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Assessment of Unmanned Aerial Vehicle for Management of Disaster Information

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재난정보 관리를 위한 무인항공기의 활용성 평가

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Abstract Recently, the need of effective technologies for disaster damage investigation is increasing. Development of geospatial information technology like UAV is the useful method for quick damage investigation. In this research, to assess the applicability of geospatial information constructed by UAV, we produced ortho images about research area and compared them with digital topographic maps for accuracy evaluation. As a result, ortho images showed within 30cm difference with 1/5,000 digital topographic maps, we could present the possibility to utilize for producing disaster information using UAV because of its effective construction and calculation of disaster information.

요 약 최근 효과적인 재난조사 기술 개발의 필요성이 증대되고 있으며, 무인항공기와 같은 공간정보 구축기술의 발달은 신속한 피해조사를 위한 적절한 방법이 될 수 있다. 이에 본 연구에서는 UAV를 통해 구축된 공간정보의 활용 가능성을 평가하기 위해 대상지역의 정사영상을 생성하고, 수치지도와 비교를 통해 정확도를 평가하였다. 연구 결과 정사영상은 1/5,000 수치지형도와 30cm이내의 차이를 나타내었으며, 효과적인 재해정보 구축 및 계산이 가능하여 재난정보 관리에 활용 가능함을 제시할 수 있었다.

Key Words : Disaster Information, Accuracy Evaluation, Ortho Image, UAV

1. Introduction

Geospatial data means the positional information about the natural or artificial objects on space and related the information necessary to spatial cognition and decision making. As it is developed the type of platform to connect all objects with internet virtual space, more added value is created. Lately, geospatial information is the base to create the next generation business like personal navigation and U-health, etc., and utilized national land planning, large-scale disaster countermeasure, urban planning, cultural heritage conservation, national safety program, business geographic decision, etc..

Meanwhile, due to rapid economic development, the growth of a city by development, change of business structure, abnormal climate changes, and others have effectuated more frequent changes in national land and topography. Such changes bring about huge problems in providing most-updated geospatial data required for

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effective national land and city management, geospatial data-related industries and society [1,2]. In this sense, in order to swiftly respond to emergent situations such as a disaster or calamity, real time monitoring systems as real time aerial data acquiring system have been continuously developed [3,4,5]. UAV assesses its area of monitoring whenever necessary to take diverse ortho pictures according to its flight altitude including inclination shooting and video recording, open to highly effective application [6,7,8].

Quick damage investigation is necessary to deal with the natural hazard and plan the recovery. To do this, UAV is the useful methods for quick damage investigation[9]. In this research, we used UAV to produce ortho image and compared it with a digital topographic map for accuracy assessment and construct disaster information with a view to present the applicability of UAV.

2. Data Acquisition and Processing

2.1 Composition of UAV

The present research utilized UX5 of Trimble for ortho image production. UX5 has GPS, digital camera, radio antenna, Pitot tube and other diverse sensors on it. The digital camera used herein, is Sony NEX5R specially calibrated for photo assessment. The cameral has APS (Advanced Photo System)-C- type sensor identical to that of DSLR, which is capable of fast and few noise videotaping. Also, the radio antenna plays the role of sending airplane flight data including speed, altitude, coordinate, etc via wireless communication to the radio modem of a ground controller. The pitot tube is a sensor that measures the pressure difference between a hole in front and a hole on the side to monitor airplane speed and altitude. Figure 1 shows UX5 and Table 1 describes UX5 data.

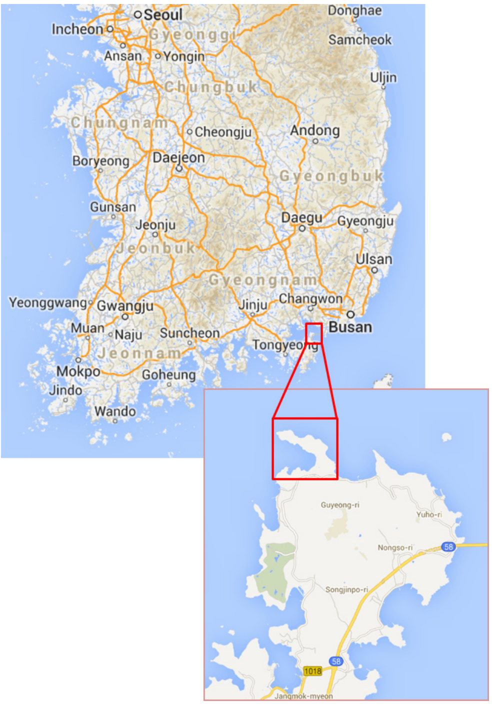
[Fig. 1] UX5 [10]

