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Collection and Classification of Jasmine Rice Germination Using Convolutional Neural Networks

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Collection and Classification of Jasmine Rice Germination Using Convolutional Neural Networks

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***Abstract*—An assessment of rice-seeds germination is a process of measuring the quality of the seeds for the benefit of rice planting farms in Surin Province and the neighboring areas in Thailand. We need specialists or experts in the area of agriculture to evaluate the seeds germination by classifying them into normal and abnormal seeds which require a lot of times and hard work.**

In this paper, we present our dataset collection and use convolutional neural networks (CNNs) to classify normal and abnormal Jasmine rice-seeds after germination of 7 days. Our purpose is to use deep learning technique such as CNNs to do the work of evaluation or classification instead of specialists or experts. We collected 1,562 sample images of Jasmine rice seed germination and categorized them into two groups, normal and abnormal. We also collected an extra 76 images mixing abnormal and normal together for testing. We set 75% of our dataset as a training set and 25% as a validation set. We build CNNs of 6 hidden layers and in each layer consists of convolution-pooling-Relu modules. It is the binary network that results as 0 and 1 which represent normal and abnormal. Therefore, in the last layer, we use a sigmoid function to acquire our score. Our experimental results show that the effectiveness of using CNNs in our work is very high. We obtain an average accuracy of 99.57% and loss 0.01% on training and accuracy 96.43% and loss 0.48% on validation.

Keywords—Jasmine rice, seeds germination, rice germination, image classification, Convolutional Neural Networks

I. INTRODUCTION

Surin Province is the land that has grown the best Jasmine rice in Thailand. Jasmine rice has been planted over 480,000 hectares of cultivated land. It has been awarded two years in a row as the best Jasmine rice in the world from 2016 to 2017.

To improve the quality of the rice, seeds germination assessment's tasks have been started. Recently, we have hired many experts and specialists to evaluate and select the best rice germination, particularly Jasmine rice. The evaluation and selection are done after 7 days of germination[1, 2]. However, hiring people to do quality evaluation takes too much effort and is a time-consuming task. The experts select rice-seeds and germinate them for 7 days before evaluation. After 7 days, experts evaluate the grown rice by classifying them into normal and abnormal [2]. The results of the classification enable us to select good rice-seeds for farmers. We have been looking for better techniques of classification to avoid repetition of the same work and replace the technique instead of specialists' effort.

There are varieties of Asian rice classification methods have been studied [3]. Recently, neural networks were applied in the task of rice classification [2-6]. However, their methods classified rice species where ours classified normal and abnormal over specific 7-day-germinated rice, Jasmine rice.

In our paper, we present our Jasmine rice germination dataset collection and apply a CNN[1] to predict normal and abnormal germination of Jasmine rice. Our results showed that the networks can produce a promising result according to the purpose of our data collection.

II. DATA COLLECTION

We obtained images from seeds cultivation in the seed laboratory of the Surin Rice Seed Center, Surin Province. We collected sets of seeds randomly from seed group. Then, we cultivated the seeds and stored in the normal environment room with normal light, and kept the seeds to grow for a period of 7 days.

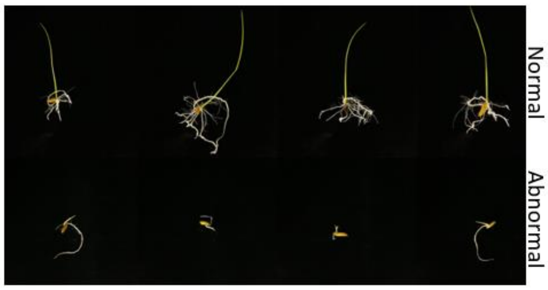

Figure 1. Sample normal and abnormal images.

Experts evaluated the germination on each seed. They categorized the grown seeds as normal and abnormal rice. Figure 1 shows the sample normal and abnormal images in our dataset. The first row displays normal germinated images and the second row displays abnormal germinated images.

Figure 2 is the activity of how the seeds are cultivated and germinated. The first row shows the activity of our experts and their assistants evaluate the seeds and the second row is how the seeds were stored.

[1]https://en.wikipedia.org/wiki/Convolutional_neural_network

Figure 2. Seeds cultivation germination process.

We take photos of those grown seeds using Samsung J7 Pro by specifying the elevation camera to the object at 11 centimeters and controlling the light in an area of a box. We choose a profession mode ISO = 800, Brightness = 0, W/B = 6500K, Size = 4128 x 3096 and AE/AF = Lock. Figure 3 exhibits the instruments used for image collection.

Figure 3. Picture of instruments used for collaborating and taking pictures.

After all, we successfully collected 1,562 images and separated them into two groups, normal germination, and abnormal germination. We collected 76 images and mixed both the abnormal and normal germinated rice together for testing.

III. CNN FOR RICE GERMINATION CLASSIFICATION

A. Dataset Setting

We manually classified the dataset of 1,562 images in our collection into 2 classes of rice germination, normal and abnormal. We use 75% of each category for training and the other 25% for validation. We also have 76 images for testing. Table 1 exhibits the detail of how we categorized our dataset.

