

SURVEY OF WILD ANIMALS IN THE SNOW IN AIRBORNE REMOTE SENSING IMAGES USING COMPUTER AIDED DETECTION OF THE MOVING WILD ANIMALS ALGORITHM

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ABSTRACT:

The coexistence of wild animals with people needs proper conservation. And conservation of wild animals needs adaptive management. And population size estimation of wild animals is essential to understand the results by adopting measures. However, there is not enough the population size information of large-sized mammals. Therefore, it is required to develop a new index of the population size variation that could be applied with wide area and used with other indexes. Besides, it is expected to increase the ecological knowledge through the wild animal monitoring using remote sensing. In this situation, we developed algorithm to detect automatically moving wild animals in the snow in airborne remote sensing images with 60% image overlap. And we survey wild animals using this algorithm.

1. INTRODUCTION

Conservation of wild animals needs adaptive management which is a systematic process for continually improving management policies and practices by learning from monitoring results. Particularly, monitoring of the population size change is essential. However, there is not enough the population size information of large-sized mammals (Teruo et al., 1997). This is partly because many of the mammals are nocturnal, and it is difficult to observe the large-sized mammals because of their large habitat area (Seiki et al., 2008). Therefore in Japan the population size of large mammals has been estimated using both direct and indirect methods, although these estimated population sizes have non-negligible errors. Accordingly indexes of the population size have been used instead of their absolute numbers. And multiple indexes are often used together to improve estimation accuracy. Under these circumstances, it is required to develop a new index of the population size variation that could be applied with wide area and used with other indexes. Estimation of the population size of large mammals over a wide area using remote sensing is one of promising methods for this purpose (Yu et al., 2009b). However it costs hard labor to find directly wild animals by visual examination of remote sensing images. In addition, we may overlook some wild animals because remote sensing image is taken from above, not from side. To solve these problems we developed “Computer aided Detection of the Moving Wild Animals Algorithm (DWA)” (Yu and Tsuneo, 2009a).

In this study, we applied DWA algorithm to a survey of wild animals in the snow in airborne remote sensing images. This is the first report on automatic detection of wild animals from remote sensing images except infrared thermal imagery in Japan.

2. MATERIAL

The study area is Sarufutsu Village in northern Hokkaido, Japan. We used airborne remote sensing images taken in the Sarufutsu River basin (45°12'N, 142°2'E Fig.1).

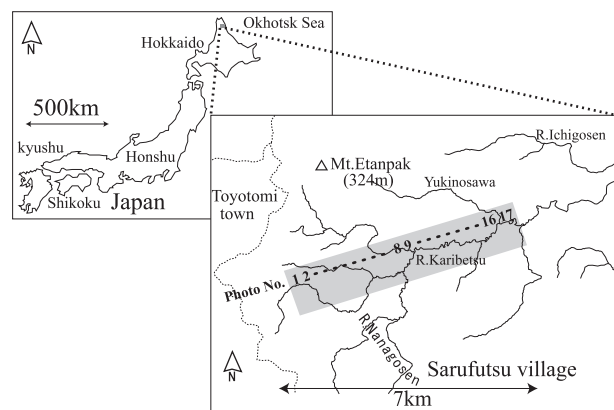


Figure 1. The study area in Sarufutsu, Hokkaido in Japan (gray rectangle is the area of aerial photographs)

Fig. 2 shows birds-eye view of the taken area from the Okhotsk Sea. A geographical feature of this area could be as follow: 100 ± 60 m above the sea, low difference of elevation, many meandering flows of rivers, and an artificial forest.

The 68 airborne remote sensing images used in this study were collected May 3, 2006 at an altitude of 750 m with 60 % image overlap at an interval of 3 seconds. The pixel resolution of the imagery was about 8 cm. The imaged area was about 600 m by

1 km per scene. And these images have four bands in the visible – near infrared region. The target species in this study are brown bear, sika deer, fox, and human which can be recognized in 8 cm resolution imagery.

