Implementation of Digital Processing for Identification of the Ripe Quality of Papaya Fruits

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Abstract

Digital processing has been developed in various fields of work in line with the development of technological innovation. With digital processing, it can facilitate human activities and reduce the risk of errors. The process of sorting papaya fruit is one of the processes to determine the quality of the fruit to be sold. The level of human perception in sorting fruit is different and unstable because humans can experience fatigue. This study aims to create a system for identifying the ripeness quality of papaya using digital processing technology, analyzing the color value level (RGB) and classifying according to class using an Artificial Neural Network (ANN). There are 3 classes of papaya ripeness class, namely unripe, half ripe, and ripe. Where each class has 10 images to be tested, so that the total images tested are 30 images. Based on the test results, an average accuracy of 86.7% was obtained, which means that the process of identifying the ripeness of papaya fruit by the system is quite good.

Keyword : Digital, Processing, Papaya Maturity, and RGB

Introduction

Digital processing research is increasingly being developed in various fields of work along with the development of technological innovation. Various kinds of digital-based tools were created to provide convenience in human activities. With digital processing analysis, it allows solving an arithmetic problem quickly and with a low risk of error (Siswanto and Utama 2017) . Digital image methods have been developed starting from *image sensors* , *image compression,* and *Digital Signal Processor (* DSP). In general, there are three types of digital image color combinations in *pixels* , *namely binary images, RGB (Red, Green, and Blue) images, and Grayscale images.*

Image processing is widely used to detect objects, the quality of ripeness in fruit, the type of object, the weight of the animal, identification of human fingerprints, and calculating a certain area. (Munantri, Sofyan, and Florestiyanto 2020) . The latest research on image processing is used for copyright security to protect the property rights of someone's work in cyberspace/the internet (Asroni and Serumena 2021) and identification of rice types using the grayscale image method because there are many types of rice in Indonesia (Suwanto, Adam, and Garno 2021) . In another study, digital image security is based on cryptography for encryption and decryption on digital image media (Riadi, Fadlil, and Tsani 2022) . Making a system for digital processing is for the effectiveness of work processes in the plantation industry by increasing the performance of the fruit sorting process (Amrozi, 2019) **.**

Indonesia is one of the largest agricultural countries in the world and is also home to a tropical country that has very promising and very good agricultural potential. One of the supports for tropical agricultural products in Indonesia is fresh products in the form of fruits and vegetables (Suyanti et al., 2018). Indonesia's agricultural sector is one of the pillars of the national economy and development. Suhariyanto is the head of the Central Statistics Agency (BPS), said the contribution of the agricultural sector in the second quarter of 2020 increased by 15.46% *year on year.* Adoption of digital technology has really helped increase agricultural productivity, for example papaya fruit with technology we can identify the quality of ripe papaya using digital images by scanning the texture of the fruit to identify the color of the texture, or the size of the fruit and then dividing it into several classification categories (Hasanah 2021) . The advantages of the digital process minimize the occurrence of observational errors in large-scale sorting. From a biological point of view, papaya fruit is a plant that belongs to the Caricaceae family with the Latin name *Carica papaya L.* This plant originates from Mexico and grows in the tropics. Papaya fruit is very easy to find and also contains rich antioxidants and glucose. This plant has a taproot type, stems are round and have holes like cavities, single leaf, compound flowers, papaya fruit is orange when it is ripe, while the seeds are black.

Digital imagery is done by scanning the texture of the fruit to identify the color, texture, or size of the fruit and then dividing it into several classification categories. The advantage of digital image processing over manual processes is minimizing the occurrence of observational errors (Bello et al., 2020). During the harvest season, which is carried out on a large scale, officers do not allow the sorting process to be carried out manually. This is because it requires a lot of energy which results in fatigue, inconsistency, and human judgment is subjective (Behera et al., 2021). Thus, it is necessary to utilize digital images by

processing them using RGB and HSV images. Image processing is carried out using the Matlab application because MATLAB is the leading image processing *software* in processing matrices. The purpose of this study was to identify the ripeness quality of papaya fruit based on the color of the fruit skin more easily using image processing.

Theoretical Basis

Digital Image

A digital image is a two-dimensional image that can be displayed on a computer screen to display a collection or area of digital values called pixels or image elements. Several types of digital images that are often used include binary images (monochrome), gray images (grayscale), and color images (truecolor). Elements in a digital image consist of brightness, contrast, contour, color, shape, and texture. At each pixel, the imaging device records a number, or a number of small numbers that describe some of the properties of this pixel, such as its brightness (light intensity) or color (Vogt & Riitters, 2017). The numbers are arranged in rows and columns according to the vertical and horizontal positions of the pixels in the image.

