Detection of free-living birds using visible and thermal cameras with an unmanned aerial vehicle

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Introduction

- Unmanned aerial vehicles (UAVs), so-called ‘drones’, have facilitated many ecological studies at fine spatial resolutions.
- Possible benefits of using UAVs exist: efficiency and effectiveness.
  - Reducing human bias
  - Enhancing accuracy
  - Obtaining massive data
  - Performing at reasonable price
  - Operating spatiotemporally repetitive surveys
  - Satisfying diverse purposes, e.g. measuring topographical changes
  - Assuring accessibility to dangerous environments

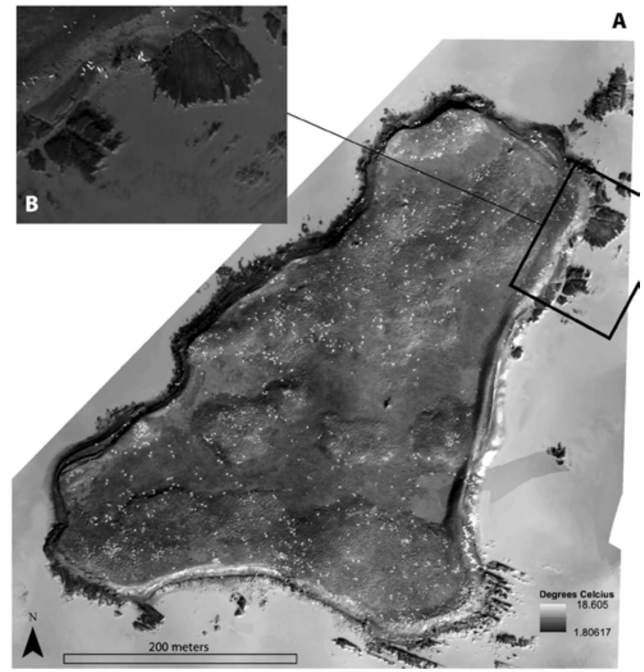
Introduction

UAVs are now widely used in wildlife research, and researchers adopted UAVs to monitor birds as supplementary tools of ground monitoring.

Reference	Research theme
Chabot and Bird (2012)	Animal count comparison (Canada and Snow goose)
Chabot et al. (2015)	Animal count comparison and disturbance (Common tern)
Grenzdörffer (2013)	Automatic animal count (Common gull)
Groom et al. (2011)	Detection algorithm (Lesser flamingo)
Israel and Reinhard (2017)	Species detection (Lapwing)
Junda et al. (2015)	Multispecies identification (Osprey nest, etc.)
Kidawa et al. (2016)	Disturbance (Adélie penguin)
Liu et al. (2015)	Species detection and image classification (Black-faced spoonbill)
McClellend et al. (2016)	Animal count (Tristan albatross)
McEvoy et al. (2016)	Multispecies detection and disturbance (Grey teal, etc.)
Ratcliffe et al. (2015)	Animal count comparison (Gentoo penguin)
Rümmler et al. (2018)	Disturbance (Adélie and Gentoo penguin)
Rümmler et al. (2016)	Disturbance (Adélie penguin)
Rush et al. (2018)	Multispecies identification and disturbance (Lesser black-backed gull, etc.)
Sardà-Palomera et al. (2012)	Animal count comparison (Black-headed gull)
Vas et al. (2015)	Disturbance (Mallard, Greater flamingo, Common greenshank)
Weimerskirch et al. (2018)	Disturbance (King penguin, etc.)
Weissensteiner et al. (2015)	Species detection (Hooded crow nest)
Wilson et al. (2017)	Acoustic recording (Wood thrush, etc.)

Introduction

In particular, thermal cameras have occasionally employed to capture nocturnal species and now can be equipped on UAVs.



- ➢ This research aims to detect bird species using visible and thermal camera combined with UAVs.

Junda et al. 2015. Proper flight technique for using a small rotary-winged drone aircraft to safely, quickly, and accurately survey raptor nests. J. Unmanned Veh. Syst. 3: 222–236

Seymour et al. 2017. Automated detection and enumeration of marine wildlife using unmanned aircraft systems (UAS) and thermal imagery. Scientific Reports 7:45127.

