Application of Backpropagation Method for Quality Sorting Classification System on White Dragon Fruit (Hylocereus undatus)

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The theme of “Development and improvement of sustainable agricultural practices toward environmental and global well-beings”. There was 180 presenters and participants with 162 article submissions encompassing the topics of Agriculture Engineering and Biotechnology, Organic Agriculture, Agroindustry and Agribusiness, Animal Nutrition, Animal Production, Veterinary Science, Food Science and Technology, Food Safety, Food Security and Sovereignty, IT for Agriculture, and Renewable and Novel Energy Sources.

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Application of backpropagation method for quality sorting classification system on white dragon fruit *(Hylocereus undatus)*

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Application of backpropagation method for quality sorting classification system on white dragon fruit (*Hylocereus undatus)*

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Abstract. Several problems related to determining the quality of dragon fruit quality are: fruit disease, harvest time selection, sorting process and post-harvest grading. Determination sorting dragon fruit quality by observing the appearance of fruit, fruit smoothness, presence or absence of defects and fruit size. However, this quality determination has disadvantages such as longer sorting time and different perceptions of farmers about the quality of dragon fruit. To solve this problem, we need a sorting system that is able to determine the quality of dragon fruit effectively and efficiently without damaging the dragon fruit. In this study, determining the quality of white dragon fruit using digital image processing techniques and intelligent systems. The output of the digital image processing technique is five morphological features such as area, perimeter, length, diameter and metric. This feature is the input of the backpropagation method so that the quality of white dragon fruit is divided into 3 classes such as class A, class B and class C. The results showed the best network architecture model was 5,8,5,3 with the best testing accuracy rate of 86.67%.

1. Introduction

Dragon fruit (*Hylocereus spp.*) or better known as pitahaya (pitaya) or dragon fruit is a well-known exotic fruit that is commonly produced in countries such as Vietnam, Malaysia, Colombia, Mexico, Costa Rica and Nicaragua [1]. Dragon fruit is a fruit whose skin is red and scaly green. For the people of Indonesia, dragon fruit is a newcomer to the world of agriculture [2]. Dragon fruit is also a promising fruit species that has begun to be cultivated in several countries, one of which is Indonesia. In Indonesia, dragon fruit is classified as a horticultural plant which is being cultivated because it can grow very well in tropical climates. One of the districts in East Java who helped develop the cultivation of dragon fruit is Jember. Dragon fruit is a mainstay commodity at the Jember Agricultural Service so that it is developed in a number of districts such as in Arjasa district which has a dragon fruit development centre, namely in Kemuning Lor Village [3].

Dragon fruit quality standards which are used as a reference are divided into 3 grades, namely dragon fruit grade A, grade B and grade C. The grade classification is based on 3 criteria, namely weight, sugar content (brix) and fruit skin [4]. Several problems related to determining the quality of dragon fruit quality, namely: fruit disease, harvest time selection, sorting process and post-harvest grading.

Determination of the quality sorting of dragon fruit is done both visually and manually, namely paying attention to fruit appearance, fruit smoothness, whether or not there are defects and size of the fruit. However, there are some deficiencies in determining the quality, the factors are the length of the sorting time, the visual limitations of humans which are influenced by experience and the difference in perceptions about the quality of dragon fruit [5]. To solve the above problems, we need a sorting system that is able to determine the quality of dragon fruit effectively and efficiently without damaging the dragon fruit.

Previously, the dragon fruit quality classification was researched. However, this system cannot detect any defects in dragon fruit[5]. Then the research was developed in 2015 with the results on the accuracy of these researches were obtained by 80% [6]. Based on the description above, the researchers developed the research by applying the backpropagation method to classify the quality sorting of white dragon fruit. Backpropagation is one of the methods of a neural network that has 3 phases, namely the feedforward phase, the backward phase and the weight updating phase. In the feedforward phase, the input pattern is calculated forward from the input to the output layer. In the (backward) phase, each output unit receives a pattern target associated with the input pattern to calculate the error value and the value is propagated backwards. While the weight update phase occurs if the classification results do not match the target, then the weight update will be carried out, which is expected to improve the accuracy level of the system.

