Okhotsk Sea and Polar Oceans Research 1 (2017) 12-15

10.57287/ospor.1.12

Article

Preparing an UAV for drift ice observation

Kanichiro MATSUMURA[1]

[1] *Faculty of Bio-industry, Tokyo University of Agriculture, Abashiri, Japan*

(Received October 7, 2016; Revised manuscript accepted November 3, 2016)

Abstract

A cost effective, unmanned aerial vehicle (herein after UAV) is getting to be widely used in various field. Especially in the civil engineering and agricultural fields, using a UAV is becoming a standard. The author has conducted surveys using an UAV since 2014. Aiming at observing drift ice observation along sea of Okhotsk, this research introduces fundamental method related to UAV technologies. Auto pilot software makes it possible for UAV to fly along a pre-calculated course as if automated cleaning machine flying. Series of pictures can be used as stereo-photogrammetry method. Very precise high-resolution digital elevation models (DEMs) are obtained easily and at low cost. Overlapping, geotagged images were obtained over grass land along sea of Okhotsk. Again, this research presents basic knowledge and techniques necessary for introducing UAV, its operation, aerial photography techniques and the possibilities of using an UAV to observe drift ice.

Key words: Unmanned Aerial Vehicle (UAV), stereo-photogrammetry method, digital elevation models (DEMs)

1. INTRODUCTION

UAV can get aerial data in remote, inaccessible regions. Series of two dimensional pictures can be transformed to three dimensional pictures so called Structure from Motion (SfM). SfM technology and multi copters technology build a 3-D model from pictures and applied for disaster areas from low altitude. (Inoue *et al*., 2014) Observation for a large outlet draining the Greenland ice sheet was conducted. (Ryan *et al*., 2015).

2. MATERIALS

DJI company has been produced a high performance multi copter since this company founded and its share is said to be up to 60 % or more. The author used DJI manufactured multi copter, Phantom2 and Phantom 3. Attaching an infrared camera on Phantom2 makes it possible to get Normalized Difference Vegetation Index (NDVI) images.

Fig. 1 DJI Phantom quadcopter
(Version2: Left and Version3: Right)

3. MISSION PLANNER, HUB, LITCHI

The open source software the Mission Planner (http'//plane.arudupilot.com/) makes it possible to conduct flight waypoint manipulation.

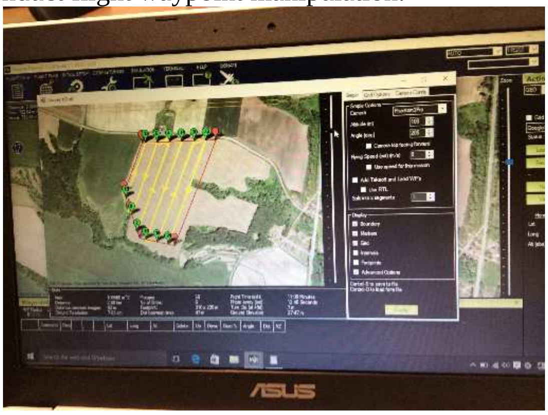

Fig. 2 Programming waypoint on Mission Planner

On the Mission Planner, choosing the area and put flags to cover selected area. Flags are associated with coordinates and altitude above ground (not see level) and then a flight plan is obtained.

Table 1. Flight plan generated by Mission Planner

	A	B	C	D	E	F	G	H	I	J	K	L
1	QGC WPL 110											
2	0	1	0	16	0	0	0	0	44.04212	144.0891	0	1
3	1	0	3	16	0	0	0	0	44.03976	144.0891	100	1
4	2	0	3	206	62	0	0	0	0	0	0	1
5	3	0	3	16	0	0	0	0	44.04304	144.0911	100	1
6	4	0	3	16	0	0	0	0	44.04304	144.0904	100	1
7	5	0	3	16	0	0	0	0	44.04039	144.0889	100	1
8	6	0	3	16	0	0	0	0	44.04103	144.0886	100	1
9	7	0	3	16	0	0	0	0	44.04304	144.0898	100	1
10	8	0	3	16	0	0	0	0	44.04304	144.0917	100	1
11	9	0	3	16	0	0	0	0	44.03944	144.0896	100	1
12	10	0	3	16	0	0	0	0	44.03935	144.0902	100	1
13	11	0	3	16	0	0	0	0	44.04304	144.0924	100	1
14	12	0	3	16	0	0	0	0	44.04304	144.093	100	1
15	13	0	3	16	0	0	0	0	44.03925	144.0908	100	1
16	14	0	3	206	0	0	0	0	0	0	0	1

Flight plan generated by Mission Planner should be transformed to csv style with the information latitude, longitude, altitude (m) using Microsoft Excel software.