Materials and Methods

Study site and populations

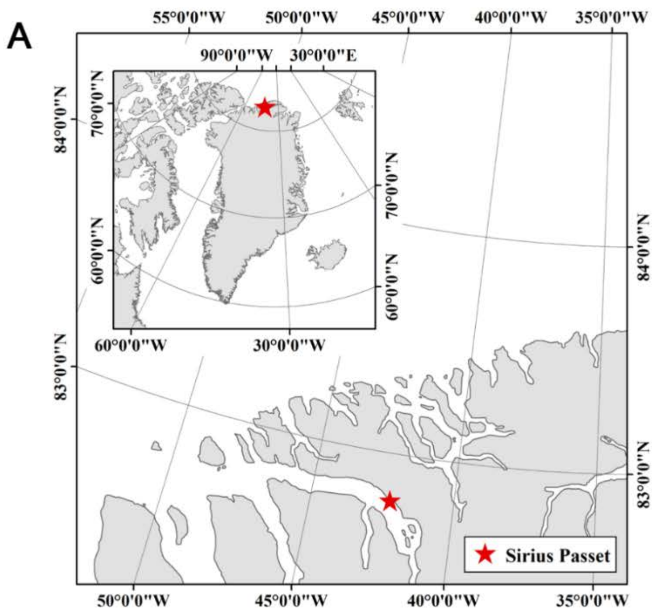


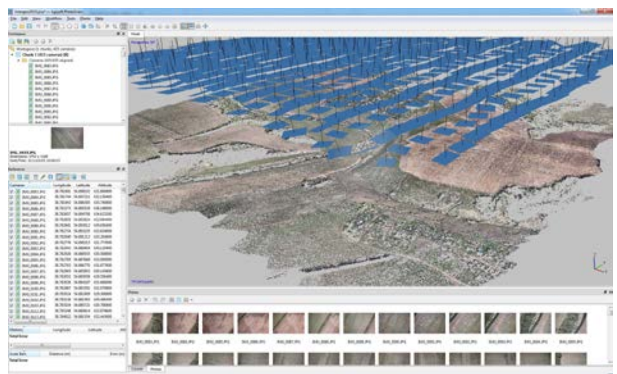
Fig 1. The location of our study site.
(A) Sirius Passet, at latitude 82°47.6´N and longitude 42°13.7´W in North Greenland.
(B) Incheon, at latitude 37°21.1’N and longitude 126°39.1’E in Republic of Korea.

Lee et al. 2019. Detection of two Arctic birds in Greenland and an endangered bird in Korea using RGB and thermal cameras with an unmanned aerial vehicle (UAV). PLoS ONE (*in revision*)
Boertmann et al. 2015. Geese in Northeast and North Greenland as recorded on aerial surveys in 2008 and 2009. Dansk Orn. Foren. Tidsskr. 109: 206-217.

Materials and Methods

Flight details and image acquisition

Operate UAV and take photos → Mosaic the images → Analyze temperature values



Frame	Visible camera	Thermal camera	Location
Phantom 4 advanced, DJI co.	Phantom 4 camera with 1-inch 20 MP sensor	FLIR Vue Pro R, 13 mm lens, 640 × 512 pixels sensor	Sirius Passet, Greenland
Phantom 4, DJI co.	Phantom 4 camera with 1-inch 20 MP sensor		Incheon, RO Korea
DAYA 550		FLIR Vue Pro R, 13 mm lens, 640 × 512 pixels sensor	

