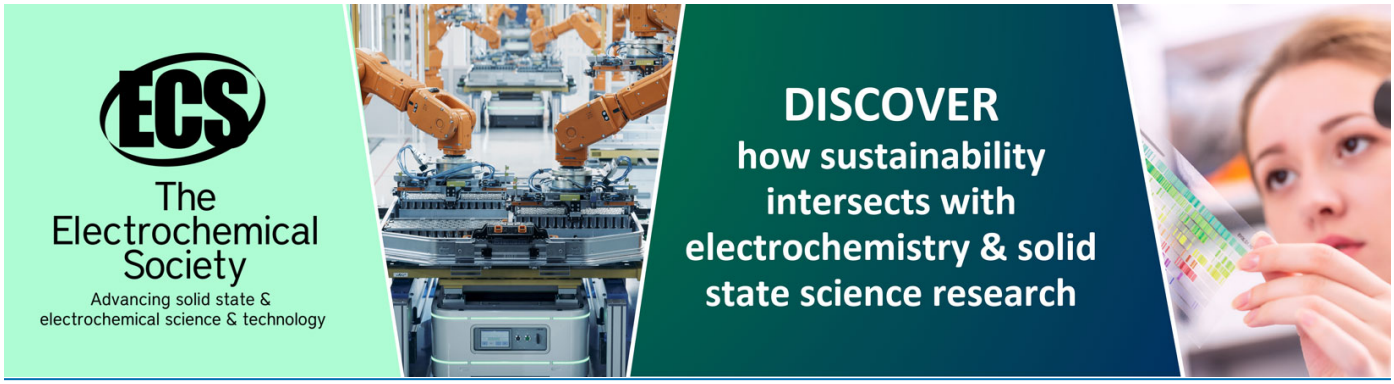
Dragon Fruit Maturity Detection Based-HSV Space Color Using Naive Bayes Classifier Method



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Dragon Fruit Maturity Detection Based-HSV Space Color Using Naive Bayes Classifier Method

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Abstract. Color is one of the elements to determine the level of maturity of the fruit because each level of maturity of the fruit has a different color level. At present, the dragon fruit is only classified based on a visual analysis of the skin color of the human eye. This study aims to classify dragon fruit using image processing with the naïve Bayes method based on HSV color space. The color feature used in this study is RGB which has been converted to an HSV value, after getting an HSV value then classified using the naïve Bayes method. Image data used amounted to 120 training images and 30 test images. The results of the classification of dragon fruit using the naïve Bayes method based on HSV color space can show an accuracy rate of 86.6%.

1. Introduction

Red flesh dragon fruit (Hylocereus polyrhizus) is a type of cactus plant or in the family Cactaceae and subfamily hylocereanea that grows in many American regions but many are also cultivated in the Asian region. Dragon fruit, in general, contains water nutrients, carbohydrates, phosphorus, vitamin C, calcium, and specifically for red fleshy dragon fruit also contains beta carotene which functions as an antioxidant. In Indonesia, dragon fruit is planted on a small scale (household) or on a large scale (garden), dragon fruit can be said to be old enough to be harvested when it is ± 50 days after the flowers bloom perfectly. In fruit harvesting, it is necessary to consider the level of fruit maturity, because this is one of the factors in determining the quality of the dragon fruit. If the fruit is harvested when it is still not ripe even though the color has started to red, the result is that the fruit will have a less sweet taste. Likewise, when the fruit is harvested in conditions for too long it will produce a sweet taste but the fruit also has a short shelf life because it rots quickly.

Image processing is one technique that can be used in processing images by manipulating them into image data to obtain the desired information. Transforming the system from color space is one of the methods used in image processing. The basic basis of color composition is RGB or red, green, blue, which is also good for displaying color information from images but there are also some image processing applications that are not suitable. To overcome these deficiencies, one way to display image information is by converting the RGB value of the image into an HSV value.

