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Research Article

The Implementation of GLCM and ANN Methods to Identify Dragon Fruit Maturity Level

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Abstract

The identification of the maturity level of dragon fruit in this study was divided into two groups of ripeness: the unripe and the ripe. This study aims to classify the maturity level based on dragon fruit images using the feature extraction method, the gray level co-occurrence matrix (GLCM). This research method consists of converting RGB data to grayscale, image normalization, detection of dragon fruit maturity, feature extraction, and identification. Data collection from real data totaled 60 images used in this study consisting of 40 training data and 20 testing data which are RGB image data in JPG format. Each data consists of 2 maturity categories. Training data consists of 20 images of 99% ripe dragon fruit and 20 images of 85%. Meanwhile, the testing data consisted of 10 of 99% ripe dragon fruit images and 10 of 85% ripe dragon fruit images. The image data is processed into a grayscale image which then detects the ripeness of the dragon fruit. After the maturity of the dragon fruit is obtained, segmentation is carried out on the location of the dragon fruit found. Then the feature calculation is performed using the Gray Level Co-Occurrence Matrix (GLCM). The Artificial Neural Network (ANN) algorithm is used for the identification process. The final test results show that the proposed method has been able to detect dragon fruit maturity level with an accuracy of = 9/10* 100% = 90%, calculated using the confusion matrix. Thus, implementing the Gray Level Co-Occurrence Matrix and Artificial Neural Network methods to the maturity level problem dragon fruit needs to be developed.

Keywords: Prediction, Dragon Fruit; GLCM; ANN.

Introduction

Dragon fruit has several different fruit species where the classification of dragon fruit includes the cactus plant group or the Cactaceae family and the Hylocereanea subfamily. So far, dragon fruit varieties are divided into four groups based on the color of the fruit, including white-fleshed dragon fruit (Hylocereus undatus), red-fleshed dragon fruit (Hylocereus. polyrhizus), super red-fleshed dragon fruit (Hylocereus costaricensis), and dragon fruit with yellow skin and white flesh. (Selenicerius megalanthus). Dragon fruit plants have tendrils that grow creeping, green in color with a triangular shape. The flowers are large, white-light yellow, and generally bloom at night. After the flowers wither, a hanging fruit will form on each stem[1].

Currently, people are also familiar with Hylocereus costaricensis (red dragon fruit), which can be found in markets and supermarkets. However, the problem is that we sometimes find dragon fruits are often bland because they have been picked too early. Moreover, it can only be observed visually by humans, which could be more consistent due to fatigue and differences of opinion among observers. Therefore the field of computer vision continues to try to find ways for computers to accept the workings of the human senses.

The Artificial Neural Network (ANN) method is also called Simulated Neural Network (SNN) and is often referred to as an Artificial Neural Network (ANN). This is because this method imitates the human nervous system (neurons). ANN is a statistical and non-statistical data modeling tool. ANN can model complex (complex) relationships between inputs and outputs to find patterns in the data[2]. ANN is a computing system whose architecture and operation are inspired by the knowledge of biological nerve cells in the brain. ANN can be described as a mathematical and computational model for non-linear approximation functions, cluster data

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classification, and non-parametric regression or a simulation of a collection of biological neural network models [3]. Research conducted by Wahyu Eko Susanto Dwiza Riana stated that the accuracy value of the ANN algorithm is better than the K-NN algorithm, with an accuracy rate of 80.00% for the ANN algorithm, while the K-NN algorithm has an accuracy rate of 71.00% [4]. ANN has advantages such as learning ability, parallel ability, ability to model non-linear functions, and fault tolerance properties. [5]

From these explanations, the researcher will conduct trials on the ANN (Artificial Neural Network) method in identifying the ripeness of dragon fruit to identify the maturity level of the fruit based on the color of the fruit's skin. For instance, unripe dragon fruit is marked with a green skin color and hard texture. As the fruit's maturity increases, the dragon fruit's outer skin will also change color. Ripe fruit has a red and even skin color. The various problems are developing applications that can identify dragon fruit maturity using computer media. How can you find out the maturity level of the dragon fruit, and can we identify the maturity level of the dragon fruit using the ANN (Artificial Neural Network) method?