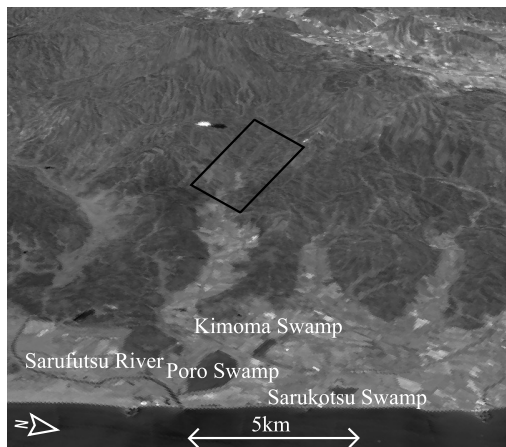


Figure 2. Birds-eye view from the Okhotsk Sea (a black rectangle is the area of aerial photographs) 2002 ASTER 3A01

3. METHODS

Fig. 3 shows flowchart of algorithm to detect the moving animals in airborne remote sensing images stereo pairs.

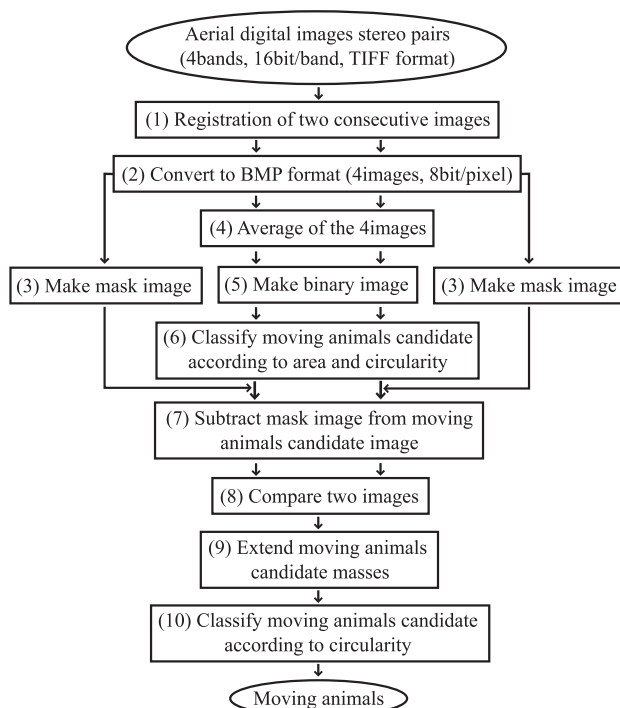


Figure 3. Flowchart of algorithm to detect the moving animals in airborne remote sensing images stereo pairs

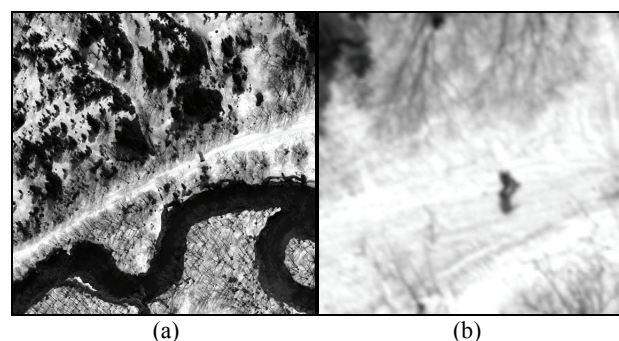
The processing of DWA algorithm could be as follow:
1) Register two overlapping images with Triangulation method in ENVI4.7.