2. Materials and Methods

The research site is in Kemuning Lor Village, Kebun Agrowisata Rembangan, Jember. The research data were variations in the quality class of white dragon fruit (*Hylocerus undatus*) based on the size of the fruit weight. Based on the results of the survey that the researchers have conducted, the quality of white dragon fruit is divided into three classes based on the size of the fruit weight, namely class A with a weight of more than 500 grams, class B with a weight of 400-500 grams and class C with a weight below 400 grams as shown in Figure 1 .

A B C

Figure 1. Variations of the white dragon fruit (*Hylocereus undatus*) quality classes

The research stages were carried out: the first stage was the image retrieval process of white dragon fruit, the second stage was image pre-processing, the third stage was the image segmentation process, the fourth stage was the process of taking object features in the image and the fifth stage was the classification process so that the image could be classified into 3 qualities class namely class A, class B and class C, as shown in Figure 2.

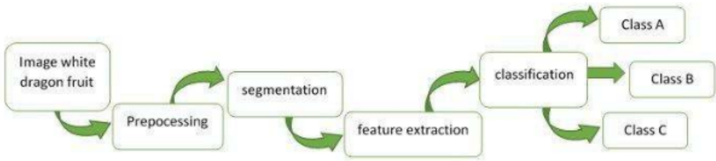

Figure 2. Block diagram of the system

2.1. Dragon fruit image sampling

This research begins with the process of measuring the weight, length of fruit and fruit diameter using digital scales and callipers. The next process is to take the image of the fruit using a smartphone camera with 13 MP specifications and a mini studio box. The distance between the camera and the research object is approximately 25 cm. In the mini studio box, three LED lights are installed which function as lighting media, while the background used is white. The image sampling process is shown in Figure 3.

Figure 3. The process of measuring and taking images of white dragon fruit (*Hylocereus undatus*)

2.2. Pre-processing image

The image pre-processing is the second step which aims to improve the quality of the image that has been obtained. At this step, two processes are carried out, the first is the image cutting process and the second is the separation of the RGB colour components. The cropping process on the dragon fruit image which was originally 2701 x 2701 pixels was cut to 300 x 300 pixels as shown in Figure 4. This process serves to reduce the size of the image by reducing unneeded background so that the computational load becomes less. The second process, namely the separation of RGB components, is carried out to facilitate the segmentation process because the RGB colour space is difficult to segment[7].

2701x2701 pixel 300x300 pixel

Figure 4. The process of cutting the size of the image

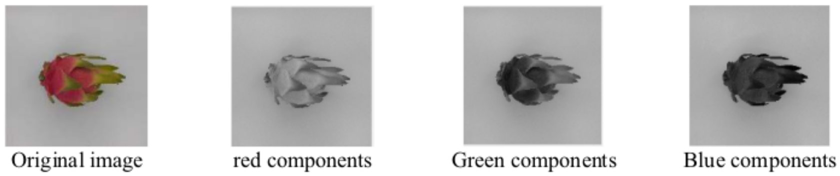

Figure 5. The process of separating components in the RGB colour space

2.3. Segmentation
Image segmentation process is a process that functions to store between objects and the background by conducting a thresholding process. Thresholding is the process of converting a gray image into a binary image by paying attention to the threshold value as in equation 1.

$$a(x,y) = \begin{cases} 1, a(x,y) \geq T \\ 0, a(x,y) < T \end{cases} \quad (1)$$

2.4. Feature Extraction
The feature extraction process is the process of taking the characteristics of the object. The feature extraction used is the shape feature (morphology) consisting of length, diameter, area (A), perimeter (P) and metric white dragon fruit.

2.5. Classification
Classification is a process where objects are grouped based on predetermined classes using artificial neural networks. In general, neural networks consist of information processing elements (neurons) that are interconnected and work together to solve problems. Neural networks are trained so that the input leads to a specific target output, therefore the training process is called supervised learning. One of the algorithms of this neural network is backpropagation. This backpropagation is known as multilayer perceptron, where there are many hidden layers that are used to update the weight values[8].

3. Results and Discussion
In this study, there are two processes that need to be considered, namely digital image processing techniques and classification processes. In this digital image processing process, the image pre-processing process is carried out which consists of a cropping process and separation of RGB components as shown in Figure 4 and Figure 5. After the process of solving the RGB components, select a component image that clearly represents the object of research, at this stage a blue component image is selected. The next process is the segmentation process which functions to separate the research object from the background using the thresholding process which takes the threshold value based on the blue component histogram image. To find the best threshold value, the test is based on the blue component histogram image. There are three threshold values tested, namely 25, 50 and 125 as shown in Figure 6.

