Research on the Arctic Bird Monitoring Deploying Unmanned Aerial Vehicle

Mijin Park*, Won Young Lee

Division of Polar Life Sciences, Korea Polar Research Institute, Incheon, Republic of Korea

** Current address: Department of Forest Sciences, Seoul National University, Seoul, Republic of Korea*

Abstract

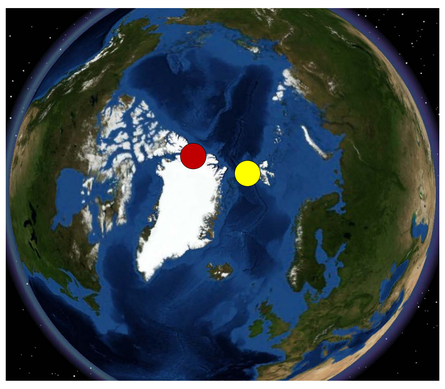
The purpose of this research is to apply the method of using unmanned aerial vehicle (UAV) to monitor the Arctic birds. The utilization of small UAVs, also known as drones, has recently become a key way of performing ecological monitoring, because they are suitable for obtaining large scale images safely. Accordingly, in this research, we utilized a quadricopter (Phantom 4 advanced, DJI co.) equipped with a visible light (Red, Green and Blue; RGB) camera (Phantom 4 camera, 1-inch 20MP sensor) and an external thermal camera (FLIR Vue Pro R, 13mm lens) in order to observe arctic birds inhabiting difficult to observe areas. On 16th and 18th of July 2018, the RGB and thermal shots were taken in Sirius Passet (82°47.6'N 42°13.7'W) in Northeast Greenland National Park, and the targets were incubating common ringed plover (*Charadrius hiaticula*) and a flock of moulting pink-footed geese (*Anser brachyrhynchus*) located on the sea. In thermal images, common ringed plover showed high surface temperature, 8.4°C higher than the background temperature, and it enabled us to detect the camouflaged nest of common ringed plover. Similarly, cold sea water and the surface temperature of pink-footed geese were well contrasted, showing 5°C difference, therefore it was possible to grasp the exact number of birds. Also, on 4th of August 2018, the nests of black-legged kittiwake (*Rissa tridactyla*), black guillemot (*Cepphus grylle*) and Atlantic puffin (*Fratercula arctica*) were filmed at the cliffs (Steinflåstupet; 78°57.5'N 11°36.4'E) near Ny-Ålesund, Svalbard. It was possible to accurately observe these bird communities with small UAVs, even at the cliffs which were difficult to approach. Like this, monitoring method of deploying small UAV is serviceable in reducing human bias and repetitive operations, hence we expect more research on the arctic bird with UAVs in the future.

Introduction

1. Thanks to technological advances, small UAVs became commercialized at reasonable price, and connectable with various cameras.
2. Small UAVs are utilized in ecological research because they can obtain high resolution images easily and safely.
3. There are constraints on traditional monitoring due to Arctic topography, glaciers, and characteristics of birds.

▶ Monitor the Arctic Birds effectively with small UAV equipped with cameras!

