A study on classification and monitoring of marine debris using multi-spectral images and deep learning

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Introduction

• Over the past three years, the Ministry of Maritime Affairs and Fisheries of Korea has collected about 114,000 tons of marine waste annually. Currently, the collection amount increases yearly, increasing the number of on-site monitors to collect marine litter, but it is inefficient in terms of time and cost. Therefore, a new detection study that combines remote sensing and artificial intelligence is needed. Although research using only optical images is underway, this study used multiple spectral images to detect and monitor marine waste using the unique spectral characteristics of each marine waste candidate group.

Data & Methods

Survey area & Drone surveys

• location: Gadeokdo seawall

• Dates : January 11th, March 29th , 2023

• Times : 11:00 a.m. – 1:30 p.m. (KST)

• Reason for location selection :

1. It is adjacent to the mouth of the Nakdong River, which is on the large side of Korea, so it has the geographical characteristic of settling marine waste as the point
2. Various marine waste caused by human activities is created as an area where tourism and activities (camping, etc.) can be conducted
3. A large amount of marine waste has been found on islands around the survey area due to the effects of ocean currents and weather

Fig. 1. Gadeokdo seawall -> Data acquire location

Image data acquisition

• The drone is equipped with Micasense Rededge MX-Dual, a multi-spectral sensor, to obtain synchronized pixel alignment images in a total of 10 bands at a photographic altitude of 20 to 150m.

• Data was obtained by directly floating a group of marine litter candidates about 3m away from this survey area.

• Ground Sampling Distance (GSD) of the acquired multi-spectral images is 1.38 to 10.41 cm/pixel (20 to 150m) to obtain high-resolution images.

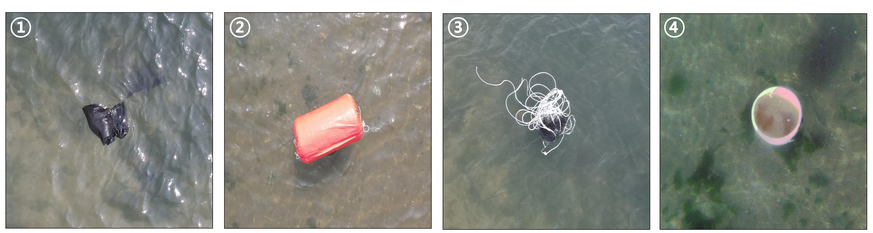


Fig. 2. 4 different colors and materials of Marine litter candidates for this study

(Black plastic bags, Orange-colored buoy, Rope, White basket)

Image processing

• Multi-spectral images data with a total of 10 bands are aligned into one image.

• After aligning with one image, size it to 128 x 128 to utilize the Deep learning model.

• Image augmentation is used to reduce the possibility of overfitting the model due to the small number of acquired images.

Deep learning algorithm

• Using the Convolution Neural Network (CNN) model, a helpful algorithm for finding Patterns for analyzing images, and multi-spectral images are directly learned, and marine litter is detected using patterns.

• Image classification is performed according to the number of pixels or the photographic altitude of the object according to the obtained marine litter candidates.