Table 2. Csv format flight plan

	A	B	C
1	latitude	longitude	altitude (m)
2	44.03976	144.0891	100
3	44.04304	144.0911	100
4	44.04304	144.0904	100
5	44.04039	144.0889	100
6	44.04103	144.0886	100
7	44.04304	144.0898	100
8	44.04304	144.0917	100
9	44.03944	144.0896	100
10	44.03935	144.0902	100
11	44.04304	144.0924	100
12	44.04304	144.093	100
13	44.03925	144.0908	100

Transformed csv style flight plan is uploaded to Mission Hub – Litchi (https://flylitchi.com/hub). Litchi's Mission Hub allows user to edit and share waypoint missions online and later execute them using the Litchi Android or iOS App.

Fig. 3 Mission Hub-Litchi

Flight plan on Mission Hub is transformed to auto pilot software (Litchi) on iOS tablet machine makes it possible for user to let the UAV fly thorough the pre-programmed course.

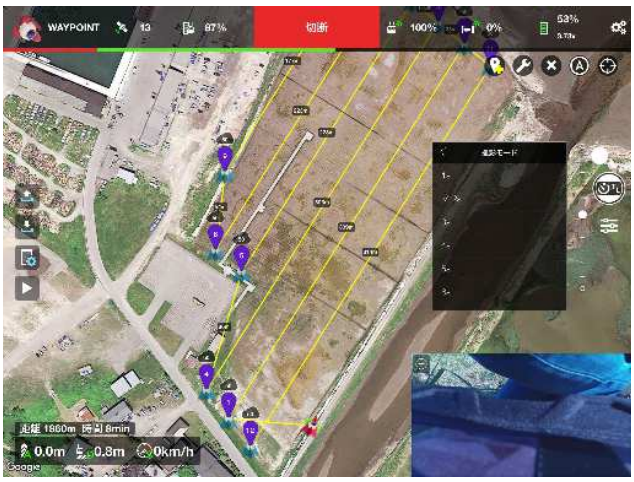

Fig. 4 Auto Pilot software LITCHI

4. STEREO-PHOTOGRAMMETRY

Auto pilot software makes it possible for UAV to fly along a pre-calculated course. Series of pictures can be used as stereo-photogrammetry method. Very precise high-resolution digital elevation models (DEMs) are obtained easily and at low cost. The author conducted auto pilot system at the grassland along sea of Okhotsk.

Fig. 5 Picture of Observatory using GoPro Camera attached to phantom 2

The author let phantom3 manually fly to the start point and then let it fly automatically using Litchi tablet software attached to controller. It is impossible for manned aerial vehicle to fly near the surface. In this research, pictures are taken every two seconds over grass land above 50 meter from ground level.

Manned aircraft must fly 300 meters high above ground level to avoid down burst. However, A UAV can fly 1 meter above ground level. It is impossible for manned aerial vehicle to fly such a low altitude. Using a UAV has a great advantage to get very precise surface data and generate 3 dimensional images.

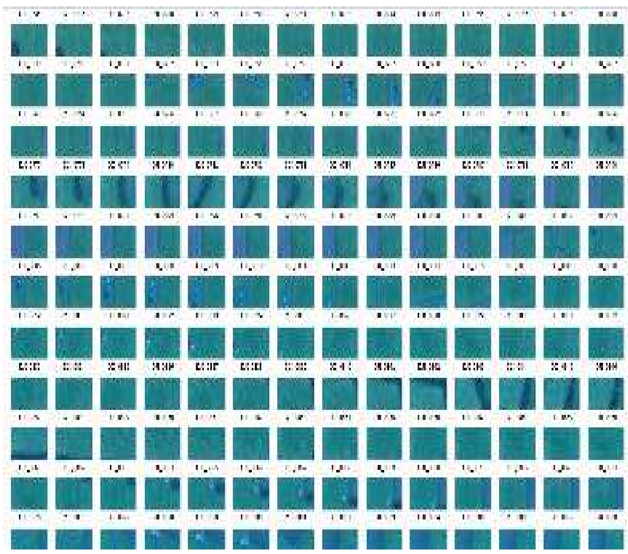

Fig. 6 Series of pictures 50 meter above ground level

ESRI recently released Drone2Map for ArcGIS. This software makes UAV into an enterprise GIS productivity tool. Using this software, the author has tried to create orthomosaics, 3D meshes using drone-captured still imagery.

