Classification of Shiitake Mushrooms by Using Convolutional Neural Networks with Edge Detection Images

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***Abstract*—In this study, we classify shiitake mushrooms based on whether their caps are open or not by using Convolutional Neural Networks (CNN). We aim at improving the classification accuracy by using edge detection. The datasets consists of images using morphological transformation and Canny method. The morphological gradients are used in the morphological transformation. We investigate the test accuracy using these datasets.**

I. Introduction

Vegetable growers face a heavy labor burden due to long working hours during the harvest season and inadequate working environment. A shortage of agricultural labor has become apparent, and vegetable production is also showing signs of stagnation. One of the reasons why vegetable cultivation is so difficult is not only because of the manual harvesting, but also because of the enormous amount of time required for shipping.A typical example of this is sorting, as no two vegetables are alike. There are so many things to check, such as shape, size, surface luster, bend, uniformity of thickness, etc. And since the wrong grade to be sorted can lead to complaints, it is not possible to hire part-time workers to help only during busy times. The most problematic thing is that spending a lot of time on this work does not necessarily increase the yield or quality of the vegetables.Vegetable sorting is a task that we want to spend as little time on as possible. Therefore, methods using AI and deep learning have been proposed[1] [4].

Mushrooms have a rank, just as fruits have luxury products. There are various factors such as roundness, thickness, and size, but when distinguishing the rank of shiitake mushrooms, it is important to determine whether the cap is open or not. Currently, people are deciding whether or not the cap is open. It is necessary to classify automatically by using AI.

In this study, we improve classification accuracy by using edge detection. We classify images with edge detection by using convolutional neural networks(CNN)[5]. We aim at emphasizing the difference between characteristics of shiitake mushrooms.

(a) (b)

Fig. 1: Edge detection by Canny method
(a) A original image (b) A edge detection image.

II. Basic techniques for image recognition

A. Convolutional Neural Networks

In recent years, neural networks have been applied in various fields. In particular, the CNN has produced many results in the image field. In image recognition, results that exceed human ability are also seen. In this study, we perform edge detection on shiitake mushroom images to create training data,and classify the images from feature extraction by CNN.

CNN has convolution layers, pooling layers, and dense layers. In a convolution layer, matrix calculation is performed using some filters, and feature quantities of the same number as the number of filters are extraction. Next, in a pooling layer, the feature map obtained in the convolution layer is reduced while leaving important information. Finally, in dense layers, a label is connected to each feature amount, and a label with high probability can be selected.

Such network having some layers is called deep learning, and many layers enable accurate image classification. In this study, we use the CNN which has four convolution layers, two pooling layers, and two dense layers in Fig. 2.

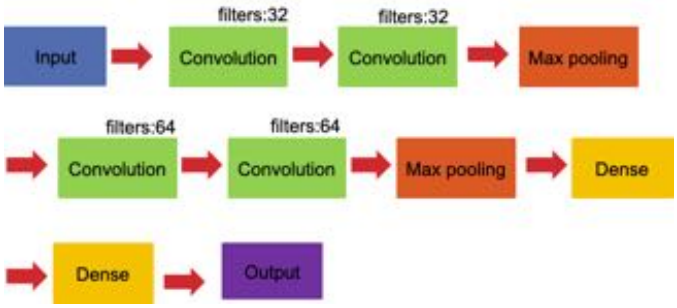


Fig. 2: Structure of CNN.

B. Morphology transformation

A morphological transform is a simple process that works mainly on binary images and on the shapes in the images. The morphological transform takes two inputs: the input image and structural elements that determine the nature of the process. The basic morphological operations are contraction and dilation. Other morphological processes include opening and closing, which are a combination of these two processes.

In this study, we used a process called morphological gradient, which is the difference between an inflated image and a deflated image.

C. Canny method

The Canny method is an algorithm for edge detection published by John F. Canny in 1986[6]. It performs edge detection by multiple steps. The process of Canny edge detection algorithm can be broken down to five different steps:

1. Apply Gaussian filter to smooth the image in order to remove the noise.

2. Find the intensity gradients of the image.

3. Apply gradient magnitude thresholding or lower bound cut-off suppression to get rid of spurious response to edge detection.

4. Apply double threshold to determine potential edges.

5. Track edge byhysteresis: Finalize the detection of edges by suppressing all the other edges that are weak and not connected to strong edges.