[Table 1] Specification of UX5 [10]

Items	Value	Unit
Weight	2.5	kg
Wingspan	100	cm
Launch Type	Catapult	-
Cruise Speed	80	km/h
Endurance (flight time)	50	Min
Flight Height(AGL)	75-750	m
Coverage (@5cm GSD)	2.19	km^2
Coverage (@10cm GSD)	4.94	km^2
GSD	2.4-24	cm
Flight Ceiling	5,000	m
Wind Speed	65	km/h
Landing Type	Belly	-
Camera	NEX5R	-

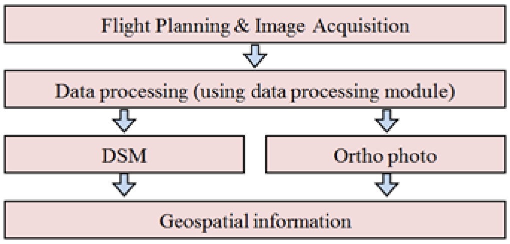
2.2 Data acquisition and processing

This research selected Geoje Island and its surrounding space for examination and used UAV to take aerial photographs. A total of 715 photos were taken. By using 2 neighboring photos of the area, a space model was built. To produce DSM (Digital Surface Model), the end/forward overlap was set at 80% and the lateral overlap at 80% for picture taking. Figure 2 exhibits the region subject to this research. Through TBC-based data processing, DSM and ortho images of the region were produced. Figures 4 and 5 each shows DSM and ortho images.This research selected Geoje Island and its surrounding space for examination and used UAV to take aerial photographs. A total of 715 photos were taken. By using 2 neighboring photos of the area, a space model was built. To produce DSM (Digital Surface Model), the end/forward overlap was set at 80% and the lateral overlap at 80% for picture taking. Figure 1 shows Research area in this study.



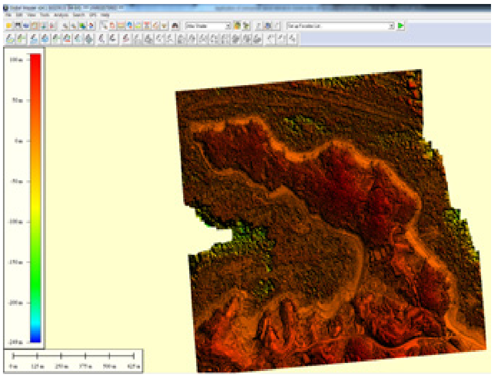
[Fig. 2] Research area

Aerial images are imported to data processing module of TBC(Trimble Bussiness Center) along with their locations, orientations, and camera calibrations. Geometric errors in the raw images from an UAV are significant as a result of the dynamic platform from which they are captured and the imprecision in the UAV's position and orientation sensors. To correct for errors in the positions and orientations of the aerial images, we used photogrammetric methods to adjust the photo stations. This is done in data processing module first as an adjustment with tie points. This module automatically finds tie points in all available stations based on state of the art computer vision algorithms, and then the TBC adjusts the stations simultaneously for a best fit. Automatically matched photo tie points are distributed densely over the complete project, even in challenging low-texture terrain. Figure 3 shows the workflow for the processing of UAV data [10].

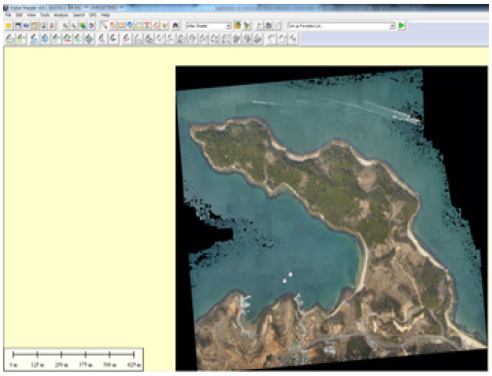


[Fig. 3] Workflow for the processing of UAV data

Through TBC-based data processing, DSM and ortho images of the region were produced. Figures 4 and 5 each shows DSM and ortho images.



