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Determining blewah fruit maturity based on skin color texture using feature extraction

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Abstract. Blewah (Cucumis Melo L) is the original fruit of Indonesia. Blewah is a similar fruit to Cantaloupe, but difference in skin texture. In Indonesia, many farmers are conducting cultivation of cantaloupe. The period of cultivation of blewah fruits need 50 days after planting period. Purpose of this research is determined blewah maturity based on skin color texture image. Feature extraction process begins with converting RGB image to grayscale image. Feature extraction is processed on the grayscale image with 11 characteristic parameters. 11 characteristic parameter is Mean, Variance, Skewness, Kurtosis, Entropy, Angular Second Moment, Contrast, Correlation, Standard Deviation, Inverse Difference Moment and Homogenity. 11 characteristic parameters are further classified using artificial neural network LVQ. The final weight obtained is used as a reference weight to identify whether the blewah is ripe. Based on the test conducted using 30 data test, the feature extraction method has a good accuracy level. 85,7% accuracy rate obtained by the number of test data as much as 30 images using first ordo feature extraction method. 78,5% accuracy rate obtained by the number of test data as much as 30 images using second ordo feature extraction method.

Keywords: Blewah Maturity, Feature Extraction, Neural Network, Learning Vector Quantization.

1. INTRODUCTION

Blewah (Cucumis Melo L) is the original fruit of Indonesia. Blewah is a similar fruit to Cantaloupe, but difference in skin texture. Blewah is closely related to cantaloupe formerly known as Melon Londo in Indonesia. Other than Cantaloupe, fruit that have similarity with blewah is Timun Suri. Blewah is similar to cantaloupe but different in cultivation group. Blewah is liana shaped, similiar with pumpkin and cucumber. Blewah is generally oval-shaped, with bright orange skin with greenish spots. In Indonesia, many farmers are conducting cultivation of cantaloupe. The period of cultivation of blewah fruits need 50 days after planting period.

After harvest, farmers separate the fruit based on quality. It aims to ensure uniformity of fruit quality. Agricultural and plantation processing industries are growing rapidly. Post-harvest activities are closely related to product quality, which ultimately determines the selling price of the product. There are two ways to determine the maturity of blewah, which is destructive and non-destructive. Determining the maturity of blewah is destructively done by splitting the fruit to determine the level of maturity. This is done when blewah will be consumed directly, but it is not possible if the fruit will be sold in the market. Determining fruit maturity in a non-destructive way is required to keep the quality of blewah.

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Fig 1 Blewah Fruit

Identification of non-destructive blewah maturity is done by considering the age of the planting of blewah, the physical size of blewah, and color change on blewah fruit. Determining the maturity of cantaloupe by non-destructively can also be applied various kinds of digital image processing methods. Method of digital image processing that can be applied are K-Nearest Neighbour, Gabor Filter, Feature Extraction, Image Clustering, HSV (Hue Saturation Value), etc. Feature extraction methods are done implemented for identification of various fruit maturity process based on color texture. In this research, proposed method for determining maturity of blewah based on the color texture are First Order Feature Extraction Method, Second Order Feature Extraction Method, and Neural Network (Learning Vector Quantization).

2. FEATURE EXTRACTION

This section describes the first and second-order statistical feature extraction methods. Extraction of first-order features is obtained through an image histogram. The extraction of second-order statistical features is obtained by a co-occurrence matrix, matrix that representing the neighbor relationship between pixels in the image in various orientation and spatial directions.

2.1First Order Feature Extraction

First-order feature extraction is a characteristic retrieval method based on the characteristics of an image histogram. The histogram shows the probability of occurrence of the pixel gray degree value in an image. From the resulting histogram values, we can calculate some first order characteristic parameters, including Mean, Skewness, Variance, Kurtosis, and Entropy.

2.2Second Order Feature Extraction

In some cases, first-order features can no longer be used to recognize differences between images. In such a case, we need to take the characteristic of a second-order statistic. The technique for obtaining a second-order statistical feature is to calculate the probability of an adjacency relationship between two pixels at a certain distance and angle orientation. This approach forms a co-occurrence matrix of image data, further defining the feature as a function of the intermediate matrix.

Co-occurrence means a common occurrence, the number of occurrences of one level of pixel value adjacent to one level of another pixel value within a certain distance (d) and angle orientation (θ). Distance is expressed in pixels and orientation expressed in degrees. Orientation is formed in 4 (Four) angular directions with angle intervals of 45 °, 0 °, 45 °, 90 °, and 135 °. Distance between pixels is usually set by 1 pixel.

Co-occurrence matrix is a square matrix with the number of elements as large as the square of the number of pixel intensity levels in the image. Each point (p, q) of the oriented θ-oriented matrix contains the probability of a pixel event having p value adjacent to the pixel having value q at distance d and orientation θ and (180-θ).

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3. LEARNING VECTOR QUANTIZATION

Learning vector quantization (LVQ) is a method for conducting learning on a supervised competitive layer. A competitive layer will automatically learn to classify input vectors. The classes obtained as a result of this competitive layer depend only on the distance between the input vectors. If two input vectors are approximately equal, then the competitive layer will place the two input vectors into the same class.

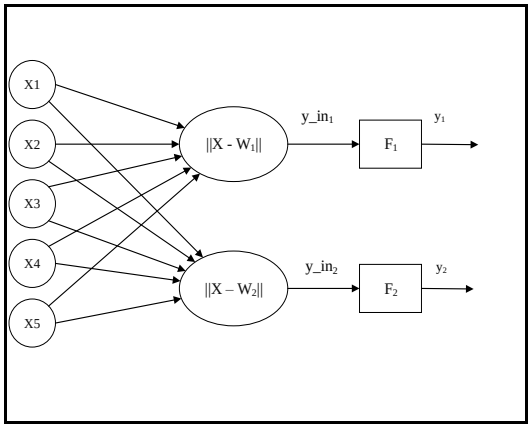

Fig 2 LVQ Architecture Example.

