A Study on Object Detection of Fish Disease using Deep Metric Learning Method

Ja Young Kang
Department of Computer Engineering
P.O. Box 58554
Republic of Korea
vawelra@naver.com

Han Suk Choi
Department of Computer Engineering
P.O. Box 58554
Republic of Korea
chs@mnu.ac.kr

Hyun Seung Son
Department of Computer Engineering
P.O. Box 58554
Republic of Korea
hson@mnu.ac.kr

Han Kyu Lim
Department of Marine & Fisheries Resources
P.O. Box 58554
Republic of Korea
limhk@mnu.ac.kr

ABSTRACT

We going to converge the ICT technologies and the intelligent technology in the smart farm due to the increasing demand for seafood and rising cost. It aims to lead the productivity innovation of the aquaculture industry by possessing the core technology for creating a smart aquaculture cluster. The representative fish of aquaculture named Paralichthys olivaceus is suffered from environmental factors and is rapidly spreading disease through water. If the disease is not detected early, fish will mass death. Therefore, it is important to diagnose fish diseases and to monitor environmental factors in order to prevent the rapid spread of the disease. In this paper, we describe the method based on Deep Metric Learning (DML). Applied targets are Scutica, Vibrio, and Lymphocystis diseases with the highest mortality rates in aquaculture of Paralichthys olivaceus.

KEYWORDS

Smart Aqua Farm, Deep Metric Learning, Deep Learning Fish Disease, halibut

1 INTRODUCTION

The Korea's Ministry of Oceans and Fisheries (MOF) intends to use intelligent technologies in the smart farming field to converge ICT technologies due to the recent increase in demand for marine products and increased production costs. It aims to lead the productivity innovation of the aquaculture industry by possessing core technologies for creating smart aquaculture clusters [1].

The representative fish of the aquaculture industry, Paralichthys olivaceus, is being severely damaged by environmental factors and a disease that spreads rapidly through water. Therefore, it is important to diagnose the fish diseases and to monitor the environmental factors to prevent the rapid spread of the disease.

According to the paper [2], the disease of Paralichthys olivaceus (a representative cultured fish in Korea) with the highest mortality rate was investigated such as Scutica, Vibrio, and Lymphocystis. For the experiment, we have collected images identifiable by the human eye for Scutica, Vibrio, and Lymphocystis diseases from internet. In our previous paper [3], the collected disease images from internet were augmented using SinGAN [4] to create 1320 images from 33 images.

In this paper, we describe a method using Deep Metric Learning (DML) to form each fish disease as an embedding space, reducing the loss function values for similar diseases and increasing the loss function values for heterogeneous diseases.

2 RELATED WORK

The Deep Metric Learning (DML) [5] is derived from the Siamese Neural Networks (SNN) [6] as a method for comparing similarities for two inputs. The loss function plays an important role in calculating the distance (similarity) between two inputs. There are three typical loss functions of DML, as shown in Figure 1.

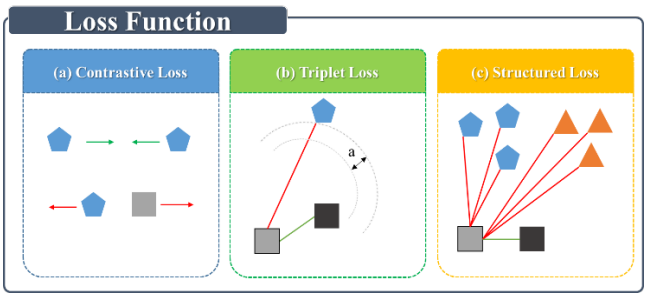

Figure 1: The type of loss function

As shown in Figure 1(a), the contrastive loss function of SNN is a model that can maximize or minimize the distance between objects to improve classification performance. The shared weights of this SNN are used to obtain meaningful patterns among images in deep metric learning and can learn similarity from image pixel, color, and texture information. It has a flexible structure capable of combining the SNN and the Convolutional Neural Networks (CNN).

The triplet loss function of triplet networks [7] utilizes Euclidean space to compare objects in the pattern recognition process. This focuses on the similarity between pairs of identical and different classes using shared weights as shown Figure 1(b). The similarity of the paired samples is compared and classified and provide higher discrimination while using both intra-class and inter-class relationships.

Models such as the SNN and triplet networks have the disadvantage of being limited to training samples. The structured loss function of Lifted Structured Feature Embedding [8] approach lifting vectors of pairwise distances in a batch to a matrix of pairwise distances through special-structure loss in a deep network. As shown in Figure 1(c), it deals with the similarity relationship between many samples at the same time, enabling the best use of contextual information within the training batch.

3 A METHOD USING DML

The Deep Metric Learning (DML) is widely used for face authentication/recognition tasks, and it can measure the distance between two input data. After measuring the distance, it is easy to classify the data by classifying the data by class label and learning the metric after checking whether the IDs of the two disease images are the same. Figure 2 shows the structure of DML.