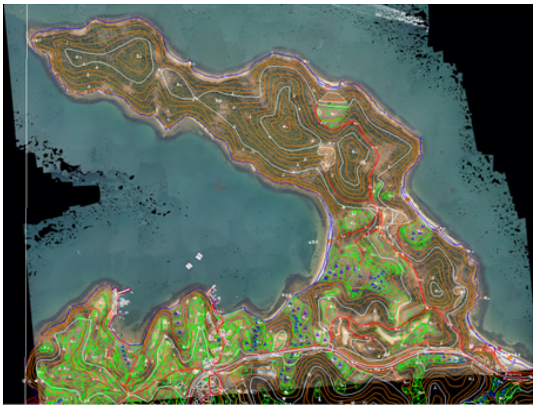
[Fig. 4] DSM



[Fig. 5] Ortho Image

3. Accuracy Assessment and Construction of Disaster Information

In this research, the 1:5,000-scale digital topographic map and ortho images were overlaid to produce ortho images again and evaluated its accuracy. 10 obviously distinguishable check points were selected on the digital topographic map and ortho images and the deviation between the map and image was calculated at each check point. Figure 6 shows the overlay of digital map and ortho image and Figure 7 is about the locations of check points. Table 2 exhibit deviations of each check point.



[Fig. 6] Overlay of Digital Map and Ortho Image

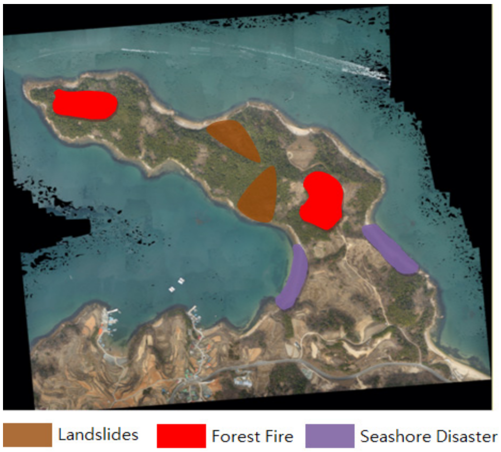
[Fig. 7] Locations of Check Points

[Table 2] Deviations of Check Points

No.	Deviation(m)
1	0.29
2	0.32
3	0.31
4	0.36
5	0.22
6	0.44
7	0.30
8	0.25
9	0.31
10	0.37
RMSE	0.06

Deviations of each check point were between 0.22 and 0.44m with the average deviation of 0.32m. Given the fact that the maximum error for horizontal position is 0.4m in making a 1:1,000-scale digital map as described in the digital map production rule of National Geospatial Information Statics Agency, such a result indicates the possibility to make a 1:1,000-scale digital map by using UAV.

In This study, The disaster information was built with Ortho image made by UAV. We assumed the disaster area since this image is not filmed the actual disaster area. As landslides, forest fire, seashore disaster can be recognized in the ortho image, we assumed it and extracted the disaster area. Figures 8 shows area of landslides, forest fire and seashore disaster and Table 3 shows extent of each disaster area.



[Fig. 8] Area of Landslides, Forest Fire and Seashore Disaster

[Table 3] Extent of Each Disaster Area

Disaster	Extent(m^2)
Landslides	30,290
Forest Fire	41,380
Seashore Disaster	27,620

The disaster information was built with precise ortho images from UAV and disaster area was calculated effectively. It is expected that disaster monitoring and management can be utilized by this information.

If UAV applicability is evaluated in more diverse topographies and regions, it can be fully utilized to make a digital topographic map. Compared to conventional aerial photographs or satellite images, UAV is capable of faster video-recording. In this sense, UAV can be used in diverse areas including ortho image production, digital map production and renewal, and natural disaster investigation.

4. Conclusion

This research assessed the applicability of disaster information established by using UAV and found the followings:

1. GPS, digital camera, radio antenna, and many other sensors were loaded on UAV. By using such UAV, data could be swiftly acquired and thanks to the automated data processing, DSM and ortho image production was possible.
2. The produced ortho images were assessed for their accuracy and their average deviation was 0.32m. This finding indicates the possibility to use multi-sensor UAV in producing and renewing a digital topographic map.
3. The disaster information was built with precise ortho images from UAV and disaster area was calculated effectively
4. If more follow-up studies are made for more regions to prove UAV's applicability, it can be fully utilized for disaster management. As UAV is faster to obtain images than other conventional aerial photographs or satellite images, it could be applied to various areas such as disaster monitoring and management.

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