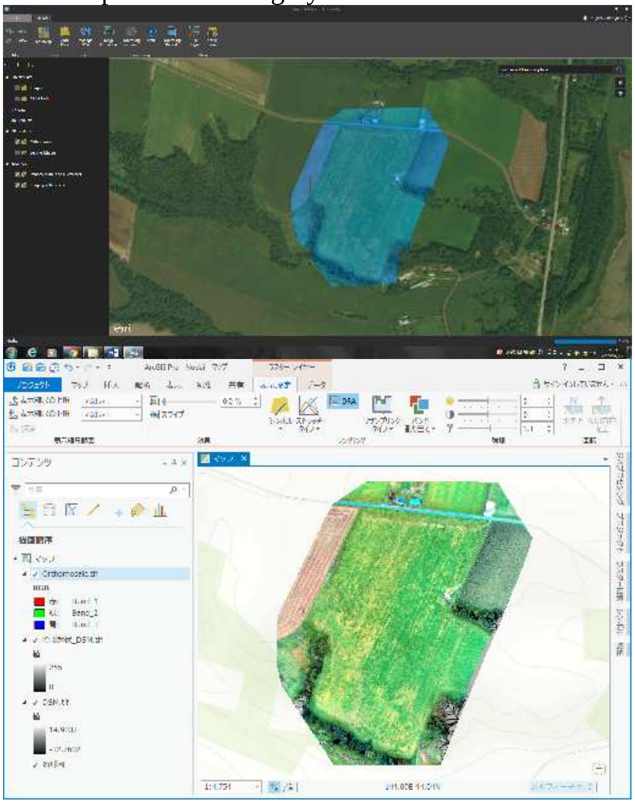

Fig. 7 Orthomosaics from drone-captured imagery

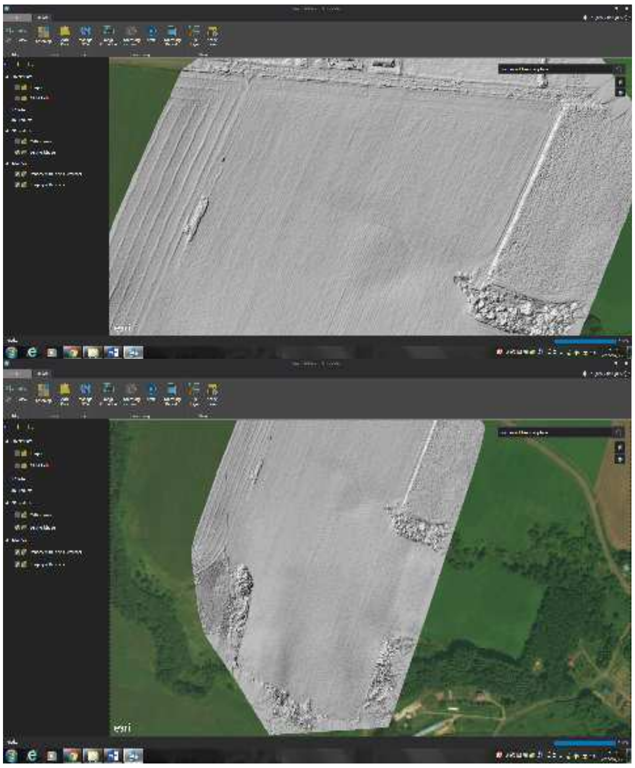

Fig. 8 High-resolution digital elevation models

This makes it possible to obtain more clear images and figures out the shape of structure such as building shown in Figure 9. Using three dimensional images, shape of buildings can be generated, that means that height of each plant can be calculated.

