Automatic Selection of High-Grade Dried Shiitake Mushrooms using Machine Learning

Ota Hamasuna, Kakeru Takemura, Kodai Hasebe, Fumito Hamakawa, Bidesh Biswas Biki
Graduate School of Engineering, University of Miyazaki, Japan

Satoshi Ikeda, Kaoru Ohe, Amane Takei, Makoto Sakamoto*
Faculty of Engineering, University of Miyazaki, Japan

Kazuhide Sugimoto
SUGIMOTO Co., Ltd., Japan

Corresponding Author

abstract

Miyazaki Prefecture is blessed with the rich nature of the Kyushu Mountains, where many mushrooms have grown wild since ancient times, and the production of dried shiitake mushrooms ranks second in Japan after Oita Prefecture. SUGIMOTO Co., Ltd., which will be cooperating with us this time, is a long-established company established in 1970, and at times it is necessary to sort over 1 ton. However, since selection is still done manually, it is very difficult for employees to do the selection. The goal of this research is to determine the quality of shiitake mushrooms using deep learning and video image processing.

Keywords: image classification, video processing, CNN, OpenCV

1. Introduction

SUGIMOTO Co., Ltd. collects dried shiitake mushrooms directly from approximately 600 producers in Takachiho. Shiitake mushrooms are at their peak in spring and autumn, and at peak times, more than 1 ton of shiitake mushrooms can be brought in a day [1]. However, shiitake mushrooms are still sorted manually, and sorting this much requires a lot of effort. The goal of this research is to use deep learning and video processing to determine the quality of donko, a high-quality dried shiitake mushroom.

2. Development environment

In creating this program, we developed it in the following environment (Table 1). In the experiment, a stand was fixed to a conveyor belt, and the smartphone camera was attached to the end of the stand with the camera facing down.

Table 1 Development environment

OS	Windows10
language	Python
camera	moto g30
software	iVCam
software	OpenCV
	PIL
	NumPy
	Pandas

3. Method

3.1. Target of selection

The following two targets are selected. The one on the left (Fig. 1) is a good shiitake mushroom, and the one on the right (Fig. 2) is a bad one.

Fig. 1 Good item

Fig. 2 Bad item

The following four main examples of bad items are listed below. Fig. 3 shows a state where the pileus of a shiitake mushroom part is broken. Fig. 4 shows a state in which the pileus of a shiitake mushroom is greatly deformed. Fig. 5 shows a state where there are holes caused by insect damage. Fig. 6 shows the pileus of a shiitake mushroom part being rubbed.

Fig. 3 Cracked

Fig. 4 Deformed

Fig. 5 Hole

Fig. 6 Rubbed

The example of a bad item mentioned this time is the front side with a pileus of a shiitake mushroom on top. Although there are characteristics of bad items on the back side as well, this experiment focused on the front side. The reason why we focused on the front side is that it takes a huge amount of time to collect samples from the front and back sides, and the camera can only capture either the front or back side due to the sorting process on the conveyor belt.

3.2. CNN

In the experiment, CNN was used as an algorithm to determine whether an image was a good item or a bad item. Explain about CNN. CNN (Convolution Neural Network) is a network often used in image recognition research. This CNN is characterized by being constructed by stacking layers with several unique functions, such as convolutional layers and pooling layers [1]. Currently, it is attracting increasing attention as it is being used in a variety of fields. The image in Fig. 7 shows the flow of handwritten digit classification using CNN. First, handwritten digits are given as an input image, the features of the image are extracted by convolution, and the extracted features are aggregated in a pooling layer. Finally, the fully connected layer transforms the output into a one-dimensional form and outputs each selection result as a probability.

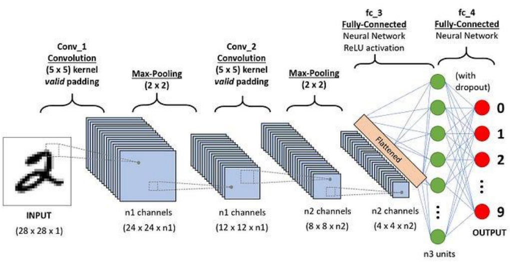

Fig. 7 Classification of handwritten digits [2]

3.3. Video image processing

In this research, we extract still images of shiitake mushrooms from moving images and select them using a model learned by CNN. The video image used in the experiment was taken from directly above the conveyor belt, and the shiitake mushrooms were flowing from left to right. Fig. 8 shows an image of the program being executed.

A still image extracted from a moving image is displayed at the top left of the screen. Extract three still images of the shiitake mushroom using OpenCV. The extraction location is when the shiitake mushrooms flow to the left, center, or right side of the screen. The three images are selected by the model, and the one with a majority of selection results is the final result. At the bottom center of the screen, a "〇" is displayed if the item is good, and an "×" is displayed if the item is bad. If the test is in progress, "・・・" is displayed. The number of good items and bad items is displayed at the top right of the screen. The count is performed when the final result is obtained.

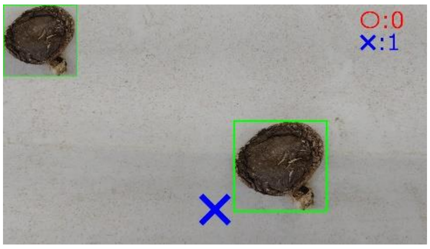

Fig. 8 Program running

4. Experiment content

An evaluation experiment was conducted to verify the usefulness of the developed sorting system. They sort out 17 good and 23 bad mushrooms, and tally up whether the final result matches the shiitake mushrooms that were flushed. The number of matches is defined as the number of correct answers, and the accuracy is defined as follows. Since the final result is updated sequentially until the flow is finished, the last displayed final result is taken as the detection result. The number of cards trained on the CNN was 668 for good and 759 for bad, split 8:2 between training and testing.

$$accuracy = \frac{Number\ of\ correct\ answers}{Number\ of\ shiitake\ mushrooms\ shed} \times 100(\%)$$

5. Experimental result

As a result, the accuracy was low, with 41.1 % of good items and 91.3 % of bad items. Most of the shiitake mushrooms thrown away by the model were sorted out as bad shown in Table 2.