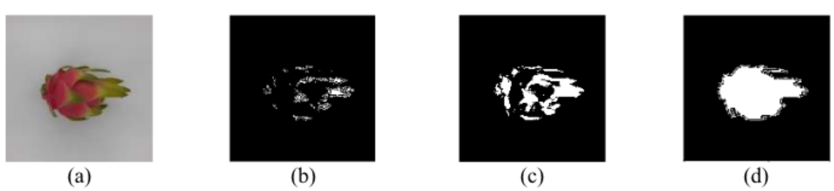

Figure 6. (a) A image of white dragon fruit and the results of image segmentation are based on variations in threshold values : (b) 25, (c) 50 and (d) 125

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Figure 6 shows that the best threshold value is 125, the threshold value = 125 is able to represent the best dragon fruit object shape when compared to dragon fruit shape with a threshold value of 25 and 50. After the segmentation process, the next process is to take the feature value based on its morphology. The features used include Length, Diameter, Area, Metric, Perimeter as shown in Table 1.

Table 1. The results of the extraction of morphological features of each class

Class	Length	Diameter	Area	Metric	Perimeter
A	140,17	198,58	20794,17	0,2985	973,96
B	117,51	174,48	15327,89	0,3324	797,03
C	110,48	159,17	12954,13	0,2959	764,44

Table 1 shows that there are differences in parameter values in each class. The feature value will be an input for the classification process so that later the system will be able to classify three classes, namely class A, class B and class C. In the area feature of class B and class C there is a slight difference in values where the area of class B is 15327.89 while the area of class C is 12954.13. Another case with the class A metric parameter whose value is very close to the Class C metric value where the class A metric is 0.2985 and the class C metric is 0.2959. This value will affect the class determination of the classification system. The classification method used is the backpropagation method. This method is a supervised learning method, which means that the target for the training is known. The amount of data used was 249 for training data and 121 for testing data. Several experiments have been carried out to determine the best network architecture in this study as in Table 2 and Table 3 show the accuracy value in the system testing process. Some other parameters used are a momentum value of 0.2 and a maximum epoch of 5000.

Table 2. Results of system training based on network architecture variations and learning rates

Network Arsitektur			Learning Rate					
Input Layer	Hidden Layer	Output Layer	0.05	0,1	0,3	0,5	0,7	0,9
5	4	3	92.54	89,83	91,86	92,54	94,24	93,22
5	5	3	91.86	92.54	94.24	92.88	94.24	93.22
5	8	3	95.59	96.61	96.95	96.27	92.88	94.58
5	8.5	3	96.95	97.29	96.27	97.29	96.61	97.97

Table 2 shows that there are 4 network architecture models that have training accuracy levels above 89%, but in 2 network architecture models, namely 5,8,3 and 5,8,5,3 have training accuracy levels above 92% with 6 variations of learning rate. The two network architecture models are then tested based on a training accuracy level above 95% with 6 variations of the learning rate so that the best level of testing accuracy is obtained as shown in Table 3.

Table 3. The results of system testing are based on network architecture variations and learning rates

Network Architecture			Learning Rate					
Input Layer	Hidden Layer	Output Layer	0.05	0,1	0,3	0,5	0,7	0,9
5	8	3	85.33	81.33	85.33	84	-	-
5	8,5	3	86.67	85.33	84	86.67	81.33	85.33

Based on the results in Table 3, the best test accuracy rate is 86.67% with a learning rate variation of 0.05 and 0.5. The level of accuracy of this test is obtained by a network architecture model using two hidden layers, each of which has a number of neurons, namely 8 neurons in the first hidden layer and 5 neurons in the second hidden layer.

4. Conclusion

Research application Backpropagation Method for Sorting Classification System Quality at the White dragon fruit (*Hylocereus undatus*) has been carried out, the most important point in this research is the selection of the colour components in the RGB colour space. From the experiments that have been carried out, it was found that the image of the blue component can represent the image of white dragon fruit very well. To compare each class, select morphological features such as length, diameter, area, perimeter and metric. When tested using the back propagation classification method, the accuracy rate is 86.67%. There is a difference of about 10% between the results of training accuracy and testing, this is due to variations in the training data and the test data used is still not optimal. In the future, the data used will be reproduced and experiments using other classification systems to get a better level of accuracy.

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