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Detection of Strawberry Plant Disease Based on Leaf Spot Using Color Segmentation

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Abstract— Strawberry plant is a fruit plants that have a high enough value. Strawberry fruit contains high amounts of fiber, vitamin C, folic acid, potassium and antioxidants. Cultivating strawberries is an easy task because strawberry plants are often affected by both micro-organisms, pests and bacteria. To reduce the spread of disease in strawberry plants, the initial introduction of strawberry disease will be carried out using digital image processing. Digital images of leaf are processed to determine the health status of the strawberry plant. The process carried out on digital images includes image improvement, color segmentation from RGB color space into HSV color space, regional segmentation to determine the area of deformed leaves and intact leaves. The image processing shows that 85% accuracy of detection is obtained.

1. Introductions

Strawberries are fruit plants that are long-termed in berries where strawberry is included in Spermatophyta division, Angiosperma subdivision, Dicotyledonae class, Rosaceae family, *Fragaria* genus and *Fragaria* spp species [1]. Strawberry plants have been known since Roman times, but strawberries at that time were different from the strawberries that we find today. The strawberry plants that we know today are strawberries from the cross between ananassa *Fragaria* originating from North America and *Fragaria Chiloensis* originating from Chilli. Strawberries first entered Indonesia in the 1980s, namely in Bali, in Indonesia alone there were 5 strawberry centers including Berastagi (Medan), Purbalingga, Ciwidey (West Java), Batu (East Java) and Bedugul (Bali).

Strawberry or arben plants are fruit trees that have a high enough value, their allure lies in the striking red color of the fruit with a small, attractive fruit shape and sweet and fresh taste that is becoming known and favored by the community. Strawberry production in Indonesia in 2011 was 41,035 tons, increasing by 313.78% to 169,793 tons in 2013. Domestic strawberry fruit production has not been able to cover the high market demand so that in 2012 there was an increase imports of the strawberry seeds by 13.7%, namely from 88,000 to 100,000. The demand for strawberries in Southeast Asia is quite high. In Indonesia there have been many emerging strawberry-themed businesses, from strawberry walks, cafes, to factory outlets. Strawberry fruit contains high amounts of fiber, vitamin C,



folic acid, potassium, and antioxidants, besides strawberries also contain low fat and calories [2]. Therefore strawberries are very suitable for use as part of a healthy heart diet because they can increase levels of folic acid in the blood and reduce blood systolic pressure which can reduce the risk of heart disease. Strawberry cultivation in Indonesia has not been carried out optimally because the lack of land management and not maximizing fertilization and maintenance techniques applied by farmers has caused these plants to be susceptible to attack by pathogens that cause disease of leaves and rotten fruit [3].

The results of exploration in several gardens in Indonesia indicated that 80% of strawberry plants showed leaf spot symptoms. The symptoms of leaf spots cause lesions on the leaves, forming circle-shaped necrotic patches 2-5 mm in diameter, dark brown, found in a number of strawberry varieties. This disease is caused by an *Alternaria alternata* fungal infection which is a saprophyte of the host plant and is a primary pathogen [4]. Fungal infections of *A. alternata* cause damage to leaf tissue, fruit, stalks, fruit stalks, and strawberry plant Calix [5]. This disease can be an epidemic or epidemic on strawberry crop land especially when the humidity is relatively high and the average temperature ranges from 20-25°C [6]. The excessive use of fungicides can cause phytotoxicity and production costs have tripled [7]. Phytotoxicity causes the leaves of plants to turn yellow, wilt and dry, especially on young leaves. In more severe symptoms the plant experiences tissue death so production decreases dramatically [8].

The problem with strawberries in Indonesia is the availability of seeds that are of high quality and free from disease, whether caused by viruses, pathogens, pests or fungi. In Indonesia, several crop failures were caused by attacks and fungi, as happened in Kab. Garut in March 2016 where nearly 95% of the 220 hectare strawberry land experienced crop failure caused by pest attack and in February 2018 there was also a crop failure in Bali due to the *Fusarium* fungus attack..

To reduce the number of crop failures of strawberries in Indonesia, the use of computer vision technology or more precisely digital image processing is done. This is done so that farmers can find out earlier the health conditions of their plants, both those affected by viruses, pathogens, pests and fungi by monitoring the condition of the leaves, fruits and stems of the strawberry plants.