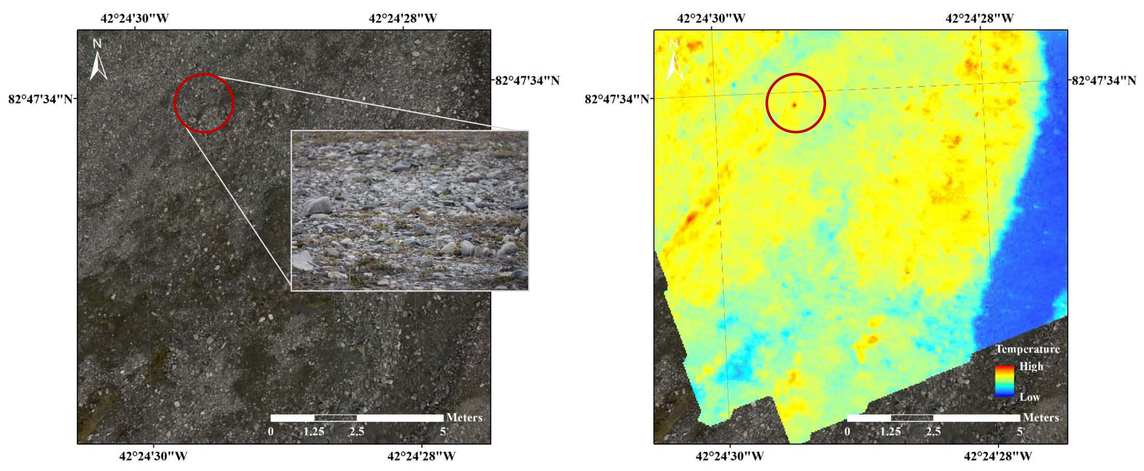
Methods and Materials



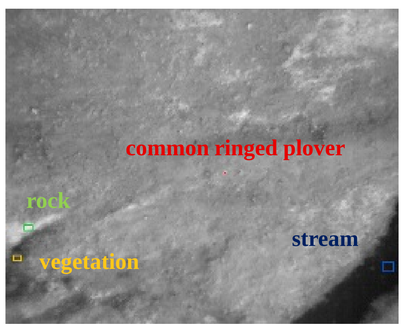
Study Site	Observed Species	Methods
● Sirius Passet (82°47.6'N 42°13.7'W)	Common ringed plover (*Charadrius hiaticula*) Pink-footed goose (*Anser brachyrhynchus*)	• Piloted quadricopter equipped with RGB and thermal camera to the targets at a speed of 5 m/s: flights at 20m-height for 5 min, controlled 100m away from common ringed plover and at 110m-height for 20 min, 500m away from pink-footed geese • Overlapped the images with PhotoScan Pro software (Agisoft LLC)
● Steinflåstupet (78°57.5'N 11°36.4'E)	Black-legged kittiwake (*Rissa tridactyla*) Black guillemot (*Cepphus grylle*) Atlantic puffin (*Fratercula arctica*)	

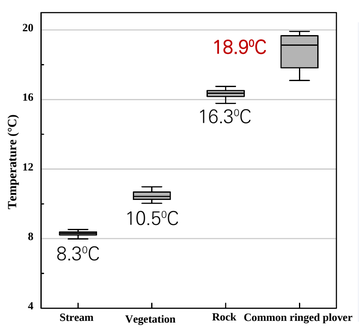
Results

▼ RGB and thermal image analysis of common ringed plover and pink-footed geese

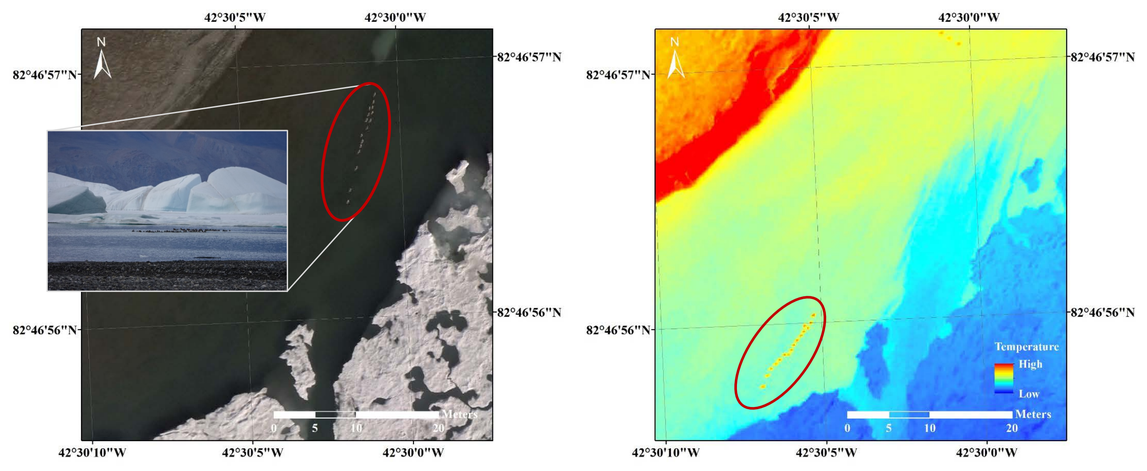


△ Incubating common ringed plover was not seen in the mosaicked RGB image (left, n=5), but the nest location was clearly detected in the mosaicked thermal image (right, n=4) due to high surface temperature.

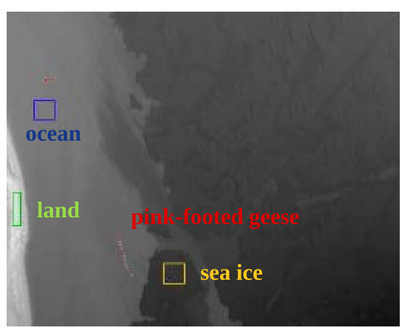


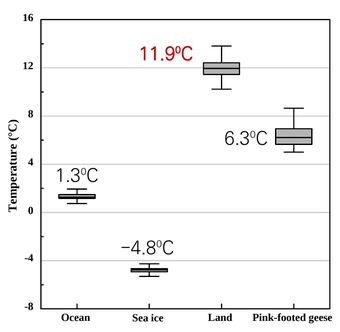


◁ 182, 70, 66, 7 pixels of surroundings (stream, vegetation, rock) and common ringed plover were selected respectively, and the bird showed the highest temperature (18.9°C).