Statistical feature extraction

Feature extraction is a method for performing statistical calculations of the distribution of gray degrees (histograms). The obtained image histogram represents the probability of the appearance of a pixel histogram value in an image (Himmah, Widyaningsih, and Maysaroh 2020) . From the values of the histogram results, calculations can then be carried out based on the feature parameters including the maximal , minimum *and* mean *values* (average) of pixels in RGB and HSV images.

1) *Mean* (Average)

To obtain the average value of an image, the following equation is needed:

$$\mu = \sum_{n=0}^{N} f_n \, p(f_n)$$

Where :

f_n = gray intensity value

$P(f_n)$ = histogram value

2) Maximum and Minimum Value

To obtain the maximum and minimum values, the following equation is needed:

Rmax = max (R)

R *min* = min(R)

Gmax = *max* (G)

G *min* = min(G)

$B_{max} = \max(B)$

$B_{min} = \min(B)$

RGB image

RGB images are usually referred to as true color images which are stored as m-by-n-by-3 data arrays that describe the red, green, and blue color components at pixel intensity values. RGB images do not use a palette and each color in a pixel is determined by a combination of red, green and blue intensities stored in each color field in the pixel. The graphics file format stores RGB images as 24-bit images, where the red, green, and blue components are each 8 bits, resulting in a potential of 16 million colors. The color field in the RGB image with the consideration of the 'I' array, namely I(:, :, 1) represents the red color, I(:, :, 2) represents the green color, and I(:, :, 3) represents the blue color (Himmah, Widyaningsih, and Maysaroh 2020)

Related Works

1. Indriyani, Susanto, and Riana, 2017 who researched "Image Processing Techniques Using the Matlab Application in Measuring Tangerine Fruit Diameters". The results of the study stated that image segmentation was carried out in several stages to obtain appropriate image results and the system was able to identify the size of oranges in accordance with the Indonesian National Standard for tangerines.
2. Permadi and Murianto, 2015 who researched "Image Processing Applications for Identification of Cucumber Ripeness Based on Fruit Skin Texture Using Statistical Feature Extraction Methods". The results showed that the detection of maturity in cucumbers using the Matlab application with a percentage of ripe cucumbers reaching 70% and 80% in immature cucumbers and said the success rate was good.
3. Miss Nikita S. Hatmode, Prof. MN Thakare, 2020 researching “Identification of Artificially Ripened Fruits Using MATLAB ". The result of the research is to develop an application to detect artificially ripe and naturally ripe fruit. The fruit image processes the image by calculating the histogram value then classifying the image with a threshold as natural and artificial ripe fruit. Thus, this method helps the user to stay healthy and eat nutritious fruit by avoiding the intake of artificially ripened fruits that are ripened with chemicals such as calcium carbide.
4. Neeraj Chauhan, Dr. Ashutosh Kr. Bhatt, Prof. Rakesh Kumar Dwivedi, Prof. Rajendra Belwal, 2018 researching "Physical Parameters Extraction of Mango Fruit Using Image Processing in MATLAB". The research results with GCLM based on extracted texture features data are given in table 2. Texture features are used to find roughness and smoothness of images. In this paper based on extracted texture features two classes of mangoes are created class 1 and class 2. Class 1 of mangoes is for a smooth surface of image representing healthy mangoes also and class 2 is for rough surface mangoes representing unhealthy mangoes.

The implementation of digital processing can be implemented based on the size of the fruit diameter to classify the size of citrus fruit, the texture of the cucumber skin for the degree of maturity, the texture feature extraction based on GCLM, and also calculate the

holographic value and classify it as a natural or artificial ripe fruit threshold if the fruit is naturally ripe. then it can be consumed properly because there are no harmful chemicals. So, various articles have tested using Matlab software to identify fruits and vegetables.

Research Methods

The research method used in this study contains structured steps to identify the ripeness of papaya fruit. Image processing in this study uses Matlab r2015b software. Papaya fruit maturity level data are grouped into 3 maturity level classes, namely immature, half ripe, and ripe. Each class has 10 images, so the total required images is 30 images. Image sampling was carried out by taking pictures of papaya according to the maturity level class using a smartphone camera. The main steps in the digital image process (González et al., 2009) are shown in Figure 1.