III. Proposed Method

We propose to use CNN to classify the caps of shiitake mushrooms. The training data are 108 images with open mushroom cap and 108 images with closed mushroom cap. The test data consists of 15 images with open mushroom cap and 15 images with closed mushroom cap. The original images and gray images are shown in Fig. 3. First, we create an edge detection image from the shiitake mushroom images using OpenCV. Edge extraction makes the contour clearer than the original image. In the morphology transformation of OpenCV, the edge detection image is created with the values of structural elements as 10, 20, 30, 40 and 50 (Fig. 4). Furthermore, Canny edge detection is used to create the edge extraction image. Furthermore, an edge extraction image is created by using canny edge detection of OpenCV. The threshold values are set as 10, 20, 30, 40, 50, and 60 (Fig. 5). The created images are classified by CNN with four convolutional layers and two pooling layers.

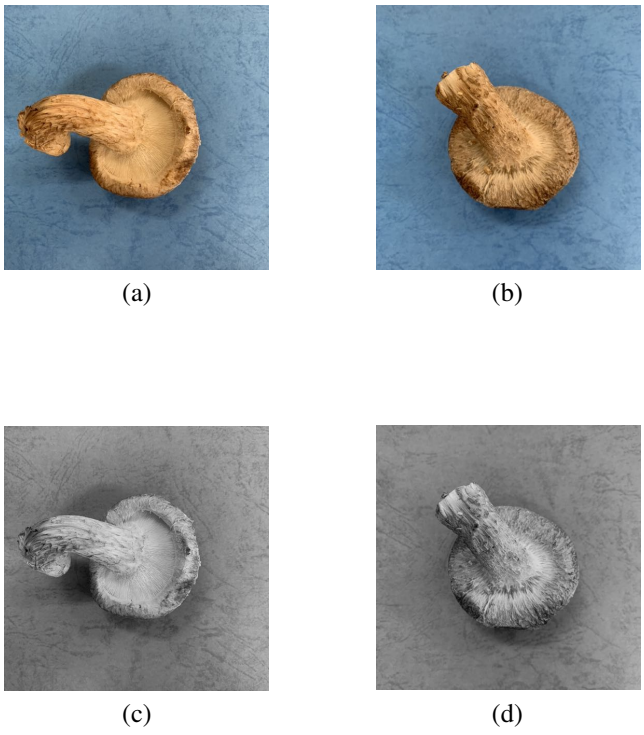
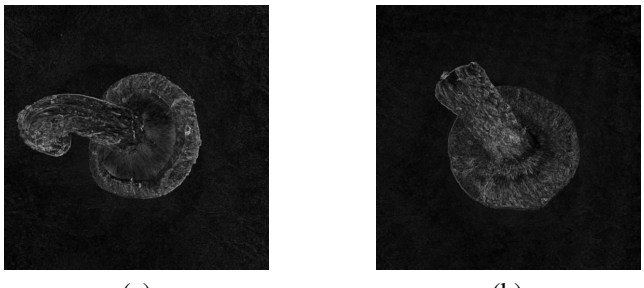
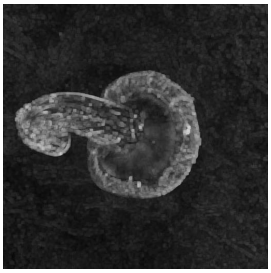
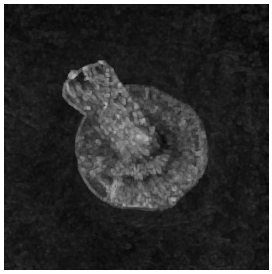

(a) (b) (c) (d)

Fig. 3: Original images and gray images.
(a) A original image of a open cap. (b) A original image of a close cap.
(c) A gray image of a open cap. (d) A gray image of a close cap.