LVQ architecture as well as SOM (Self Organizing Map), LVQ consists of 2 layers, input (X) and output (Y), between layers connected by certain weights that are often referred to as vector representatives (W). Information provided to the network during learning is not just a data vector, but class information from the data is also included. Figure 2 shows an LVQ network with 6 units on the input layer and 2 units (Neuron) on the output layer. The processing that occurs in each neuron is to find the distance between an input vector to the corresponding weights (*w_1* and *w_2*). *w_1* is a weight vector that links each neuron in the input layer to the first neuron in the output layer, whereas *w_2* is the weight vector that connects each neuron in the input layer to the second neuron in the output layer. The activation function F1 will map y_in1 to *y1 = 1 if* || *x - w1* || <|| *x - w2* ||, and *y1 = 0* if otherwise. Similarly, what happens to the F2 activation function will map *y_in1 to y1 = 1 if* || *x - w2* || <|| *x - w1* || and *y1 = 0* otherwise.

4. DETERMINING BLEWAH FRUIT MATURITY

In this research, image used as training data is 16 data skin fruit of blewah. Consists of 8 images of mature fruit, and 8 images of raw fruit. Skin image of blewah fruit taken at the curve of blewah skin. Trained data image used extension *.JPEG, with image size 512x512 pixels. Image testing is 14 pieces of data. Image of blewah skin used extension *.JEG. Consists of 8 images of mature fruit, and 8 images of raw fruit. Skin image of blewah fruit taken at the curve of blewah skin.

The research process is designed on a flowchart. In this section there are 3 processes, Pre-processing, Feature Extraction Process and Classification Process with Artificial Neural Network using Learning Vector Quantization. Figure 2 shows the main program design flowchart in this research.

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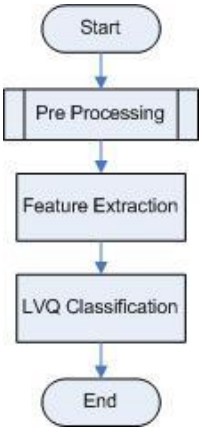

Figure 3. System Flowchart.

In pre-processing stage can be explained as follows. The first stage of this process is to insert a RGB image that is 512x512 pixels in size. Then image is converted into grayscale. Histogram value is then calculated from the grayscale image resulting in a value on the histogram.

In this research, there are 2 artificial neural networks, each for first order feature extraction method and second order feature extraction method. This is done to compare the results of identification of maturity of blewah. The first step is to determine the value of training data and test data values for data needs to be processed on the LVQ network. After the initialization of variables that exist within both artificial neural networks LVQ, variables used include input vector (*Xij*), iteration (*Epoch*), initial weight (*Wij*), Learning Rate *(α),* Minimal Learning Rate (*Minα*), Decrease of Learning Rate (*Decα*), Learning Function (*LF*), and Target Class (*Tk*).

Variables used to create artificial neural networks for the first order feature extraction method are the input vector (*Xij*) of 5 vectors, the iteration (*Epoch*) is 100 Epoch, the initial weight (*Wij*) is obtained from 2 row data 1 and 2 in the data of train and data test, node hidden layer is 10, Learning Rate (*α*) is generally '0.05', Minimal Learning Rate (*Minα*) is' 0.05 ', Decreasing Learning Rate (*'000'*), Learning Function (*LF*) using "learnlv1", target class (*Tk*) worth 1 and 2 (1 for raw and 2 for mature), and ouput node amounted to 2. As for LVQ neural networks the second order characteristic extraction method as a whole variables used equal to the variable used to create artificial neural network LVQ first order extraction method, only input vector used in LVQ network second order feature extraction method amounted to 6 vectors due to parameters on the first order feature extraction has 5 characteristic parameters of second order feature extraction feature has 6 characteristic parameters.

To determine the value of *Decα* can be done by means $\alpha = \alpha$ - *Decα* or $\alpha = \alpha$ * *Decα*. The value of Learning Rate (*α*) can be changeable, the closer to the number 1 then the LVQ network learning is getting better.

From table 1 is the sample data from the total data of 14 test images. The number of images in accordance with the classification of neural network Learning Vector Quantization amounted to 11 pieces. While the number of unsuitable images amounted to 3. Thus the value of accuracy of success amounted to 78.5%.

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Table 1. Testing Result Sample

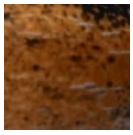
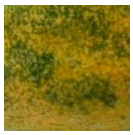
Image Testing (Blewah)	Cate-gories	Class	Result (First Order Feature Extraction)	Result (Second Order Feature Extraction)
	Raw	1	1	1
	Mature	2	2	1
	Raw	1	2	1
	Mature	2	2	2
	Raw	1	1	1
	Mature	2	2	2
	Raw	1	1	1
	Mature	2	2	2

Table 1 on column Second Order Feature Extraction is a sample data of all 14 test data. The number of images in accordance with the classification of neural network Learning Vector Quantization amounted to 12 units, While the number of unsuitable images amounted to 2. Thus the value of accuracy of success amounted to 85.7%.

5. CONCLUSION

Based on the testing result, the maturity of Blewah can be known from the age of planting, fruit aroma, and physical size of the fruit. Blewah maturity also known from the texture of skin color. In

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addition, it can be compared from the calculation of first order feature extraction and second order feature extraction.

Results of determining maturity of blewah based on fruit color texture has a good recognition rate percentage that using second order feature extraction methods. Accuration percentage of second order feature extraction method reached 85.7%, while the accuration percentage of first order feature extraction method reached 78,5%.

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