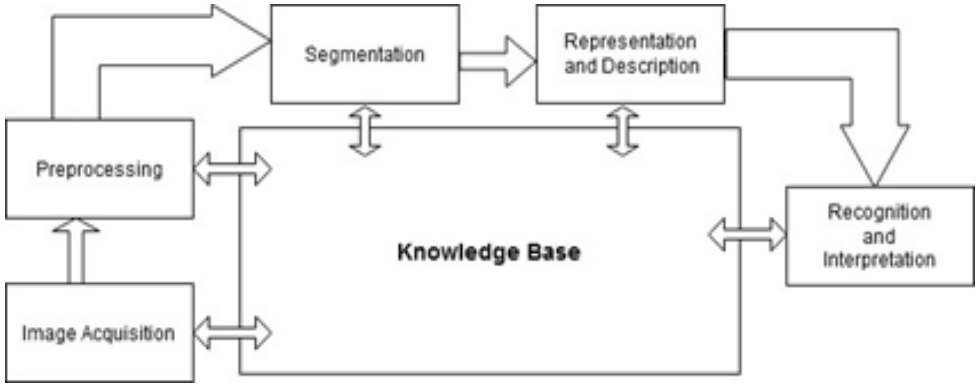

Figure 1. Steps in Digital Image

The digital image steps in Figure 1 are explained as follows:

a. *Image acquisition* : the process of taking some original image samples from papaya using a camera. Each maturity level class requires 10 images, so there are a total of 40 images from all classes.

b. *Preprocessing* : in this step, optimization of image size, brightness, removal of noise in the image, repair of image restoration, and determining the part of the image to be observed is carried out.

c. *Segmentation* : in this step, the object you want to separate is separated from other objects. The result of segmentation is the boundary of the object to be processed, for example separating the object from the background.

d. *Representation and Description* : this step aims to represent the boundaries of the object. After the representation is carried out, a description of the image is carried out by means of statistical feature extraction.

e. *Recognition and Interpretation* : this step is the last step which aims to label the image/object based on the information determined by the descriptor and is followed by the interpretation stage to interpret or interpret the results on the group of objects that are recognized.

e. *Knowledge base* : the knowledge base is one of the important things in image processing which is used as an information guide to solve problems.

Results and Discussion

The ripeness identification process system for papaya fruit is shown in Figure 1 which was created using Matlab R2015b software. The data used in this image processing is papaya fruit which is divided into 3 maturity groups (3 classes) with 10 image samples in each class. The 3 classes will be identified by 1) immature papaya fruit (green), 2) half ripe papaya fruit (half yellow), and 3) ripe papaya fruit (yellow).

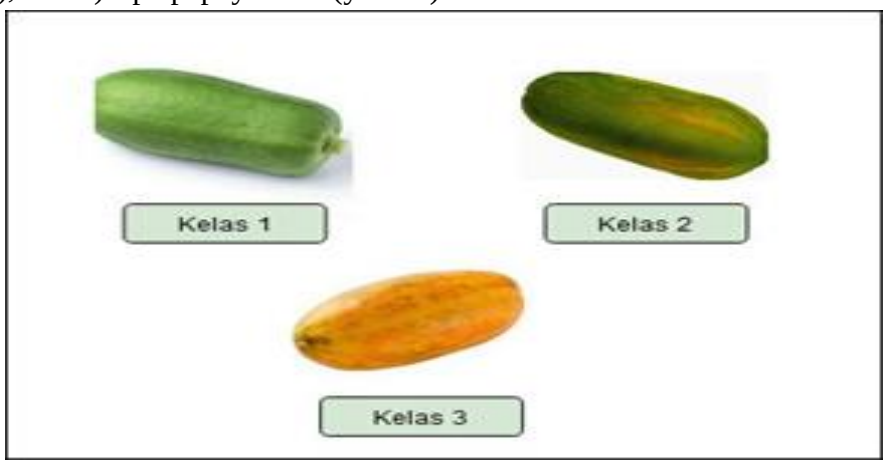

Figure 2. Image of bananas in each class

After obtaining the original image, then the *preprocessing process is carried out* to optimize image size, image brightness, and remove noise in the image. *Preprocessing* is important before the feature extraction processing stage so that the extracted images produce factual feature extraction values. The following shows the image processing system