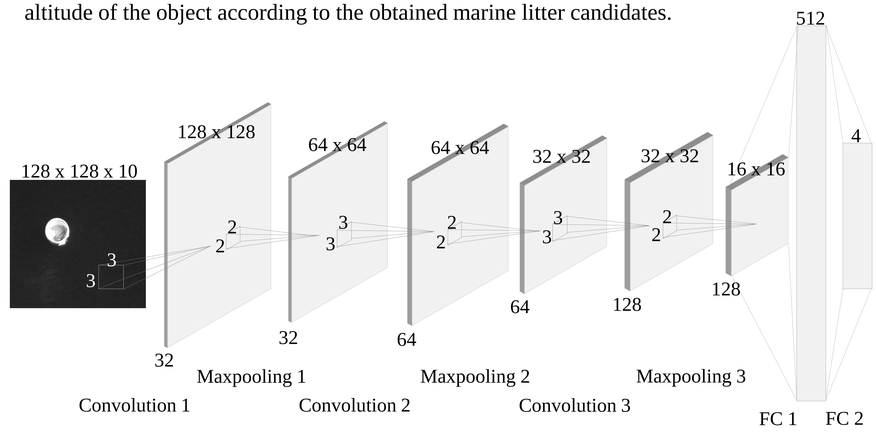


Fig. 3. Data processing and CNN model structure

Results

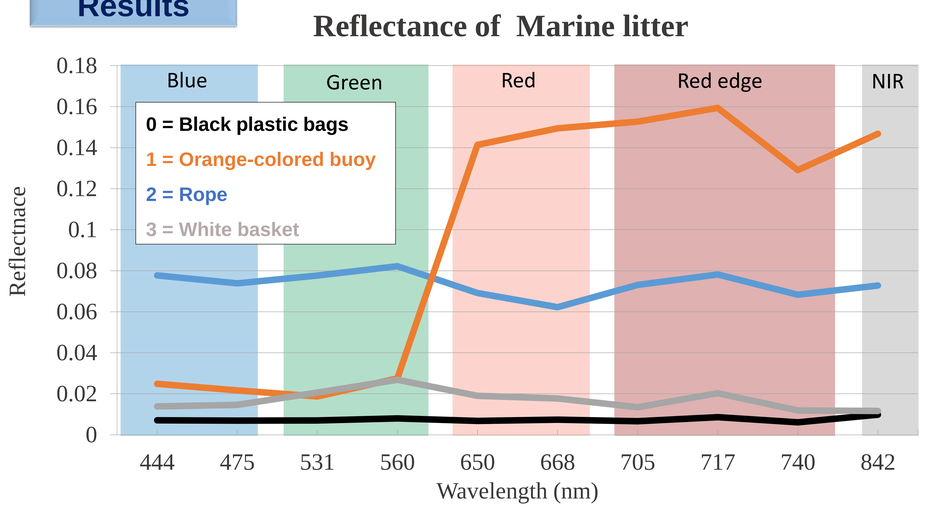


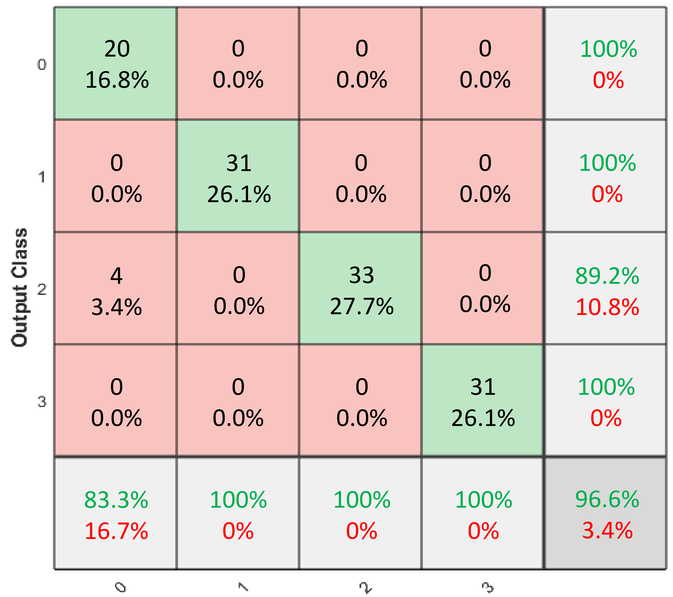
Fig. 4. Results of Reflectance graphs of this study of marine litter candidates

Reflectance of marine litter candidates

• Based on GSD, multi-spectral images obtained at a photographic altitude of 40 to 100m are used to check the reflectance of each marine litter candidate for effective reflectance measurement.

• Reflectance results of marine litter candidates to be used in the model vary according to colors and materials characteristics.

• In the case of black plastic bags, it was confirmed that they absorb reflectivity due to the characteristics of colors and materials.



Training set 70% (834)

Validation set 20% (238)

Test set 10% (119)

Mini-batch size : 64

Epoch : 10

Evaluation index	Rate (%)
Precision	97
Recall	95
F1 score	96
Accuracy	96

Fig. 5. CNN Model performance (confusion matrix)

Table. 1. The values of precision, recall, f1 score, and accuracy in the confusion matrix

Conclusion & Discussion

• It was confirmed that the spectral characteristics were different for each marine waste classification group taken in this study (Fig. 4), and about 93% through the CNN model, an image analysis algorithm.

The above evaluation indicators are confirmed to be good results (Fig. 5). In the future, the accuracy of marine waste detection obtained from Socheongcho Ocean Research Station or other areas will be measured using the model of this study.

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