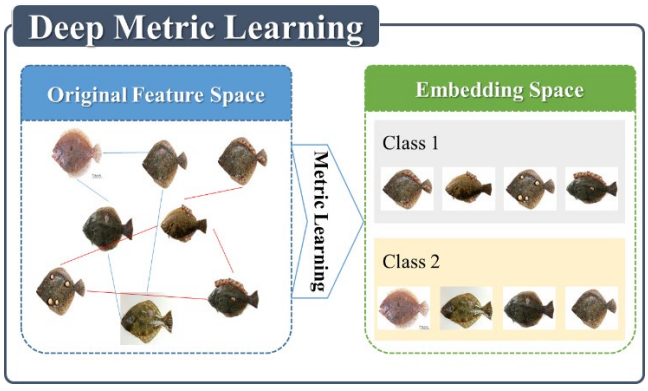

Figure 2: The structure of Deep Metric Learning (DML)

We intend to perform the DML using triplet loss in three types of loss functions. The triplet loss is metric learning used in multi-class classification and consist of three identical sub-networks. Triplet loss utilizes three inputs for embedding. Anchor, the data selected from the given dataset, is a positive sample with the same class label as the anchor, and a negative sample with a different class label. Figure 3 shows the structure of triplet loss.

To perform training in DML, the disease dataset of Paralichthys olivaceus uses 1320 images that created in our previous paper [3] based on SinGAN.

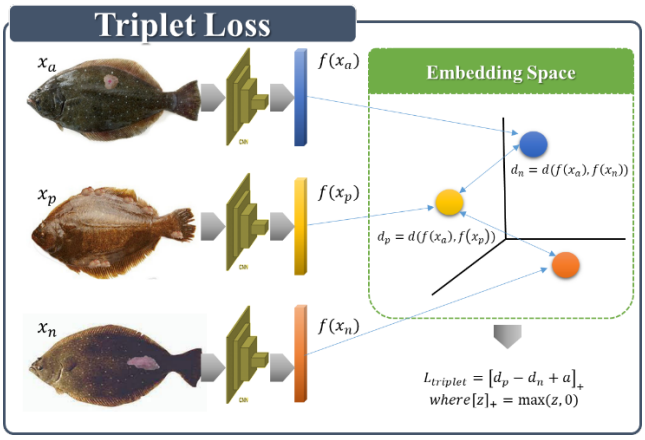

Figure 3: The structure of Triplet loss

4 CONCLUSIONS

In this paper, we described a method using the Deep Metric Learning (DML) to apply to halibut disease. We also limited the types of diseases to three such as Scutica, Vibrio, and Lymphocystis which have the highest mortality rates in the Paralichthys olivaceus aquaculture. Early detection and diagnosis of diseases through the development of a fish disease identification system using the DML can minimize the spread of disease infection and mass mortality. And it will be possible to prevent major damage in the farm.

ACKNOWLEDGMENTS

This research was supported by Korea Institute of Marine Science & Technology Promotion (KIMST) funded by the Ministry of Oceans and Fisheries, Korea (20220579)

REFERENCES

[1] Ministry of Oceans and Fisheries (MOF), Five Technological Innovation Strategies for Marine Fisheries, https://www.mof.go.kr/article/view.do?articleKey=44624&boardKey=84&menuKey=1065&currentPageNo=1

[2] Shim, J. D., Hwang, S. D., Jang, S. Y., Kim, T. W., & Jeong, J. M. (2019). Monitoring of the mortalities in oliver flounder (Paralichthys olivaceus) farms of Korea. Journal of fish pathology, 32(1), 29-35.

[3] H. S. Son, and H. S. Choi. 2021. Image Augmentation of Paralichthys Olivaceus Disease Using SinGAN Deep Learning Model. *The Journal of the Korea Contents Association* 21(12), 322-330.

[4] Shaham, Tamar Rott, Tali Dekel, and Tomer Michaeli. 2019. SinGAN: Learning a generative model from a single natural image. In *Proceedings of the IEEE/CVF International Conference on Computer Vision*, 4570-4580.

[5] M. Kaya, and H. Ş. Bilge. 2019. Deep metric learning: A survey. *Symmetry*, 11(9), 1066.

[6] G. Koch, R. Zemel, and R. Salakhutdinov. 2015. Siamese neural networks for one-shot image recognition. In *ICML deep learning workshop*, Vol. 2, 0.

[7] E. Hoffer, and N. Ailon, 2015. Deep Metric Learning Using Triplet Network. In *International workshop on similarity-based pattern recognition*, Springer, 84-92.

[8] H. Oh Song, Y. Xiang, S. Jegelka, and S. Savarese. 2016. Deep metric learning via lifted structured feature embedding. In *Proceedings of the IEEE conference on computer vision and pattern recognition*, 4004-4012.