Method

Based on the level of application, this research is an applied research. Then based on the type of the data obtained, the research is a quantitative study. According to the treatment of the data, it is a confirmatory research. This study uses experimental research methods. The subject of this study is the classification of dragon fruit objects. The research method is proposed as shown **Figure 1** below:

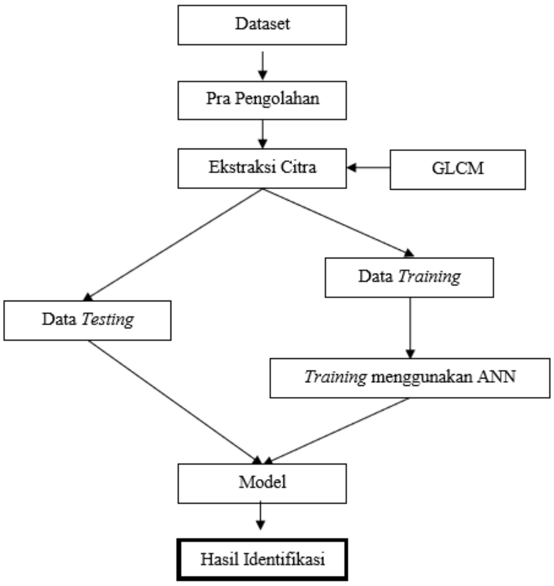


Figure 1 Identification Modeling

1. Preprocessing
   Data goes into processing, then it processed first using the segmentation process, this is done to separate the desired object.
2. Color Feature Extraction
   Feature extraction functions as a feature detector of an image. Characteristics that can be used to distinguish one image from another include shape features, size characteristics, geometric characteristics, texture characteristics, and color characteristics. This study used color feature extraction using RGB (Red, Green, Blue). Each image's characteristics are extracted based on certain parameters and grouped in a particular class. The values of these parameters are then used as input data in the classification process.
3. Data Training
   The training data is a collection of data that has extracted features which will then be trained using an artificial neural network algorithm. This algorithm will determine or find the best weight. The training data is a feature extracted from the RGB (Red, Green, Blue) image of dragon fruit maturity.
4. Training Using ANN

Training using ANN is done by inputting training data to determine the suitable mode. The architecture of the ANN algorithm will be carried out experimentally to determine the composition of the number of neuron screens to get the best performance results.

5. The model is the result of the KNN algorithm training process using training data.
   Data Testing is the data that has extracted features and is used to test data that has been trained. Data testing is used to measure the extent to which the classification succeeds in carrying out the classification correctly. Therefore, the testing data should be outside the training data to identify whether the classification model is smart in classifying. Data testing is a characteristic of the results of the GLCM extraction of dragon fruit maturity.
6. Classification Results
   The classification results are the output results on the testing data obtained from the classification process carried out by the ANN algorithm based on the model obtained from the training results.
7. Evaluation
   The evaluation aims to determine the performance of the texture analysis method used. The evaluation process is carried out on all data testing then the resulting target output will be mapped into the Confusion Matrix to calculate the accuracy value.

Findings and Discussions

A. Results of data collection

Researchers have carried out the data collection process and succeeded in collecting 60 data of dragon fruit images with different maturity levels, see in **Table 1**.

Table 1. Collection of Data Sets

Ripe 99%				
Unripe 85%				

To proceed into the analysis process in this study, we have to select image data to serve as training and testing data. The amount of training data is 40 image data and 20 image data testing.

1) Modeling Results

a. Preprocessing

Image pre-processing (image pre-processing) is the earliest process in image processing before the main process is carried out. At this stage, the dragon fruit image will be converted to get the fruit image that suits your needs. The initial process is to change the training or testing image, initially an RGB image, to a grayscale image. This change was made because grayscale images have a simple equation and can reduce memory requirements where white values are represented by 255, and black values are represented by 0.