2. Method

In this paper, the implementation of experiments is carried out with the following steps: (i) Data acquisition, data acquisition or image sampling for strawberry plants using Sony α 5000 mirrorless cameras with rooms that have lighting conditions so they can reduce noise when sampling (ii) Improving image quality, improving image quality is a step to improve digital image by manipulating the digital image before performing feature segmentation and extraction. The method of image repair performed on this experiment is the Gaussian Blur method. (iii) Image Segmentation, image segmentation is a step to separate objects that are recognized against their background. Image Segmentation Method used in this study is Image Segmentation based on HSV color space. (iv) Extraction Characteristics, extraction of features is a stage to obtain information that represents the characteristics of each segmented image. The feature extraction method was carried out in this study by comparing the total pixel segmentation image with a total pixel error. (v) Verification, verification is a stage to ensure the accuracy of the extraction of these features.

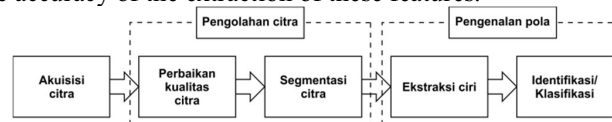


Figure 1. Scheme of Leaf Image Processing

The digital image is the image of $f(x, y)$ where sampling / spatial coordinate discretization is carried out and discretization of the quantization level (gray / brightness). Digital image is a function of light intensity $f(x, y)$, where the values x and y are spatial coordinates. The value of the function at each point (x, y) is the level of brightness of the image at that point. A digital image is a matrix where

the row and column indices represent a point in the image and the matrix elements (called image / pixel / pixel / picture element) state the gray level at that point. Matrix stated Digital image is with a matrix measuring N (row) x M (column), with L is the maximum color intensity.

$$f(x,y) \approx \begin{bmatrix} f(0,0) & f(0,1) & \dots & f(0,M-1) \\ f(1,0) & f(1,1) & \dots & f(1,M-1) \\ \vdots & \vdots & \ddots & \vdots \\ f(N-1,0) & f(N-1,1) & \dots & f(N-1,M-1) \end{bmatrix}$$

Binary imagery is an image that only has two gray values, namely black and white or also called monochrome imagery. Although currently color images are preferred because they give a richer impression than binary images, they do not make binary images die. In some applications binary imagery is still needed, for example agency logo images (which only consist of black and white), bar code images (bar codes) that are printed on the item label, text document scan images, and so on.

The HSV color space is one of the color spaces consisting of Hue, Saturation, Value. Hue is a value that represents the color spectrum of visible light (red, orange, yellow, green, blue, and purple). Saturation is a value that indicates the level of saturation or purity of a color. The greater the saturation value, the more pure the color is produced. While value can be defined as a value that indicates the brightness of the color. The HSV color space is obtained from the RGB color space through the following equation.

$$\begin{aligned} r &= \frac{R}{(R+G+B)}, g = \frac{G}{(R+G+B)}, b = \frac{B}{(R+G+B)} \\ V &= \max(r, g, b) \\ S &= \begin{cases} 0, & \text{jika } V = 0 \\ 1 - \frac{\min(r, g, b)}{V}, & V > 0 \end{cases} \\ H &= \begin{cases} 0, & \text{jika } S = 0 \\ \frac{60 \cdot (g-b)}{S \cdot V}, & \text{jika } V = r \\ 60 \cdot \left[2 + \frac{b-r}{S \cdot V} \right], & \text{jika } V = g \\ 60 \cdot \left[4 + \frac{r-g}{S \cdot V} \right], & \text{jika } V = b \end{cases} \\ H &= H + 360 \text{ jika } H < 0 \end{aligned}$$

A grayscale image is an image that only has a gray level color. The use of grayscale images is because it requires a little information given to each pixel compared to the color image. The gray color in the grayscale image is the color R (Red), G (Green), B (Blue) which has the same intensity. So that in grayscale image only requires a single intensity value compared to the color image requires three intensities for each pixel. The intensity of grayscale images is stored in 8 bit integers which gives 256 possibilities which start from level 0 to 255 (0 for black and 255 for white and the value between them is degree of gray).

3. Results and Discussions

In testing this study, to determine the disease of strawberries using the color segregation method based on HSV color space with Visual Studio 2012 which is equipped with a library of OpenCV 3.0 support programs. The object used in this study was strawberry leaves which were attacked by the disease so that the leaf samples used were several defects and holes in the leaves. The input data displayed is an image with RGB color space, the image size processed by the program is 480x320 pixels in JPG format.

The digital image that has been taken will improve the image quality first using the Gaussian Blur method before segmenting using color segmentation based on the HSV color space. The results of segmentation will be used to determine the parameters needed to determine the quality level of

strawberries based on the strawberry leaves. The parameters used in this study are total objects that can be segmented in digital image processing. The more segmented objects means more defects in the leaf.