The use of image processing technology is expected to help improve accuracy in the classification of fruit maturity levels. The condition of fruit maturity can be observed through the color of the image when taken against a background that contrasts with the object of study. This is what underlies the conduct of this research so that there are thoughts to build an image processing application to predict the maturity of dragon fruit based on the dragon fruit skin color features. The application of fruit maturity detection previously investigated include star fruit [1], banana [2], apple [3], manga [4], persimmon [5], palm oil [6], and there are also applications used in image processing for beef eligibility classification

[7], human skin recognition [8], and email spam classification based on text and images [9], classification tanning of leather [10].

2. Method

In this study the data obtained through the study of literature, observation and interviews. A literature study is one of the information gathering techniques related to the theme of image processing and detection of maturity based on fruit skin to support the theoretical basis of the research conducted by referring to research that has previously been done. An interview is a technique of collecting information directly from sources or experts that are useful for the design of the image processing system model. Furthermore, there are observations where we make observations directly on the object to get information and then it will be processed by the system.

Based on the image data of the red dragon fruit taken using a smartphone camera, we can obtain information values and the maturity classification of the dragon fruit based on their skin color. Dragon fruit which is still green means the dragon fruit is still unripe if it is reddish-green, it can be categorized as half-ripe, and dragon fruit can be said to be ripe when it is red. In Table I can be shown the level of maturity of the dragon fruit based on changes in color.

Table 1. Maturity Level of Dragon Fruit

Color Index	Fruit picture	Fruit Feature
1		The entire surface of the skin is green and has a red color on the tip of the fruit scales
2		The skin is purple mixed with yellow and green, the fruit is a little hard
3		The surface of the skin is red and has a soft texture on the skin

The implementation of the dragon fruit maturity detection system based on skin color in the HSV color space with classification using the naïve Bayes method is shown in Figure 1.

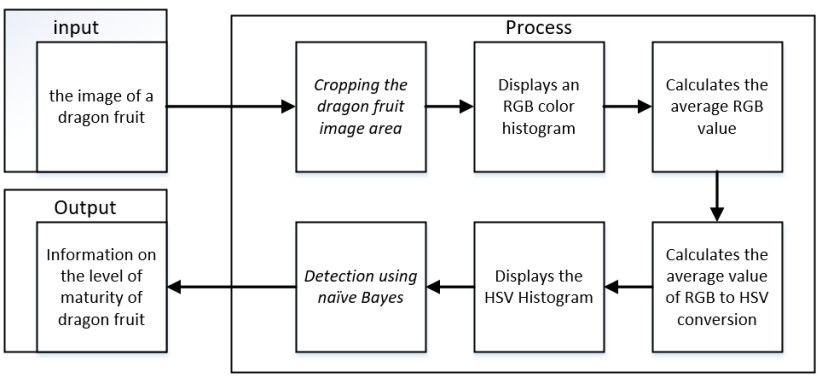

Figure 1. Flowchart of maturity determination program based on HSV color space

The steps taken in the program are:
1. Displays the original image taken from the file directory.
2. Propping the original image into the desired area to facilitate the classification process.
3. Calculate the average value of each RGB component of the cropped image
4. Transform the average RGB value into the HSV value by calculating the value of equation (1) first and then looking for the value of H by using equation (2), the value of S is calculated using equation (3), and the value of V is calculated using equation (4)[10].

$$r = \frac{R}{R+G+B}, g = \frac{G}{R+G+B}, b = \frac{B}{R+G+B} \quad (1)$$

$$H = \begin{cases} 0 & jika\ S = 0 \\ \frac{60+(g-b)}{S+V} & jika\ V = r \\ 60 * \left[2 + \frac{b-r}{s+v}\right], & jika\ V = g \\ 60 * \left[4 + \frac{r-g}{s+v}\right], & jika\ V = b \end{cases} \quad (2)$$

$$S = \begin{cases} \theta & jika\ V = 0 \\ 1 - \frac{\min(r,g,b)}{V}, & V > 0 \end{cases} \quad (3)$$

$$\mathrm{V} = \frac{R+G+B}{3} \quad (4)$$

5. Calculate the maximum and minimum average values of H, S, and V from the results of trials of 10 samples of unripe dragon fruit, 10 samples of half-cooked dragon fruit, and 10 samples of ripe dragon fruit.
6. Classify the maturity level of the dragon fruit based on skin color using the naïve Bayes method using equation (5)[12].