Results

Monitoring of molting geese flocks

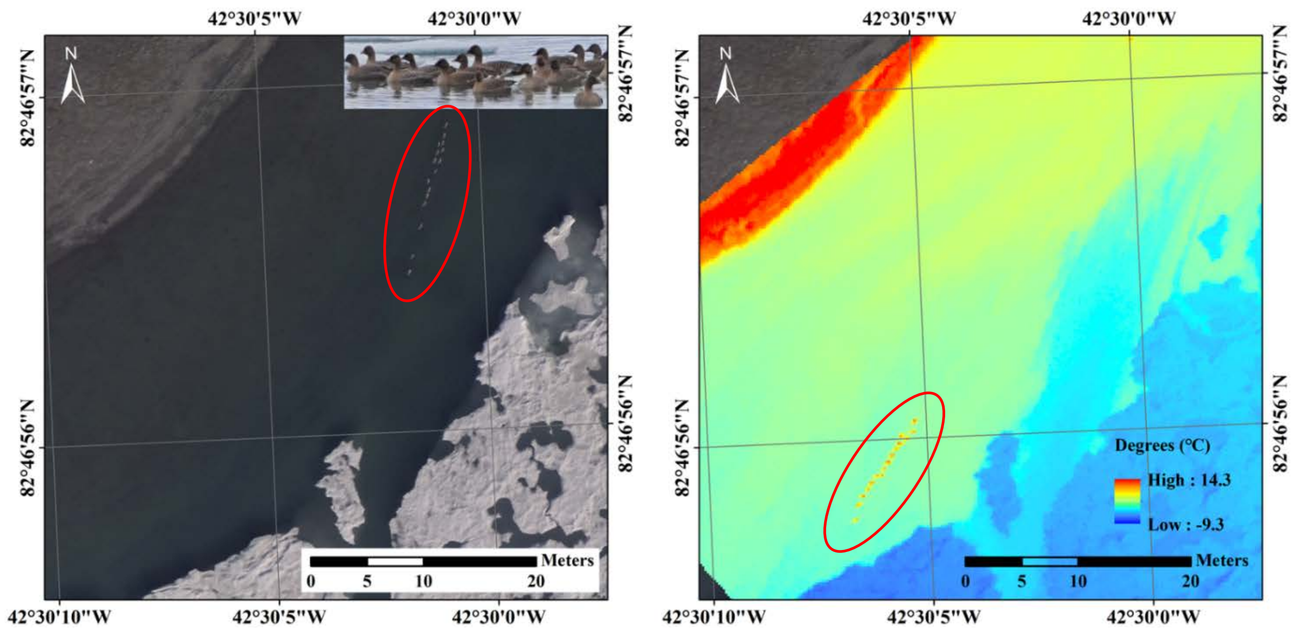


Fig 2. Mosaicked RGB images (left, n = 69) and thermal images (right n = 24), which cover the geese and the surrounding area with enough overlap between images. The pink-footed geese on the open water that were detected by binoculars by the researchers are presented (upper right in the left RGB image).

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Results

Monitoring of molting geese flocks

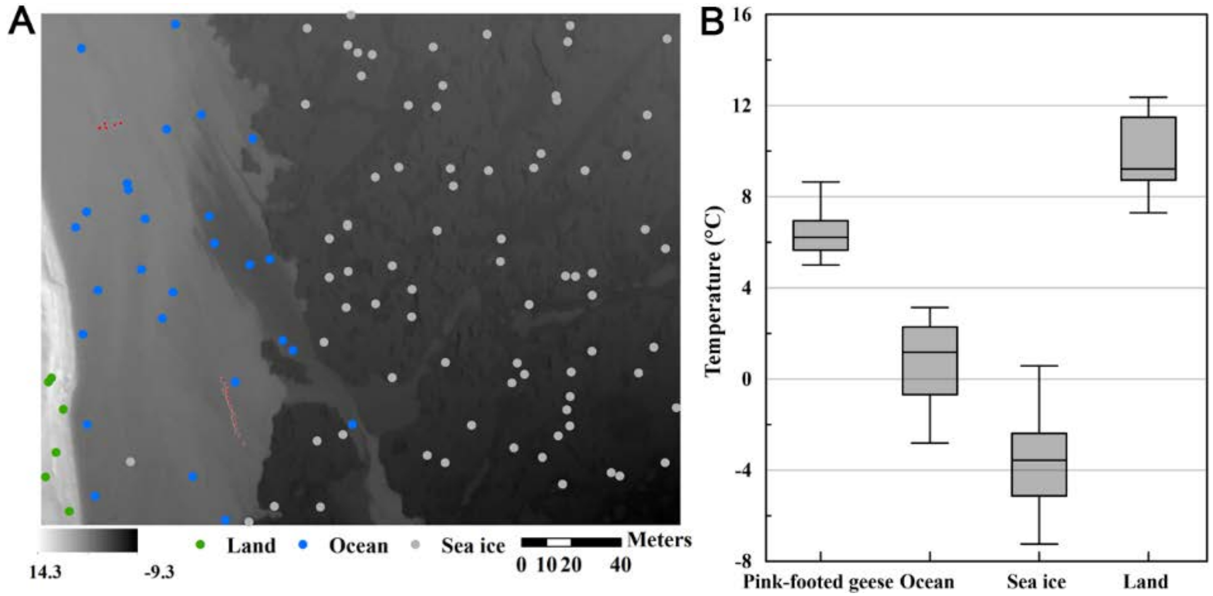

Fig 3. A thermal image shot and temperature distributions of each group image pixel.
(A) A thermal shot at 110 m high with UAV on a geese flock (red dots), ocean (blue circles), sea ice (grey circles) and land (green circles). (B) Temperature distribution of 16 pink-footed geese body shapes and randomly selected dots in each group (ocean, sea ice and land) which were presented in box-whisker plots (from the lower quartile to the upper quartile box with median line in the box with whiskers from the lowest to the highest value) of the temperature distribution of thermal image pixels in ocean, sea ice, land and pink-footed geese.