In the process of taking samples of digital images of leaves, all leaf samples were dislodged together as for the treatment given, namely:

- a. The lighting level of the sampling room is between 400-1400 lux
- b. The device used in taking digital images is Sony Alpha α 5000
- c. The camera's resolution is 17MP
- d. Leaf samples are strawberry leaves
- e. The area around the sample is covered with dark objects to reduce noise

The digital image processing process in this study consisted of 5 stages, namely the data input stage, Pre-processing, feature extraction, training and verification. Data Input, at this stage digital image data leaves in the form of two-dimensional images that have the file of ".JPG" format as Figure 2 will be input into the image processing program that has been designed.

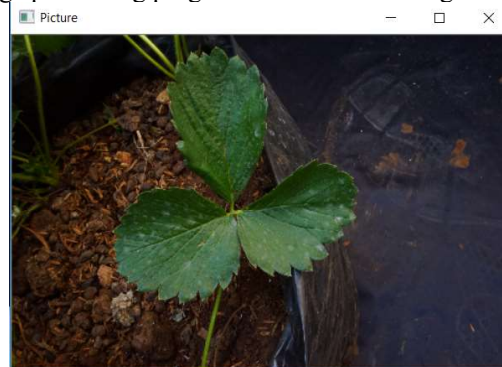


Figure 2. Initial digital image

In the Pre-processing stage, there are two stages before the feature extraction process is followed, namely the improvement and segmentation of digital images. Image improvement aims to improve the quality of an image so that the image of the acquisition can be segmented properly. Image repair can be done before segmentation or after segmentation, if the segmentation results have been segmented properly, the image repair stage is not necessary because the segmentation stages are optional. Image repair can be done with morphological operations such as erosion and dilatation or filter operations such as the median filter, low pass filter and high pass filter. On leaf image acquisition, the improvement is done after the image of the leaf is segmented by the erosion and dilatation morphology method. Digital image segmentation aims to separate the desired objects with unwanted objects in the digital image to be processed. In leaf digital image processing, the segmentation method used is the HSV and Grayscale segmentation method, where the results of segmentation are binary images where the desired object must be 1 while the unwanted object is logic 0. The digital image after Gaussian Filter is shown in Figures 3 and 5.

After going through the Pre-processing stage, the digital image of the leaf that has been segmented before will be processed into information that represents the characteristics of each sample. Processed leaves, these characteristics will be used as parameters or input values to distinguish the health conditions of the leaf samples that have been treated earlier. In leaf digital image processing this feature extraction method used is feature extraction based on color, texture and shape of objects that have been segmented. The result of one of the leaf digital image extraction is given in Figure 6. After the feature extraction process, then a training process will be carried out, namely the process where digital images that have been extracted feature will be trained so that the leaf conditions that have been processed by the digital image are obtained.

