor. Considering the VUX-1 transmission and reception of the laser, the shape of the multicopter around the sensor was specially designed so that be able to acquire the 330 degree wide viewing angle data from low altitude flight. This makes it possible to create a wide area and high speed ultra-high-resolution 3D model of terrain and structures from the sky to the same extent of the accuracy by ground-based laser scanner measurement.

This new measurement system is considered as effective where measurements from the ground level are difficult, such as the landslide disaster. Various applications, such as early condition ascertainment, prevention of secondary disaster and recovery and reconstruction planning are expected by this system.

It is planned to upgrade the system to retrieve data in various weather conditions and to view and print the measurement results in real time in disaster area. After upgrading, the system will be used in the activities of ”Tokyo Metropolitan University Disaster Investigation & Assistance Special Team by Unmanned Aerial Vehicles” in a real disaster field.

Acknowledgments

We would like to give a special thanks to Mr. Mitsunori KOHATA, the president of KoHaTa Inc. This research was partially supported by RISTEX, JST.

Keywords: Unmanned Arial Vehicle, Laser scanner, 3D measurement, Mmulticopter, Drone

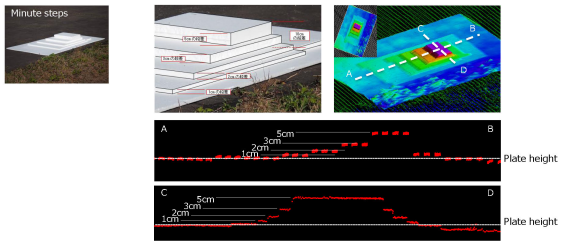

Fig.1 Result of the accuracy verification test

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Glacier change analysis in Tien Shan using digital camera images

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In mountainous regions of Central Asia, benchmark glaciers which mass balance has been observed for a long time period are Abramov, Golubin, Karabatkak, Tuyuksu, and Urumqi No.1 Glaciers (UNEP, 2007). Because of collapse of the former Soviet Union, some glaciers had been stopped to observe in the late 1990s. Observation of glacier mass balance has some problems such as optimal glacier to the survey, approach, greater burden budget and effort for observation. Although there are reports of mass balance changes using digital elevation model (DEM) generated from satellite data, it is difficult to calculate the annual variation of glacier surface in arid or semi arid region using DEM for small scale glaciers. In this study, we researched glacier mass change of small glaciers in Tien Shan, using SfM (Structure from Motion) and digital camera images from aerial. Average annual mass balance of small scale glacier (0.129km^2) was -1042mm/a^{-1} between ALOS/PRISM DEM (2006) and Camera DEM (2014). We found that it is effective to use digital images taken from the aerial for glacier research.

Keywords: mall-scale glacier, mass balance, Tien Shan, digital camera image, DEM

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HTT30-P06 Room:Convention Hall Time:May 25 18:15-19:30

Research method development by using UAV over restricted areas of volcanoes

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It is known that deformation and tephra fallout by volcanic eruptions could cause severe geographical changes around the crater. If some volcanic ash emitted from the crater can be collected, we have a greater chance of getting information on its magma reservoir and its eruption type, and by examining the contents of volcanic ash, we may be able to assess the possibility of an occurrence of a secondary disaster such as debris flows.

We have been conducting a series of field test for collecting ash or gravels from volcanic area, obtaining images at crater and creating DSM by using UAV and other devices. In this study, we present methods and results based on a field test conducted in Sakurajima volcano, in December, 2014.

The UAV used in this project is ZionQC730 by Enroute Co., Ltd., equipped with four pieces of propellers. At Sakurajima, we send this device from lower Kurokami River to over Showa crater. Translational distance from take-off point to the crater was about 3,700 m, at altitude 1,200 m, flying distance of 8,000 m with speed of 10 m/s, and flight duration was approximately 20 minutes per flight. 56 % of the battery remains after a flight under the wind speed 5 m/s. A total of three flight experiment was conducted to the crater and at each flight, 4K resolution images were successfully obtained. Though lower in resolution, the UAV also provided real-time images during these flights. As stated above, it is possible to obtain high-resolution images at restricted area by these UAVs.

We used 300 images obtained at upstream area of Kurokami River to create DSM by using several utilizing structure from motion (SfM) softwares, and compare them in terms of their accuracies, point densities, and model creation times.

We then assess the difference between existing laser profilers (LP) and our models. As a result, we found that these softwares had a little difference for data accuracies while point densities differed significantly. We also found a few meter differences in vertical direction when not employing GCPs. Usually erupting volcanoes do not allow little time to set them up, therefore we have to resolve the problem as to fix this inaccuracy.

In this project, we attached a special device to UAV to collect samples of volcanic ash from the surface. This device equips a motor to rotate double rollers inwards to collect soils. It has been used successfully in some test fields.

We collected soil from Kurokami River sediment using above device. The rainfall from the previous day might cause harder soil and collecting insufficient amount of sample. In the future, it may be necessary to be able to make changes to the physical structure of the device according to soil conditions.

Keywords: UAV, Sakurajima, Volcano