Table 1. Data Collection and Categorization

<table>
<tr><td rowspan="6">1,562 images</td><td colspan="2">Training set 74.9%</td></tr>
<tr><td>Normal</td><td>585</td></tr>
<tr><td>Abnormal</td><td>585</td></tr>
<tr><td colspan="2">Validation set 25.1%</td></tr>
<tr><td>Normal</td><td>196</td></tr>
<tr><td>Abnormal</td><td>196</td></tr>
<tr><td rowspan="3">76 images</td><td colspan="2">Test set</td></tr>
<tr><td>Normal</td><td>38</td></tr>
<tr><td>Abnormal</td><td>38</td></tr>
</table>

B. Rice Germination Classification

Classifying rice-seeds germination takes too much effort. Therefore, we propose a convolutional neural network to do the job for us. In our work, we went through several steps such as seeds cultivation (Figure 2), photo collection, analysis of germination results by experts (Figure 4) and categorizing data manually (Table 1).

Using the images data that we collected, we want to train rice germination using CNN. We train our dataset on a shallow CNN that consists of 6 hidden layers. Each layer contains modules as Convolution-Relu-Pooling and the last two layers are fully connected layers. We use the sigmoid function at the end of the network. Proposed network architecture is depicted in Figure 5.

Figure 4. Image data collection by experts.

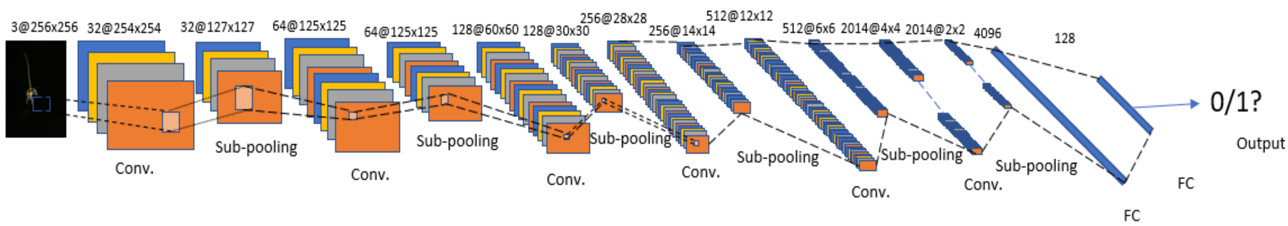

Figure 5. Applied CNNs architecture for our task.

Figure 6. Test results

IV. EXPERIMENTAL RESULTS

We train our convolutional neural network on our training and validation set with the architecture as shown in Figure 5.

We trained on a binary shallow convolutional neural network that has only six hidden layers with 30 epochs. We use Adam as our network's optimizer and set the batch size to 32. Our training results are shown in Table 2.

Table 2. Training results (%)

	Accuracy	Loss
Training	99.83	0.049
Validation	96.43	0.48

We also tested on a test set which mixed normal and abnormal together as shown in Table 3 and Figure 6.

Table 3. Test results (%)

Accuracy	Precision	Recall
93.42	96	96

Table 3 is the test results of the test images we have collected. We obtained the results of Accuracy, Precision, and Recall of 93.42%, 96%, and 96%. Total test dataset is 76 containing normal and abnormal. For each class (normal, abnormal), we recorded False Negetives (FN), False Positive (FP), True Positive (TP) and True Negative (TN). The equations below are the methods we have used to calculate the Accuracy, Precision, and Recall of the test images:

$$Accuracy = \frac{TP+TN}{Total\ Images},$$
$$Precision = \frac{TP}{TP+FP},$$
$$Recall = \frac{TP}{TP+FN}.$$

V. DISCUSSION

The network seems to learn very well according to the results that we have shown above. Our dataset was collected and captured using the black flannel background for each image and well calibrated as mentioned in Section II. It's one of the reasons that made our network learned fast and obtained such high accuracy. The disadvantage is that when we want to test a real rice-seed, we need to take an image that calibrated and captured with the background like our dataset or it can't predict. Therefore, we need to upgrade our dataset on the amount and diversity of the image data that we collect, meaning we need more images and as well as various images i.e. various background, the various distance between camera and object, and various angles of the seeds. Figure 7 is the wrong prediction of the input image that has different brightness, noise and bad background, and wrong calibration. The seeds are abnormal but the network predicted as 100% normal.

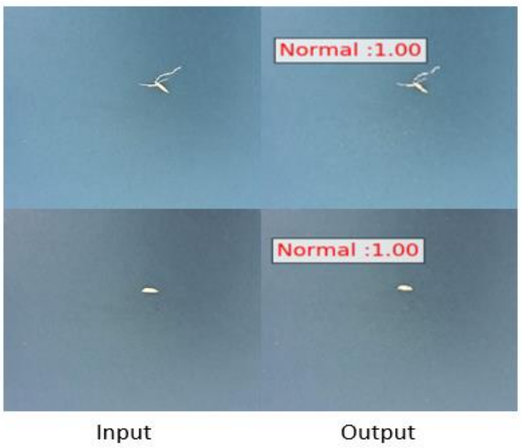

Figure 7. The case of the wrong prediction

VI. CONCLUSION

This paper presents the collection of Jasmine rice-seeds germination dataset and CNNs application for normal and abnormal rice germination classification. We implemented a shallow network of 6 layers and two fully connected layers. In each layer consists of modules such as convolution, ReLu, and max pooling. Our network is a binary network classification that uses the sigmoid function at the end of the network. We experimented with our rice germination dataset. The dataset was divided into three sets such as training set, validation set, and test set. Our network learned well over the dataset we collected. Our training and validation obtained an accuracy of 99.8% and 96.4%. We tested the network model with our test images and obtained accuracy, precision, and recall of 92%, 96%, and 97%. Even though we achieved high accuracy on testing but it requires specific preparation to capture images for testing like we already mentioned in Section V. Therefore, our primary future work is to the build a rich and larger Jasmine rice germination dataset for training.

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