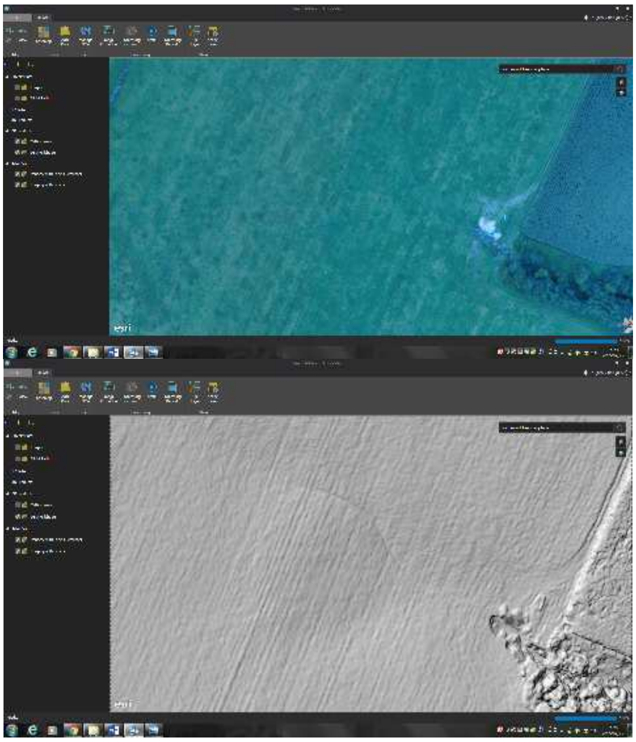

Fig. 9 Comparison between visible and DEMs

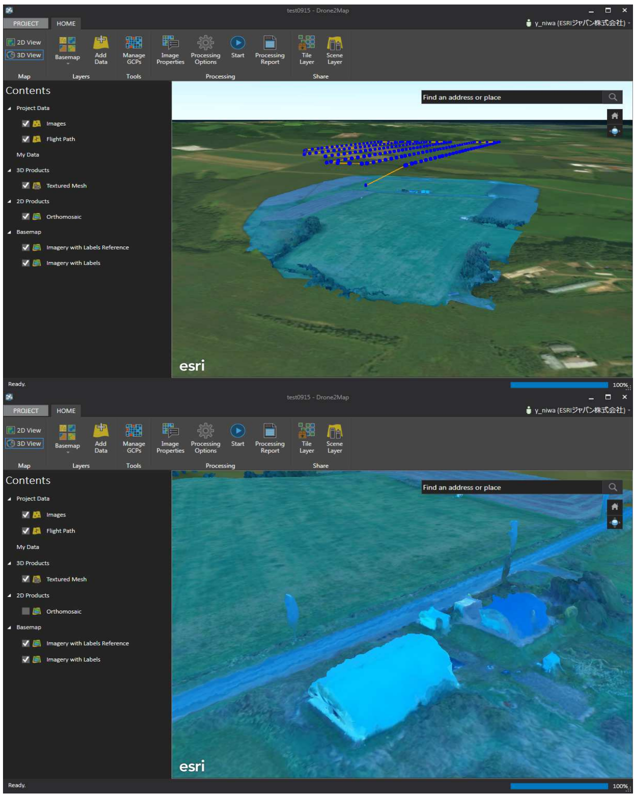

Fig. 10 Three dimensional images

5. CONCLUSION

In this paper, the fundamental methodologies to let UAV fly automatically and stereo-photogrammetry method are introduced. There must be potential and promising future applying proposed methodology to observe drifting ice along the sea of Okhotsk. The author let phantom2 to fly over drifting ice along the sea of Okhotsk (Drifting ice, 2015) as preliminary study during winter 2015.

To let UAV to fly under low temperature, battery must be pre-warmed up in advance. Once operation started, heat comes up from battery itself. To conduct operation above drifting ice, not quad copter but also aircraft shaped material can fly over much longer distance and collect more information.

The author conducted a drone work shop at Graduate school of Hokkaido University Oct the 3rd, 2016. Graduate student from Philippine, Nigeria, Tanzania, Indonesia, Russia, Malaysia, Bangladesh, Nepal participated. End of workshop, presentation entitled “How we can apply UAV to research field?” Three teams gave presentations there (See presentation movie files, 2016). A graduate student coming from Tanzania is interested in using air-craft shaped drone to observe Serengeti and Ngorongoro national park. The size of each park is more than 14,000 square km. The author proposed Tanzanian the method to let aircraft shaped drone to fly one way and change the battery and return to starting point. The author is interested in using aircraft shaped drone “Firefly6” and “Parrot”. Each aircraft shaped drone can gain 80km per hour and battery lasts more than 45 min. Applying series of proposed methodology and aircraft shaped drone for drifting ice observation leads to producing an innovation.

