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Quick and low-cost high resolution remote sensing using UAV and aircraft to address initial stage of disaster response

S Sugita[1], H Fukui[1], H Inoue[2], Y Asahi[3] and Y Furuse[4]

[1] International Digital Earth Applied Science Research Center, Chubu University, Matsumoto-cho 1200, Kasugai, Aichi 487-8501, JAPAN
[2] Integrated Research on Disaster Risk Reduction Division, National Research Institute for Earth Science and Disaster Resilience, Tennodai 3-1, Tsukuba, Ibaraki 305-0006, JAPAN
[3] Digital Earth Lab. Ltd., Aoi 2-11-22-503, Higashi, Nagoya, Aichi 461-0004, JAPAN
[4] Falcon Corporation, Sakae 2-2-5, Naka, Nagoya, Aichi 460-0008, JAPAN

E-mail: satoru@isc.chubu.ac.jp

Abstract. The experiments of aerial photogrammetry using UAV and aircraft are demonstrated to compare their performance and resolution. Instruments used for the aircraft photogrammetry is commercial product digital camera. This is much lower-cost than professional photogrammetry instruments, however the results shows enough quality for information gathering in the initial stage of disaster response. On the other hand, The UAV aerial photo sharing web system "UAV oblique photo browser" has been newly developed as a light weight and simple system that is useful in the initial stage of disaster response.

1. Introduction

Recently, the demanded cases of UAVs (Unmanned Aerial Vehicles) have dramatically increased to collect information at the initial stage of disaster. In particular, the practicability of low-altitude aerial photography is increasing along with spreading of SfM/MVS (Structure from Motion/Multi-View Stereo) photogrammetry technique, which arrows us to generate three-dimensional model, point cloud, DSM (Digital Surface Model), and ortho-projection image from multiple pictures [1].

Although UAV can collect high resolution images, its area is limited because of the battery capacity. We have been promoting experiment of high resolution aerial photography using Nagoya city helicopter with commercial reflex digital camera in collaboration with disaster prevention department and fire department of Nagoya city to develop a method to collect information at the initial stage of disaster.

2. Comparisons of aerial photogrammetry using UAV and aircraft

We performed the experiment to compare UAV and aircraft using following instruments. We use DJI Phantom 4 Pro for UAV. The image sensor of the camera is 20M pixel and 1 inch CMOS type. The focal length of the lens is 24mm (35mm full-frame format equivalent). Max flight speed of Phantom 4 Pro is 72km/h and max flight time is 30 minutes. The battery capacity is 5870mAh and voltage is 15.2V. For the flight planning and automated flight, we use Map Pilot for DJI. We use Nikon D810 reflex digital camera on the helicopter. The image sensor of the camera is 36.35M pixel and 35mm full-frame CMOS type. Mounted lens is AF-S Nikkor 28mm f/1.8G. The Nogoya city helicopter is

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Eurocopter AS365N3. Max flight speed is 324 km/h and max flight time is 3 hours and half. Fuel capacity is 1,158 litter. For the flight planning, we use Mission Planner. During helicopter flight, we show the planned route and present position of the helicopter to pilot using GPS and GIS software. For SfM/MVS processing, we use Agisoft PhotoScan software (Figure 1).

In an example of the UAV flight, flight time is about 10 minutes, mission time is about 8 minutes, flight altitude from the ground is about 100m, cruising velocity is 5m/sec, and we get 103 images with 80 percent overlap. As a product of SfM/MVS procedure, we get 15.2 hectare coverage area with 2.55 cm/px ground resolution. In an example of the helicopter flight, flight time is about 1 hour, mission time is about 30 minutes, flight altitude from the ground is about 800m, cruising velocity is 25m/sec, and we get 1466 images with 2 seconds interval shutter. As a product of SfM/MVS procedure, we get 4960 hectare coverage area with 14.5 cm/px ground resolution.

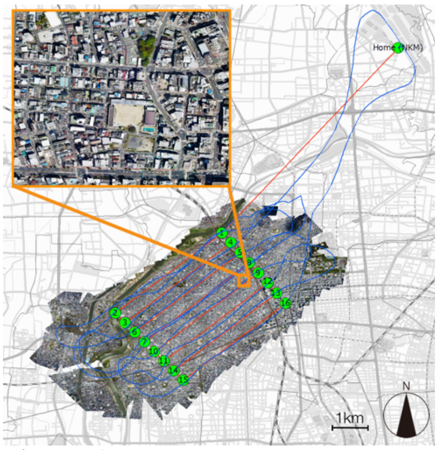

Figure 1. Ortho-mosaic aerial photo using helicopter and commercial camera. Red line is planned route and blue line is flight path respectively.

3. The UAV oblique photo browser

On the other hand, we have been promoting photo-map integration tool without SfM/MVS technique.

Recently, UAVs are introduced to lots of Japanese local governments for their disaster response. People recognize that UAVs are quite useful for information collection in the early stage of disaster [2]. However, there is no established method of sharing/utilizing information obtained by UAVs. Although detailed three-dimensional modelling and ortho mapping using SfM/MVS technique are very powerful, there are some problems that should be solved for use in emergency cases: techniques of image processing, time consumption of image processing, and constraints for taking aerial photos.

To approach this situation, we have newly developed the UAV aerial photo sharing web system "UAV oblique photo browser" as a simple system that is useful in the initial stage of disaster [3].

The advantages of oblique photo and the browser comparing with vertical photo or ortho photo are as follows: (1) It is easier to distinguish partial damage of buildings. (2) It is possible to shoot objects and place even when it is difficult to shoot from directly above such as a fire case. Also, the reliance on the skill of UAV operation is low. The operator is able to collect disaster information in the similar way to ordinary use. (3) It is possible to visualize on geographic information system (GIS) quickly and easily. Since high-level processing such as SfM does not exist in the process, time and skill are not required for processing. When UAV photos are uploaded to the server, they are immediately visualized on webGIS.

In the UAV oblique photo browser, an arrow pointing to camera direction is displayed on the map at the UAV photo taking position. By selecting a location on the webGIS, photographs with its position in the imaging range is filtered using the estimation algorithms of image footprint on a map (Figure 2). By selecting a photo that you are focusing attention, its shooting range is visualized on webGIS and the photo can be magnified and displayed. It is also possible to download photos to local drive.

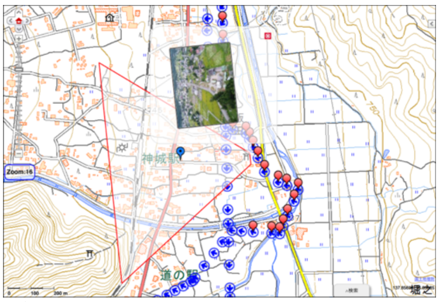
Figure 2. webGIS interface of UAV oblique photo browser.

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