$$\boldsymbol{f(x)} = \frac{\mathbf{1}}{\sqrt{(\mathbf{2\pi})^{D}\ \mathbf{det}(\sum\ )}} * \mathbf{exp}(-\frac{\mathbf{1}}{\mathbf{2}}(\boldsymbol{x}-\boldsymbol{\mu})^{T}\sum^{-\mathbf{1}}(\boldsymbol{x}-\boldsymbol{\mu}) \quad (5)$$

3. Result and Discussion

The system testing phase in this study was carried out by processing 30 images with *. Jpeg, *. Jpeg and * .bmp extensions with 10 images divided by 10 unripe images, 10 half-cooked images, and 10 ripe images. The image is cropped on the skin where you want to calculate the average RGB histogram value which is then transformed into the HSV color space. After obtaining the average value of HSV from the image, classification is done using the naïve Bayes method. Table II shows the values of H (hue), S (saturation) and V (value).

Table 2. Range of HSV values of unripe dragon fruit

Test Image Data	Hue	Saturation	Value
1	0.22425	0.85481	0.44024
2	0.21237	0.83432	0.63619
3	0.25027	0.32475	0.71868
4	0.20195	0.84625	0.66707
5	0.25828	0.51748	0.68915
6	0.20992	0.70125	0.42190
7	0.19355	0.72828	0.55938
8	0.19683	0.81568	0.67465
9	0.20561	0.72721	0.67178
10	0.20894	0.63579	0.70850
total	2.16197	6.98582	6.18754
Average	0.21620	0.69858	0.61875
Min	0.19355	0.32475	0.42190
Max	0.25828	0.85481	0.71868

Table 3. Range of half-ripe dragon fruit HSV values

Test Image Data	Hue	Saturation	Value
1	0.27505	0.48658	0.90462
2	0.55273	0.35087	0.60747
3	0.36432	0.31128	0.54466
4	0.25564	0.46469	0.84682
5	0.27481	0.54343	0.62916
6	0.31326	0.26961	0.69397
7	0.36014	0.40330	0.86763
8	0.29003	0.35765	0.78002
9	0.34182	0.47223	0.80405
10	0.16776	0.33256	0.61703
Total	3.19556	3.99220	7.29543
Average	0.31956	0.39922	0.72954
Min	0.16776	0.26961	0.54466
Max	0.55273	0.54343	0.90462

Table 4. Range of HSV values of ripe dragon fruit

Test Image Data	Hue	Saturation	Value
1	0.85200	0.56615	0.94806
2	0.91995	0.56648	0.96886
3	0.93848	0.58993	0.98491
4	0.89152	0.44855	0.97257
5	0.87888	0.53696	0.97311
6	0.86429	0.57267	0.93820
7	0.91878	0.70491	0.91073
8	0.82015	0.62398	0.96775
9	0.80875	0.54576	0.97071
10	0.83701	0.58775	0.96600
total	8.72981	5.74314	9.60090
Average	0.87298	0.57431	0.96009
Min	0.80875	0.44855	0.91073
Max	0.93848	0.70491	0.98491

Table 5. Range of minimum and maximum HSV values based on the level of maturity

	Hue	Saturation	Value	Note
Min	0.19355	0.51748	0.42190	Unripe
Max	0.27481	0.85481	0.70850	Unripe
Min	0.16776	0.26961	0.54466	Half Ripe
Max	0.82015	0.62398	0.96775	Half Ripe
Min	0.55273	0.35087	0.60747	Ripe
Max	0.93848	0.70491	0.98491	Ripe

Table 6. Result of classification maturity level red dragon fruit

No	Test Data	Expert Judgment	Average Value			System Test Results	Conclusion
			H	*S*	*V*		
1	Citra 1	Unripe	0.22425	0.85481	0.44024	Unripe	Passed
2	Citra 2	Unripe	0.21237	0.83432	0.63619	Unripe	Passed
3	Citra 3	Unripe	0.25027	0.32475	0.71868	Half ripe	Not passed
4	Citra 4	Unripe	0.20195	0.84625	0.66707	Unripe	Passed