Table 2 Program execution results

	Good item	bad item
number of flows	17	23
The number of correct answers	7	21
accuracy	41.1%	91.3%

The figure below (Fig. 9) shows the selection results of the CNN model in the still image state. Although the accuracy of sorting out bad items as bad items was high, the accuracy in sorting out good items as good items was poor.

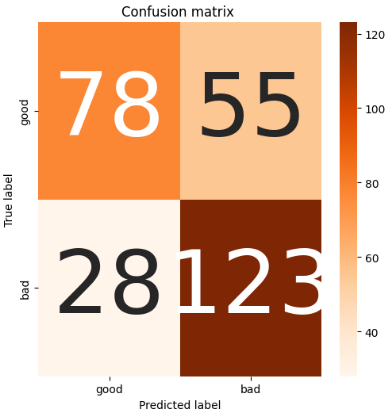

Fig. 9 Results of still image selection using CNN

6. Conclusion

This research is still in its infancy, and the experimental results were very poor. First, there is the problem that it is difficult to distinguish between good items at the CNN learning stage. It was difficult for me to sort by just looking at still images. When actually sorting, not only the front side but also the back side is important. Since this study was an experiment on only the front side, information on the back side was missing, and we believe that the accuracy is reduced. As a result, the accuracy of moving images deteriorated even more than the accuracy of still images. The reasons for the lower accuracy in the video images are that in the case of the video images, the shiitake mushrooms swayed on the conveyor belt, making it impossible to obtain accurate images, and that the images to be trained by the CNN and the video images on the conveyor belt had different lighting and size of the shiitake mushrooms within the frame. Future issues include the following.

- Increasing the number of images for learning
- Collect images of the back side of shiitake mushrooms
- Organizing the environment in which still images are collected and the environment in which video images are taken
- Reconstruction of CNN model

Acknowledgment

I would like to thank my supervisor, Professor Masato Sakamoto, for his guidance in preparing this thesis. We would like to thank Kazuhide Sugimoto of Sugimoto Shoten Co., Ltd. for providing information on shiitake mushrooms for this study.

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Authors Introduction

Mr. Ota Hamasuna

He is a master student at Department of Computer Science and System Engineering, University of Miyazaki. His current research interests are augmented reality, computer graphics, and so on.

Mr. Kakeru Takemura

Currently enrolled in the Master's course in Mechanical Information Systems, Graduate School of Engineering, University of Miyazaki. His current research theme is museum support using AR technology.

Mr. Kodai Hasebe

He is a master student at Department of Computer Science and System Engineering, University of Miyazaki. His current research interests are image processing, machine learning, and so on.

Mr. Fumito Hamakawa

He is a master student at Department of Computer Science and System Engineering, University of Miyazaki. His current research interests are computer graphics, cellular automaton simulation, and so on.

Mr. Bidesh Biswas Biki

He is master's student in Data Science at Department of Statistics from TU Dortmund. He is an enthusiast of Machine Learning and Deep Learning. He has done some research work and individual projects on supervised learning especially on "Classification" and "Regression" techniques. Also has done some work on Image Processing and NLP.

Prof. Satoshi Ikeda

He received PhD degree from Hiroshima University. He is an associate professor in the Faculty of Engineering, University of Miyazaki. His research interest includes graph theory, probabilistic geometry, fractal geometry and measure theory.

Prof. Kaoru Ohe

She received her Ph.D. degrees from University of Miyazaki, Japan, in 2014. Currently she is an Associate Professor of the Center for Science and Engineering Education, Faculty of Engineering. Her research is separation engineering especially adsorption hazardous heavy metals and oxyanions

Prof. Amane Takei

He is working as Associate Professor for Department of Electrical and systems Engineering, University of Miyazaki, Japan. His research interest includes high performance computing for computational electromagnetism, iterative methods for the solution of sparse linear systems, domain decomposition methods for large-scale problems. Prof. Takei is a member of IEEE, an expert advisor of IEICE, a delegate of IEEJ, a director of JSST.

Prof. Makoto Sakamoto

He is presently a professor in the Faculty of Engineering, University of Miyazaki. His first interests lay in hydrodynamics and time series analysis, especially the directional wave spectrum. He is a theoretical computer scientist, and his current main research interests are automata theory, languages and computation. He is also interested in digital geometry, digital image processing, etc.

Mr. Kazuhide Sugimoto

He was Born in Takachiho town, Miyazaki Prefecture. After working in sales in the food service and apparel industries, he joined SUGIMOTO Co., Ltd., a wholesaler of dried shiitake mushrooms produced in Takachiho town, in 2011 after the Great East Japan Earthquake. In response to the current harsh situation, such as aging contract farmers and sluggish demand for dried shiitake mushrooms, he decided to protect the producers by promoting new business development, which he had experienced in sales. New items developed using shiitake mushrooms from Takachiho Township have become a standard item at supermarkets and department stores outside the prefecture. In March 2020, he was appointed as Representative Director, and in 2021, he was selected as a Small and Medium Enterprise Supporter and GFP Ambassador.