Formula of RGB Image Conversion to Grayscale:

RGB IMAGE → GRAYSCALE IMAGE → HISTOGRAM IMAGE

$$S = \frac{R + G + B}{3}$$

Where:

R = Red,

B = Blue,

G = Green

Where:

Ko = gray value of the histogram results

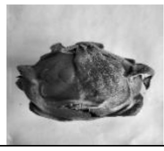
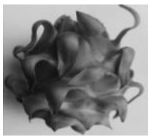
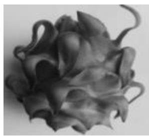
Ci = Cumulative distribution of the I-th grayscale values of the original image

Round = rounding function to the nearest number

W = Image Width = Image Height

Converting color images to Grayscale and normalizing images is conducted by using Histogram Equalization. After the original image is converted to gray, the next pre-processing is image normalization with an equalization histogram. Histogram equalization is a process that changes the distribution of the gray degree values in an image to become uniform. The purpose of histogram equalization is to obtain an even distribution of histograms so that each degree of gray has a relatively equal number of pixels. The **Table 2** is the process of converting a color image to grayscale and normalizing a gray image with an equalization histogram:

Table 2. Output results from the RGB to Grayscale and Grayscale to Histogram Equalization conversion processes.

Original Image	Grayscale Image	Equalization Image
		
		

b. Segmentation Image

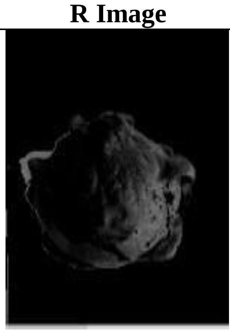
Image segmentation means to divide an image into homogeneous regions based on certain similarity criteria between a pixel's gray level and neighboring pixels' gray level. Then the results of this segmentation process will be used for further processing.

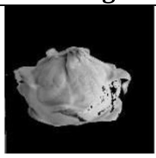
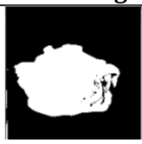
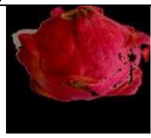
c. Otsu Thresholding Method

The Otsu method is a method for segmenting digital images by automatically using a threshold value, namely changing a gray digital image to black and white based on comparing the threshold value with the pixel color value of the digital image. The Otsu Thresholding method was first introduced by Nobuyuki Otsu in his scientific journal entitled "A Thresholding Selection Method from Grayscale Histogram" in 1079.

The **Table 3** is the RGB image process that was converted to Segmentation, along with the commands used in python and the output results:

Table 3. Segmentation Image

Original Image	R Image	G Image
		

B Image	Otsu Image	Segmentation Image
		

d. Feature Extraction

This stage is carried out to change image segmentation using GLCM feature extraction. GLCM represents a relationship between two neighboring pixels where two connected pixels have a certain gray intensity and distance and direction between them. The distance is expressed as pixels and the direction as an angle. The distance can be 1, 2, 3, and so on, while the direction can be 0°, 45°, 90°, or 135°. The following is an example of calculating a matrix with a size of 10 x 10 pixels, see in **Table 4** dan **Table 5**:

Table 4. Value of an Image

r/k	0	1	2	3	4	5	6	7	8	9
0	176	176	175	175	174	174	177	177	177	177
1	175	175	175	175	175	175	176	176	177	177
2	174	175	175	175	175	175	176	176	176	176
3	174	175	175	175	175	175	176	176	176	176
4	174	174	175	175	175	175	175	176	176	176

Table 5. GLCM Matrix

x/y	173	174	175	176	177
173	1	2	0	0	0
174	2	4	13	0	1
175	0	13	39	9	0
176	0	0	9	12	1
177	0	1	0	1	4

The total number of GLCM values = 112

Furthermore, in **Table 5** the values in pixels are added up with the total number in the previous pixel.

Table 6. Normalized Matrix

x/y	173	174	175	176	177
173	0.0089	0.0178	0	0	0
174	0.0178	0.0347	0.1160	0	0.0089
175	0	0.0116	0.3482	0.0803	0
176	0	0	0.0803	0.1071	0.0089
177	0	0.0089	0	0.0089	0.0347

After that, the contrast, homogeneity, energy, and entropy values were calculated manually. After all the feature calculation processes have been carried out, the next step is to add up each matrix of these features so that the following results are obtained in **Table 7**:

Table 7. Extraction Feature Value Results

No	Contras	Energy	Homogeneity	Entropy
1	0.5937	0.162634	0.5907	-0.9104

The next step is to measure the average values from all angles to obtain a single value for each feature to ease the classification naming.