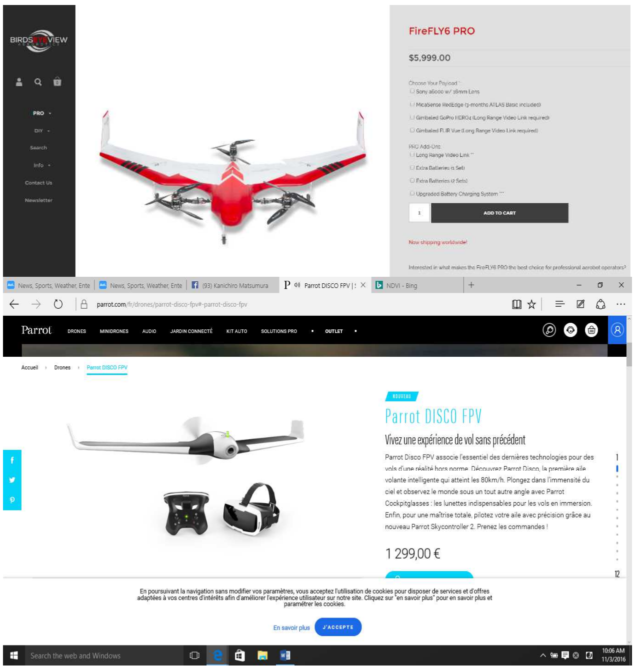

Fig. 11 Firefly6 (above) and Parrot Disco (below)

ACKNOWLEDGEMENTS

We thank to Dr. Issei Watanabe, Research Institute for Humanity and Nature, providing series of information related to UAV automatic flight and Firefly6, Parrot Disco. We also thank to Dr. Satoshi Inoue, National Agriculture and Food Research Organization providing agriculture information and Ms. Yuko Nakamura, ESRI Japan company to use Drone2 map software. This research is supported by Grant-in-Aid for Scientific Research from Ministry of Education, Culture, Sports, Science and Technology 2016 to 2018, entitled「ドローンを使ったおいしい牧草生成のための施肥システムの構築」

REFERENCES

Inoue, H, S. Uchiyama and H. Suzuki (2014): Multicopter Aerial Photography for Natural Disaster Research, *NIED Research Report*.

Ryan, J., C. and 7 others (2015): "UAV photogrammetry and structure from motion to assess calving dynamics at Store Glacier, a large outlet draining the Greenland ice sheet".

Litchi, App software (2016): available at https://itunes.apple.com /jp/app/litchi-for-dji-phantom-inspire/id1059218666?mt=8.

Drone2 map, Esri Company (2016), available at http://www.esri. com/products/drone2map.

Matsumura, K., K. Okuno (2015): Drifting Ice, available at https://www.youtube.com/watch?v=paB119vybNY.

A workshop at Hokkaido University, October (2016):
https://www.youtube.com/watch?v=OyGo_Pkh5w8
https://www.youtube.com/watch?v=yMN4Uufikng
https://www.youtube.com/watch?v=bKfyQYdvy_w.

Firefly6 Pro (2016): https://www.birdseyeview.aero/products /firefly6.

Parrot Disco (2016): https://www.parrot.com/fr/drones/parrot-disco-fpv#-parrot-disco-fpv.

Summary in Japanese

和文要約

無人航空機の流氷観測への可能性

松村寛一郎 [1]

[1] 東京農業大学

オホーツク沿岸域でのドローンによる自動飛行の設定と遂行の方法を紹介し，牧草地上での自動飛行による連続写真の撮影を遂行した．連続撮影された一連の写真群から，オルソ画像を生成し，精細な標高データ，建物の判別が立体的に可能となることを示した．夏季に蓄積されたノウハウを厳冬期のオホーツク海沿岸域での流氷観測へ適用する際の注意，固定翼機材の利用可能性について言及した．著者自身による北海道大学大学院での留学生向けのドローンワークショップを通じてタンザニアの留学生による国立公園での固定翼機材による観測の情報交換を続けている．オホーツク地域における厳冬期の流氷観測に対するイノベーションを生み出す可能性が見えつつある．