5	Citra 5	Unripe	0.25828	0.51748	0.68915	Unripe	Passed
6	Citra 6	Unripe	0.20992	0.70125	0.42190	Unripe	Passed
7	Citra 7	Unripe	0.19355	0.72828	0.55938	Unripe	Passed
8	Citra 8	Unripe	0.19683	0.81568	0.67465	Unripe	Passed
9	Citra 9	Unripe	0.20561	0.72721	0.67178	Unripe	Passed
10	Citra 10	Unripe	0.20894	0.63579	0.70850	Unripe	Passed
11	Citra 11	Half ripe	0.27505	0.48658	0.90462	Half ripe	Passed
12	Citra 12	Half ripe	0.55273	0.35087	0.60747	Ripe	Not passes
13	Citra 13	Half ripe	0.36432	0.31128	0.54466	Half ripe	Passed
14	Citra 14	Half ripe	0.25564	0.46469	0.84682	Half ripe	Passed
15	Citra 15	Half ripe	0.27481	0.54343	0.62916	Unripe	Not passed
16	Citra 16	Half ripe	0.31326	0.26961	0.69397	Half ripe	Passed
17	Citra 17	Half ripe	0.36014	0.40330	0.86763	Half ripe	Passed
18	Citra 18	Half ripe	0.29003	0.35765	0.78002	Half ripe	Passed
19	Citra 19	Half ripe	0.34182	0.47223	0.80405	Half ripe	Passed
20	Citra 20	Half ripe	0.16776	0.33256	0.61703	Half ripe	Passed
21	Citra 21	Ripe	0.85200	0.56615	0.94806	Ripe	Passed
22	Citra 22	Ripe	0.91995	0.56648	0.96886	Ripe	Passed
23	Citra 23	Ripe	0.93848	0.58993	0.98491	Ripe	Passed
24	Citra 24	Ripe	0.89152	0.44855	0.97257	Ripe	Passed
25	Citra 25	Ripe	0.87888	0.53696	0.97311	Ripe	Passed
26	Citra 26	Ripe	0.86429	0.57267	0.93820	Ripe	Passed
27	Citra 27	Ripe	0.91878	0.70491	0.91073	Ripe	Passed
28	Citra 28	Ripe	0.82015	0.62398	0.96775	Half ripe	Not passed
29	Citra 29	Ripe	0.80875	0.54576	0.97071	Ripe	Passed
30	Citra 30	Ripe	0.83701	0.58775	0.96600	Ripe	Passed

Based on Table 2 it can be seen that the range of HSV values in every level of Nature for the Unripe category is minimum (0.19355; 0.51748; 0.42190) and maximal (0.27481; 0.85481; 0.70850), Half-ripe minimum (0.16776; 0.26961; 0.54466) and maximal (0.82015; 0.62398; 0.96775), as well as minimal Ripe (0.55273; 0.35087; 0.60747) and maximal (0.93848; 0.70491; 0.98491).

After analyzing the results of testing the level of maturity of the dragon fruit conducted by the system and also the Expert Judgment, the results show that the overall image of the dragon fruit has a match between the system and Expert Judgment. Where the value of N is the sum of all dragon fruit test images, 30 images consisting of 10 unripe images, 10 half-cooked images, and 10 ripe images

Table 7 Results of the classification of dragon fruit

		Prediction Class			Total
		Unripe	*Half Ripe*	*Ripe*	
Actual Class	*Unripe*	9	1	0	10
	Half Ripe	1	8	1	10
	Ripe	0	1	9	10
Total		10	10	10	30

Then the accuracy of the system can be calculated in a way

$$\text{Accuracy} = \frac{26}{30} x100\% = 86,6\% \quad (6)$$

4. Conclusion

Based on the results of research conducted it can be concluded that:

1. The level of maturity of the dragon fruit we can know besides the manual way can also automatically use a computer system
2. Detection results performed by the image processing system using the naïve Bayes method based on the HSV color space have an accuracy rate of 86.6% with a test data of 10 images in each category.

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