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Results

Monitoring of an incubating plover

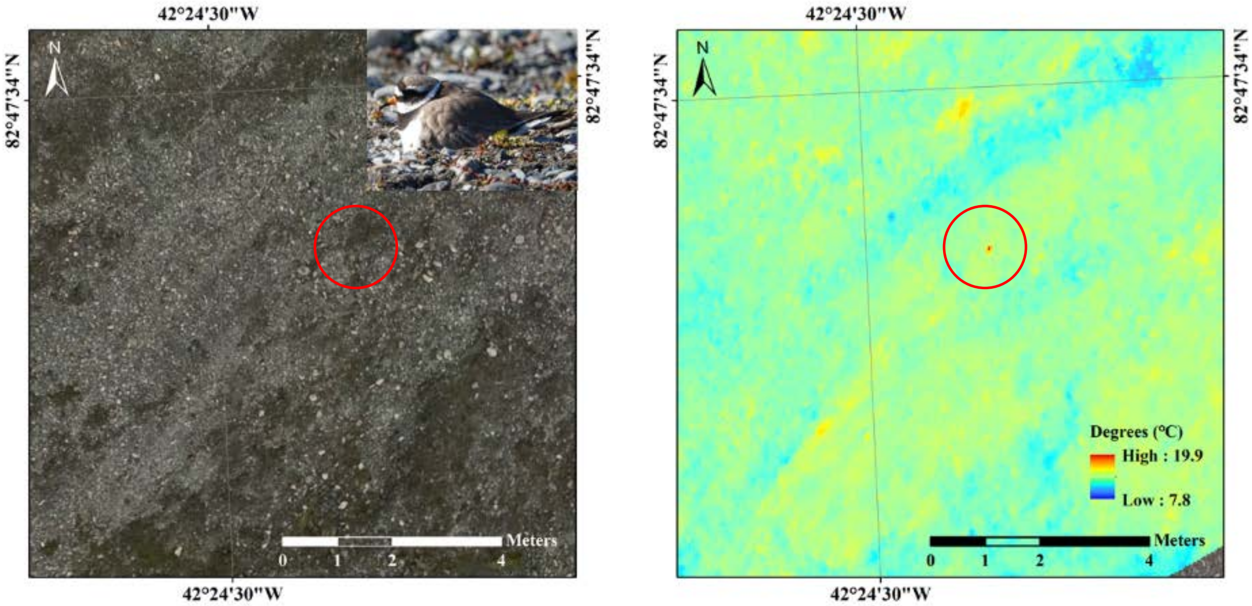

Fig 4. A RGB image (left) and a thermal image (right), which cover one incubating nest (in a red circle). The incubating plover that had been previously detected by the researchers during the survey is presented (upper right in the left RGB image).