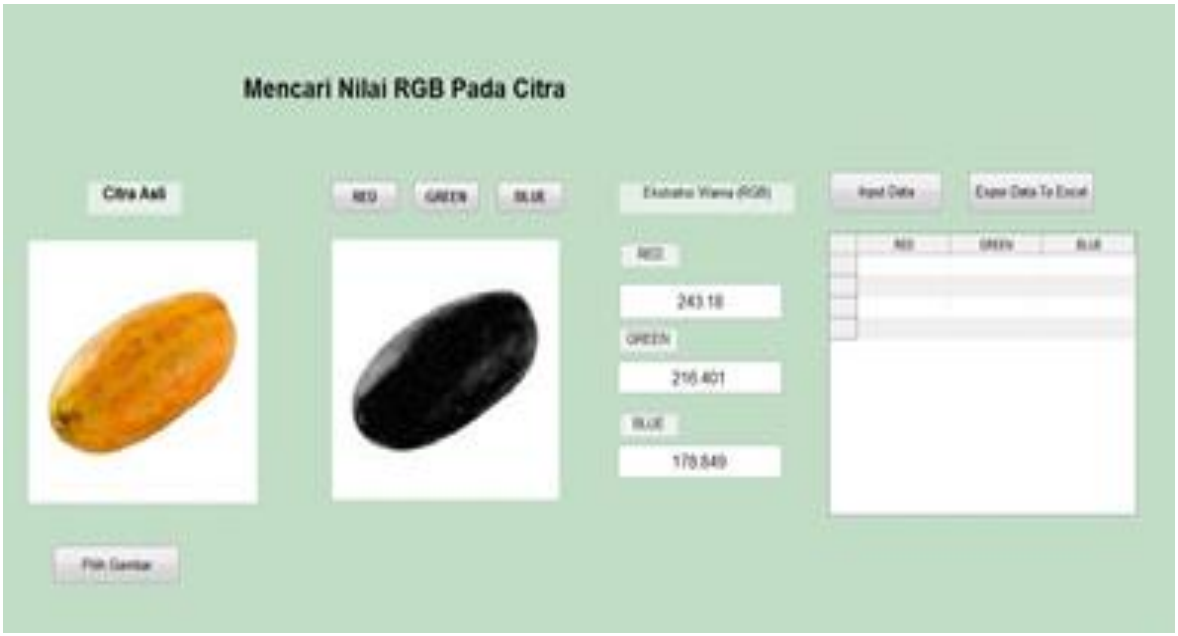

Figure 3. Display of the Image System GUI

From the system that has been made, the RGB values for each class are obtained. In each class, image initialization is carried out using RGB. From the results of the RGB values, class classification is carried out using an Artificial Neural Network (ANN).

Table 1. Test Data

Class	Original Image	RGB value	Manuals	Application	Results
Raw		R = 190.267 G = 206,774 B = 174.64	Raw	Raw	In accordance
Half-baked		R = 144,759 G = 149,563 B = 87.357	Half-baked	Half-baked	In accordance
Ripe		R = 243.18 G = 216,401 B = 178,849	Ripe	Ripe	In accordance

From table 1. The test data obtained range of values in the raw class R = 190,267, G = 206,774, B = 174.64, while in the half cooked class R = 144,759, G = 149,563, B = 87,357, and in the mature class R = 243.18, G = 216.401, B = 178.849. Image testing was carried out on 30 sample images with the extension JPEG and JPG. Of the 30 types of images, qualification was then carried out using the Artificial Neural Network method. Where is the test of 10 unripe fruit, 10 half ripe fruit, and 10 ripe fruit.

Table 2. Classification Results

Class	Test Image	Classification Results		accuracy
		Correct	Wrong	
Raw	10	10	0	100%
Half-baked	10	7	3	70%
Ripe	10	9	1	90%

Based on the results in table 2. Classification results in class 1 of immature papaya fruit using 10 test images produced an accuracy of 100%, which means that it was identified very

well. In the half-baked class the accuracy is 70%, because 3 images are not identified. Meanwhile, in the mature class, 90% accuracy was obtained because 1 image was not identified. The identification results are affected by the skin color of the papaya fruit which affects the system identification process.

Conclusion

Based on the results of identifying the maturity level of papaya using feature extraction of the RGB color space and classification of maturity levels using an Artificial Neural Network (ANN). From the accuracy results, an average accuracy rate of 86.7 % was obtained . From the results of these tests indicate that the results of the identification of ripeness in papaya fruit is quite good. In future research it is suggested to increase the accuracy of ripeness using other methods and the type of papaya fruit used.

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