- 2) Convert images to BMP format by converting minimum DN value to 0, maximum DN value to 255, and linearly interpolating between them.
- 3) Make a mask image of trees and rivers with NDVI (normalized difference vegetation index).
- 4) Calculate an average image from four-band images.
- 5) Make a binary image by Laplacian-histogram method with moving window function, P-tile method, and Otsu method.
- 6) Classify moving animal candidates according to their areas and circularities. The area is determined from size of target animals and circularity is determined from circularity of the form which was considered as moving animals by visual inspection.
- 7) Subtract a mask image from moving animal candidate image.
- 8) Compare two overlapping images. Step1), the tips of a tree in an image are not same as those of a same tree in another image in a position and form. However, the position of the root of a tree is same. In case the position of a part of a mass is superimposed between overlapping images, this mass is regarded as a non-moving object. Therefore we rejected it. Step2), we compared the animal candidate mass and those within the possible moving range in another image. And in case two compared masses resemble closely, we extracted the masses as moving animal candidates.
- 9) Extend moving animals candidate masses: The moving animal masses are clear. However, shadows of tree branches that cause many “dummy masses” (false detection of moving animals) are obscure. In other words, DN values of dummy masses are close to surrounding DN values but DN values of the moving animal masses are not. Therefore when surrounding DN values are closer to DN values of masses, we extended the masses.
- 10) Classify moving animal candidates according to their circularities. The extended dummy masses have low circularity.

4. EXPERIMENTAL RESULTS

4.1 Detection Accuracy Test of DWA Algorithm

Since we found a walking human in images used in this study by visual observation, we applied developed algorithm to two images of 2000x2000 pixels including the human. Fig. 4 shows input images, human images taken from input images, and the human extracted in a result image.



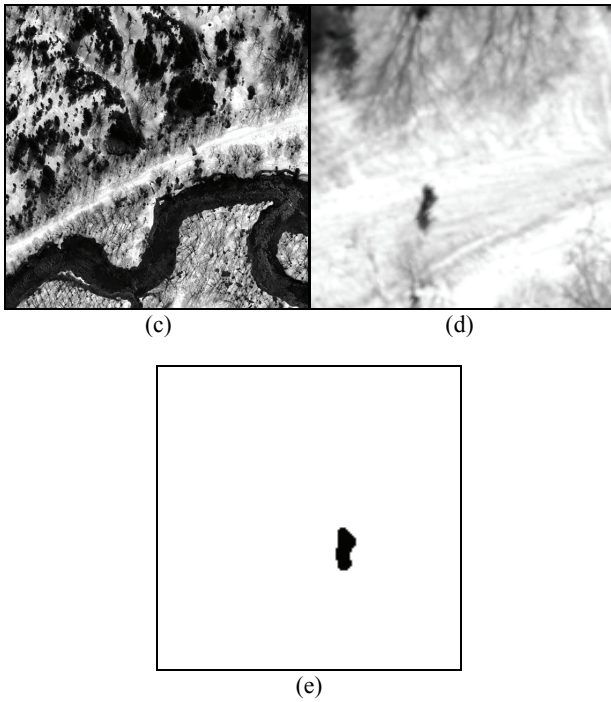


Figure 4. Input images and a result image
 (a) Input image 1 (b) A human in input image 1
 (c) Input image 2 (d) A human in input image 2
 (e) A result image with an extracted human

DWA algorithm could extract the walking human from a total of 2192 masses. However 2 dummy masses are extracted as moving animal candidates.

4.2 Survey of Wild Animals by Using DWA Algorithm

The survey of wild animals by applying this algorithm to 68 airborne remote sensing images has carried out and is still continuing. And we discovered an another walking human in 3 images. Fig. 5 shows 3 images with an extracted human.

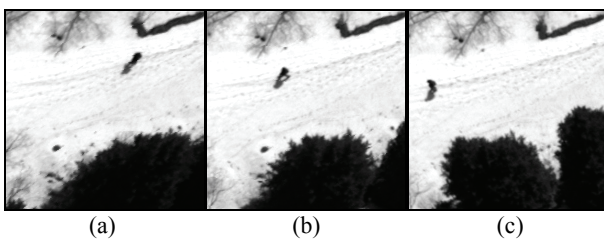


Figure 5 A discovered walking human in 3 images

5. CONCLUSION

The survey of wild animals using DWA algorithm is still continuing. By the result we discovered a walking human in 3 images. And only 20 dummy masses are extracted as moving animal candidates in 13000x4000 pixel images. Therefore DWA has a no problem of accuracy as aerial image interpretation support system of moving wild animals.

6. REFERENCES

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