(a) (b)



(c)



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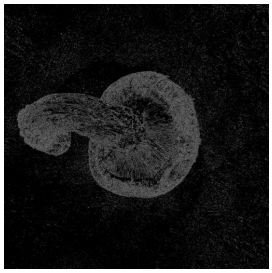
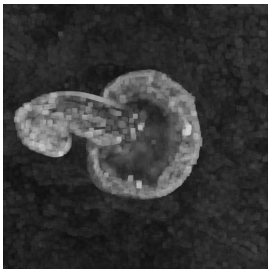


(e)

(f)



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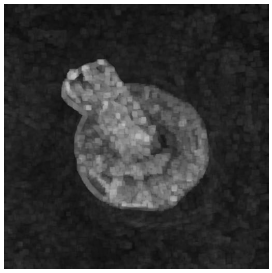
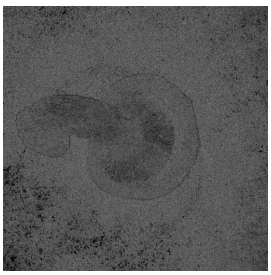
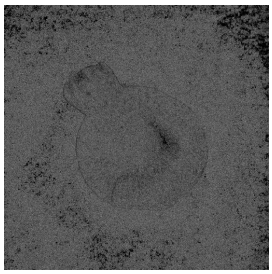


(f)

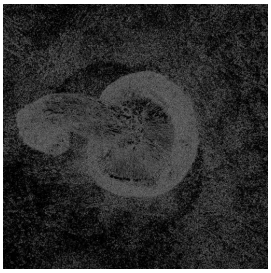
Fig. 4: Edge detection images of morphology transform.
(a) A open cap (kernel=10). (b) A close cap (kernel=10).
(c) A open cap (kernel=30). (d) A close cap (kernel=30).
(e) A open cap (kernel=50). (f) A close cap (kernel=50).



(a)



(b)



(c)

(d)

Fig. 5: Edge detection images of canny method.
(a) A open cap (threshold=10). (b) A close cap (threshold=10).
(c) A open cap (threshold=30). (d) A close cap (threshold=30).
(e) A open cap (threshold=50). (f) A close cap (threshold=50).

IV. Simulation results

The number of epochs is 100, the optimizer is Adadelta, and the Batch size is 32. The original images and the gray images are classified by using CNN, and the average of five times is taken. These results are shown in Table I. The test accuracy is 0.800 when the CNN learns original images. In other words, gray images are more effective than color images for shiitake mushroom caps classification. The images created using morphological transformation are classified using CNN and the average of five times is taken. These results are shown in Table Ⅱ. The test accuracy is the best, 0.881 when the value of kernel is 40. The accuracy tends to get better as the value of kernel is increased. The test accuracy of images created using morphological transformation is not as good as the test accuracy of Gray images.

The images created using Canny method are classified using CNN and the average of five times is taken. These results are shown in Table Ⅲ. The test accuracy is the best, 0.956 when the value of threshold is 30. The test accuracy of the image created using the Canny method is better than the test accuracy of the Gray images.

TABLE I: Test accuracy of original images and gray images.

Data set	Test accuracy
Original images	0.800
Gray images	0.938

TABLE II: Test accuracy of images with edge detection of morphology transform.

Data set	Test accuracy
Edge detection (kernel is 10)	0.788
Edge detection (kernel is 20)	0.813
Edge detection (kernel is 30)	0.819
Edge detection (kernel is 40)	0.881
Edge detection (kernel is 50)	0.863

TABLE III: Test accuracy of images with edge detection of Canny method.

Data set	Test accuracy
Edge detection (threshold is 10)	0.894
Edge detection (threshold is 20)	0.881
Edge detection (threshold is 30)	0.956
Edge detection (threshold is 40)	0.950
Edge detection (threshold is 50)	0.819
Edge detection (threshold is 60)	0.729

V. CONCLUSIONS

In this study, we classify shiitake mushrooms based on whether their caps are open or not by using CNN. We tried to improve the classification accuracy by using Edge detection. Edge detection images were created using morphological transformation and Canny method. Original images, Gray images, and the created edge detection images were classified by using CNN. From the simulation results, it was found that the edge detection images were effective in classifying whether shiitake mushrooms were open or not.

The test accuracy of the edge detection images using the morphological transform is higher than that of the original images, but lower than that of the Gray images. Increasing the value of kernel tends to improve the test accuracy.

The test accuracy of the edge detection images using the Canny method is higher than the test accuracy of the original and Gray images. The accuracy is best when the threshold value is 30.

These results show that the classification accuracy is higher when the contrast is clearer by using CNN to classify whether shiitake mushroom caps are open or not.

In the future, we will investigate the classification accuracy in networks other than CNN.

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