The four characteristics obtained from the Co-Occurrence Matrix will then be used in the classification stage.

e. Classification

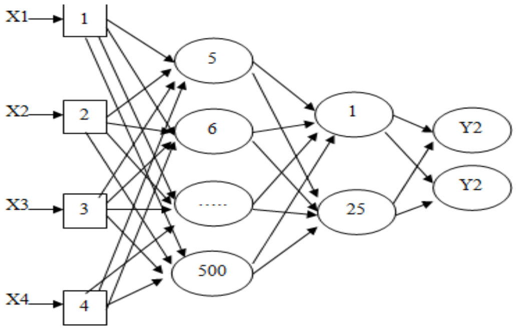


Figure 2. Backpropagation Network Architecture

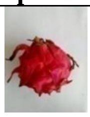
The classification of the data used is 53 Training data and 30 Testing data, which consists of 73 images of ripe dragon fruit and 11 images of unripe dragon fruit. From the 83 datasets, each image has a value of contrast, homogeneity, entropy, and energy. As in **Table 8** below:

Table 8. Data Training Results

Data Training	Con (x1)	Ene (x2)	Hom (x3)	Ent (x4)	Y
	107.8044	0.3402	0.6553	0.9476	**Ripe 99%**
	50.6657	0.5211	0.8628	0.9819	**Ripe 99%**
	73.6496	0.3407	0.7329	0.9705	**Ripe 99%**
	104.2028	0.3672	0.7217	0.9625	**Ripe 99%**
	123.3798	0.4311	0.7240	0.9468	**Ripe 99%**
	94.5004	0.3890	0.7354	0.9656	**Ripe 85%**
	76.2630	0.5879	0.8137	0.9705	**Ripe 85%**

Table 9. Data Testing Results

Data Testing	Con (x1)	Ene (x2)	Hom (x3)	Ent (x4)	Y
 **Ripe 85%**	75.8744	0.6696	0.8393	0.9829	**Ripe 85%**
 **Ripe 85%**	68.8290	0.8262	0.9095	0.9680	**Ripe 85%**

 **Ripe 85%**	44.4893	0.8330	0.9329	0.9730	**Ripe 85%**
 **Ripe 85%**	48.3818	0.7473	0.9045	0.9739	**Ripe 85%**
 **Ripe 85%**	55.8302	0.7617	0.8968	0.9743	**Ripe 85%**
 **Ripe 99%**	77.6835	0.3515	0.7467	0.9677	**Ripe 99%**
 **Ripe 99%**	67.0526	0.4706	0.7893	0.9771	**Ripe 99%**

Furthermore, the learning process will be carried out on the training data table above using the MLP backpropagation network architecture that has been presented previously.

At each data processed in one iteration, the output error is stored to be counted as an error criterion, such as SSE, MSE, etc. If the MSE result < error is obtained, the iteration stops. Otherwise, the propagation continues until the iteration/epoch limit.

2) Evaluation

a. Confusion Matrix

This study uses the Confusion Matrix as a method in calculating the accuracy of the application of the identification of the maturity level of dragon fruit. Evaluation of maturity identification performance is based on the number of false and correct object tests detected, which can be seen from the following **Table 10**:

Table 10. Confusion Matrix Results

		IDENTIFICATION	
		Ripe 85 %	***Ripe 99%***
ACTUAL	***Ripe 85 %***	5	0
	Ripe 99 %	1	4

Number of data identified correctly = 9

Number of data identified incorrectly = 1 Accuracy = 9/10* 100% = 90%

Conclusion

This study concludes that the identification of the maturity level of dragon fruit has been successfully tested in this study. It was divided into two groups of ripe dragon fruit, namely the raw group and the ripe group. The proposed method has been able to detect dragon fruit maturity with an accuracy result of = 9 /10* 100% = 90%, calculated using the confusion matrix. Thus the suggestion is that the application of the Gray Level Co-Occurrence Matrix and Artificial Neural Network methods on the dragon fruit maturity level problem can be further developed.

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