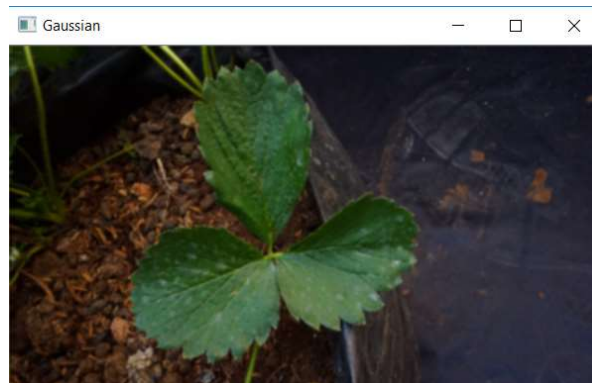


Figure 3. Digital image from the Gaussian Filter



Figure 4. Digital image in HSV color space

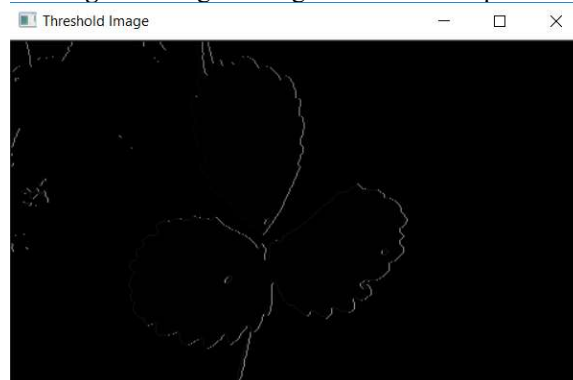


Figure 5. Threshold of segmentation results

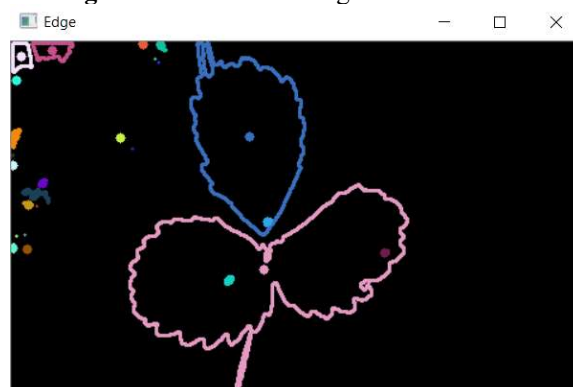


Figure 6. Edge of segmented object

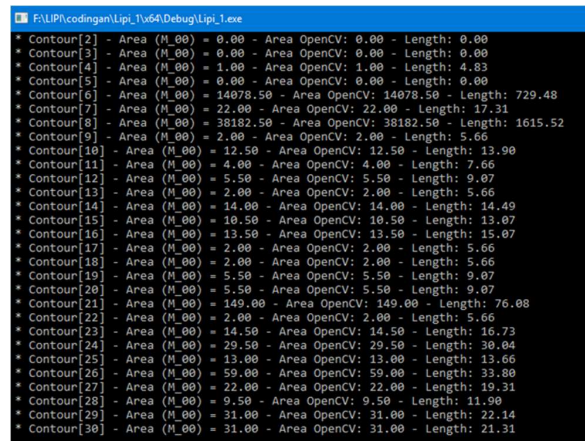


Figure 7. Number of segmented objects

The following is the cumulative data on the number of segmented objects in one digital image with the same digital image processing treatment. In the first experiment 16 digital image samples were used, in the second experiment 21 digital image samples were used, in the third experiment 36 digital image samples were used.

Table 1. Data Collection 1

No	Experiment Data	Number of objects
1	Experiment 1 - 1	66
2	Experiment 1 - 2	70
3	Experiment 1 - 3	63
4	Experiment 1 - 4	51
5	Experiment 1 - 5	76
6	Experiment 1 - 6	23
7	Experiment 1 - 7	119
8	Experiment 1 - 8	63
9	Experiment 1 - 9	100
10	Experiment 1 - 10	121
11	Experiment 1 - 11	47
12	Experiment 1 - 12	46
13	Experiment 1 - 13	51
14	Experiment 1 - 14	34
15	Experiment 1 - 15	74
16	Experiment 1 - 16	29

Table 2. Data Collection 2

No	Experiment Data	Number of objects
1	Experiment 2 - 1	49
2	Experiment 2 - 2	38
3	Experiment 2 - 3	41
4	Experiment 2 - 4	36
5	Experiment 2 - 5	34
6	Experiment 2 - 6	43
7	Experiment 2 - 7	19
8	Experiment 2 - 8	19

9	Experiment 2 - 9	20
10	Experiment 2 - 10	28
11	Experiment 2 - 11	29
12	Experiment 2 - 12	29
13	Experiment 2 - 13	64
14	Experiment 2 - 14	79
15	Experiment 2 - 15	65
16	Experiment 2 - 16	26
17	Experiment 2 - 17	39
18	Experiment 2 - 18	28
19	Experiment 2 - 19	22
20	Experiment 2 - 20	25
21	Experiment 2 - 21	44

Table 3. Data Collection 3

No	Experiment Data	Number of objects
1	Experiment 3 -1	139
2	Experiment 3 -2	119
3	Experiment 3 -3	134
4	Experiment 3 -4	148
5	Experiment 3 -5	125
6	Experiment 3 -6	130
7	Experiment 3 -7	131
8	Experiment 3 -8	239
9	Experiment 3 -9	222
10	Experiment 3 -10	228
11	Experiment 3 -11	272
12	Experiment 3 -12	53
13	Experiment 3 -13	56
14	Experiment 3 -14	52
15	Experiment 3 -15	102
16	Experiment 3 -16	109
17	Experiment 3 -17	117
18	Experiment 3 -18	64
19	Experiment 3 -19	54
20	Experiment 3 -20	64
21	Experiment 3 -21	131
22	Experiment 3 -22	143
23	Experiment 3 -23	140
24	Experiment 3 -24	89
25	Experiment 3 -25	91
26	Experiment 3 -26	99
27	Experiment 3 -27	102
28	Experiment 3 -28	81
29	Experiment 3 -29	238

30	Experiment 3 -30	243
31	Experiment 3 -31	283
32	Experiment 3 -32	269
33	Experiment 3 -33	277
34	Experiment 3 -34	193
35	Experiment 3 -35	196
36	Experiment 3 -36	139

4. Conclusions

All digital image processing activities have been completed until the extraction stage features performed on 3 types of strawberry plant leaf samples. Initially the extraction of form features is done by finding the object's edge value with the Canny Filter Method, after the object's edge value is found, the next step looks for the middle value of the segmented object. With the Canny Method there are more than 30 detected objects. The extraction of form features is done using several methods, namely the Canny Method, Gabor Method and Threshold Method. From the results of this study it can be concluded that the more objects that are segregated, the more damage to the leaves, if the number of objects is segmented a little, the less damage to the leaves of the strawberry plant.

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