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Results

Monitoring of an incubating plover

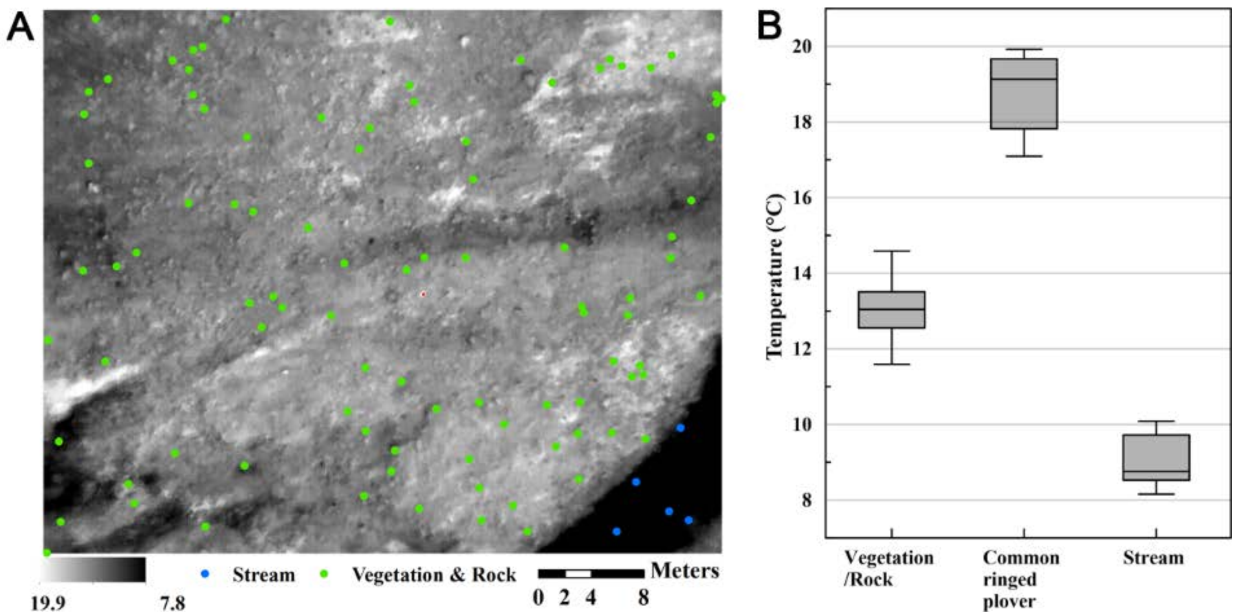

Fig 5. A thermal image shot and temperature distributions of each group image pixel.
(A) A thermal shot at 20 m high with UAV on an incubating plover (red dot), stream (blue circles) and vegetation and rock (green circles). (B) Temperature distribution of one common ringed plover body shape and randomly selected dots in each group.

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Results

Monitoring of birds in a muddy tidal area

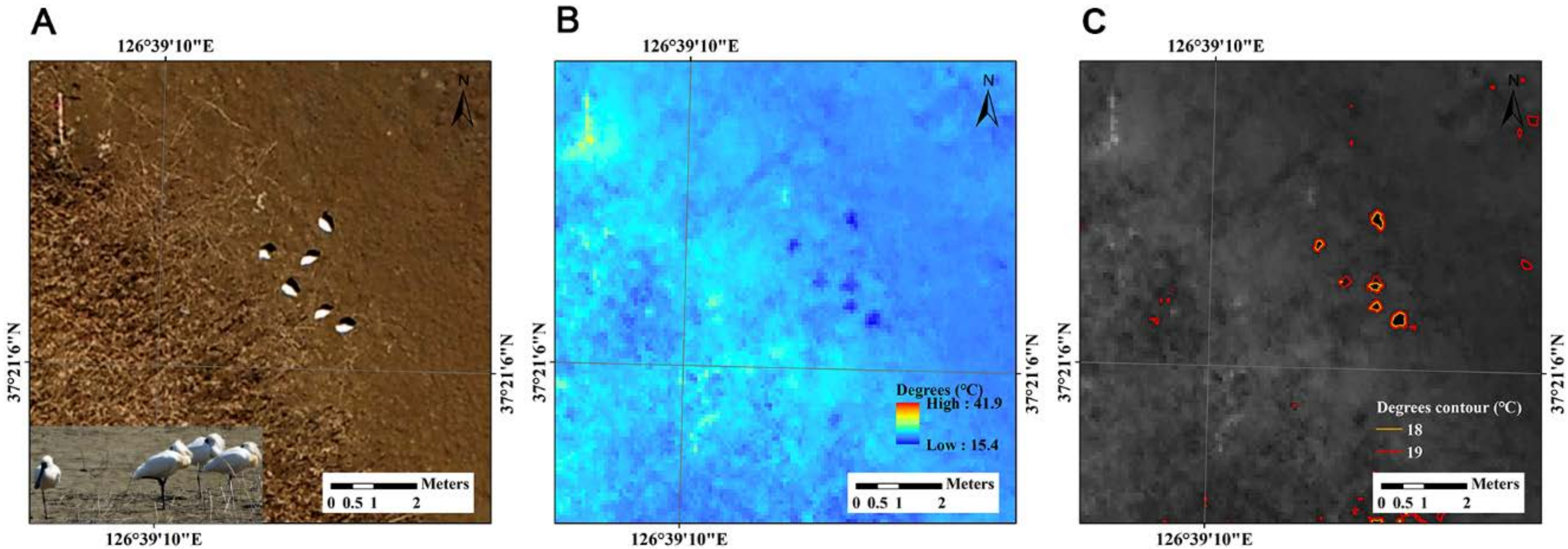

Fig 8. A blind survey with UAV images on white objects in a mud flat area.
(A) Zoomed RGB image at 110 m height.
(B) Thermal image on the same spot with the RGB image.
(C) Selected contours using 18°C temperature threshold on a flock of six spoonbills provided the countable round shape figures.

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Discussion

The effectiveness of a UAV combined with a thermal camera was tested in an Arctic environment and in restricted area.

Israel and Reinhard. 2017. Detecting nests of lapwing birds with the aid of a small unmanned aerial vehicle with thermal camera. 2017 ICUAS. 1199 – 1207.

Acknowledgements

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Q & A

Thank you!