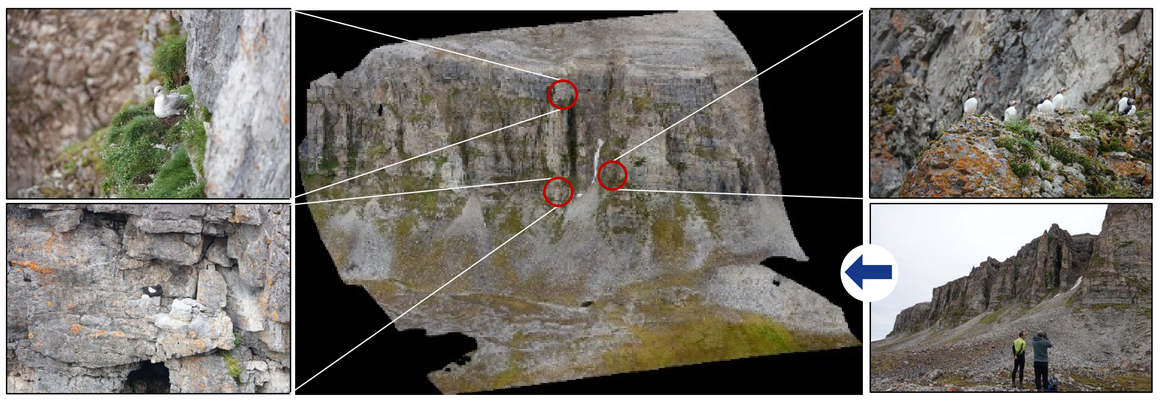
△ A flock of pink-footed geese (16 individuals) were shown as grey dots in the mosaicked RGB image (left, n=69), and the exact number could be clearly counted also in the mosaicked thermal image (right, n=24) due to higher surface temperature.





◁ 868, 960, 572, 83 pixels of surroundings (ocean, sea ice, land) and pink-footed geese were selected respectively, and the birds showed the highest temperature (11.9°C).

▼ RGB image analysis of black-legged kittiwake, black guillemot and Atlantic puffin and cliff modeling



◁ Stereoscopic images were obtained through point cloud modeling of 291 RGB images. Through this cliff model, the nest location of observed species could be elaborately shown in three-dimensional space, and the breeding status were identified. The nests of black-legged kittiwake were gathered near the top of cliff, black guillemots were in the middle, and Atlantic puffins were at the bottom.

Discussion

Small UAV combined with RGB and thermal camera may serve a complementary role to traditional ground monitoring. Via high resolution thermal image, the well camouflaged nest of common ringed plover was detected, and the exact number of pink-footed geese on the sea was counted. First shooting and later analyzing method ensures safety and reduces mistakes that happen in the field.

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Also, this has been conducted under permissions from the Greenland government (permission no. C-18-4-09). All applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

소형 무인항공기를 활용한 북극 조류 모니터링 방법에 관한 연구

박미진[p1], 이원영[c2]
서울대학교 산림과학부[1], 극지연구소 극지생명과학연구부[1,2]

본 연구의 목표는 드론이라 불리는 소형 무인항공기(UAV; unmanned aerial vehicle)를 이용한 모니터링 기법을 북극 조류에 적용하는 것에 있다. 소형 UAV를 활용하면 선명하면서 방대한 영상을 안전하게 얻을 수 있어 최근 다양한 생태학적 모니터링 방식으로 각광받고 있다. 따라서 본 연구에서는 육안으로 관찰하기 어려운 곳에 서식하는 북극 조류에 가시광선 영역의 카메라(Phantom 4 camera, 1-inch 20MP sensor)와 열화상 카메라(FLIR Vue Pro R, 13mm lens)가 장착된 쿼드리콥터(Phantom 4 advanced, DJI co.)를 접근시켜 사진을 획득한 후 분석하였다. 2018년 7월 16일과 18일에는 북동 그린란드 국립공원의 시리우스 파셋(Sirius Passet; 82°47.6'N 42°13.7'W) 지역에서 포란 중인 흰죽지꼬마물떼새(*Charadrius hiaticula*)와 바다에서 깃갈이 중인 분홍발기러기(*Anser brachyrhynchus*) 한 무리를 가시광선과 열화상 카메라로 촬영하였다. 열화상 사진에서 높은 체표면 온도와 지면 온도가 8.4°C의 차이를 보여 잘 위장된 흰죽지꼬마물떼새 둥지를 탐지할 수 있었으며 차가운 해수와 분홍발기러기의 체표면 온도도 5°C 대비되어 정확한 개체수를 파악할 수 있었다. 그리고 2018년 8월 4일에는 스발바르 제도의 니알슨(Ny-Ålesund) 인근 절벽(Steinflåstupet; 78°57.5'N 11°36.4'E)에서 서식하는 세가락갈매기(*Rissa tridactyla*), 흰죽지바다비둘기(*Cepphus grylle*), 코뿔바다오리(*Fratercula arctica*)의 둥지를 가시광선 카메라로 촬영하였다. 접근하기 어려운 해안절벽에서도 소형 UAV를 이용하여 정밀하게 조류 군집의 둥지 관찰이 가능하였다. 이처럼 소형 UAV를 활용한 연구방법은 지상 관찰과 같은 전통적 모니터링 기법과 병행할 경우 적은 인력으로 정확한 결과를 얻을 수 있어 앞으로 더욱 많은 북극 조류 모니터링에 활용할 수 있을 것으로 기대한다.

교신저자 E-mail: wonyounglee@kopri.re.kr