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Classification of Tomato Leaf Based on Gabor Filter Extraction And Support Vector Machine Algorithm

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Abstract

Tomato production in Indonesia is reduced because tomato leaves are stricken with disease. The main disease that often attacks tomato leaves is rotten leaves and bacterial patches or commonly called dry patches. Identification of tomato leaf disease is still done manually with human vision. The shortcomings of the method manually required a technology that is able to extract the texture of tomato leaf disease. One of them is by the process of extracting the texture of leaves with gabor filters, namely by using frequency and orientation parameters. Based on the results of the experiment obtained that the input parameter gabor filter with orientation of 90^o with a combination of frequency 4 produces a fairly clear contrast. The process of extracting the texture of the leaf aims to get the magnitude value of the tomato leaf that will be used as inputs for the classification process. The svm algorithm grouped data that had the same characteristics into one class. Training data used 42 images and test data used 30 images, with the success rate of 83.33%.

***Keywords**: leaf image, gabor filter, frequency, orientation, SVM*

1. Introduction

Tomatoes (Solanum lycopersicum) are plants that are included in horticultural plants. Tomatoes are one of the fruits that are widely consumed by the people of Indonesia and the need continues to increase from year to year. Tomato production is threatened by several diseases resulting in considerable losses and causing a decrease in the quality of tomatoes. One of the main diseases that attack tomatoes is leaf rot or commonly called leaf blight (late blight) and other diseases in tomato plants that are often found are dry patches (early blight). Therefore, it is necessary to do identification on tomato leaves in order to be known diseases that attack tomato plants. Tomato disease can be identified from various ways related to the tomato plant itself, as stated by Astiningrum et al, (2020) in his research, He wrote that tomato disease can be seen from the shape of the leaves and the texture of the leaves is the most appropriate feature used in leaf classification. But the diverse shape of tomato leaves is not easy for humans to detect, especially for ordinary farming communities. Therefore, the technology can help detect tomato leaf disease through leaf texture with the method of gabor filter and support vector machine using matlab. Where later the results of this research can be developed in the form of other applications that are easier to use by prospective users, including farmers such as in the form of the web or others. In this study, first the image input with RGB mode (red, green, blue), then the preprocessing stage where rgb leaf image will be converted into grayscale mode as input in the filter cork segmentation process, the next step of the extract of the filter gabor to get the magnitude value of knowing from the tomato leaves. Gabor filter has been widely used for texture analysis, one of which is batik image segmentation based on texture features using the gabor filter method and K Means Clustering with a percentage result of 80%, then the analysis of results and the classification of results. For

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classifying many methods have been applied – methods that have been done by researchers. Among the methods that can be used is the SVM (Support Vector Machine) algorithm. This method can do classification by finding the best hyperplane that separates two classes. Based on the results of previous tests, researchers can conclude that the Support Vector Machine (SVM) method can be used to classify the ripeness of citrus fruits with a percentage of success is 80%[2].

2. Research Methodology

Gabor filter is one of the filters that is able to simulate the characteristics of the human visual system in distinguishing textures based on the ability to identify the various frequencies and spatial orientations of the texture of the observed image. Gabor filter is a sinusoidal function modulated by Gaussian function. This method often functions as an edge, line, and shape detector. To evoke the Gabor kernel, the following equation[4] is used:

$$G(x,y) = \frac{1}{2\pi} exp\ \{\frac{x}{\sigma x} + \frac{y}{\sigma y}\} exp(2\pi\mu_0(x\cos\theta\ + y\sin\theta)) \quad (1)$$

Support vector machine when first introduced by Vapnik (1995), the SVM concept can be explained simply as an effort to find the best hyperplane that serves as a two-class separator in input space. Classification problems can be translated by attempting to find a hyperplane separating between the two groups[5]. There are two options for applying binary multiclass, namely with a one-against-all and one-against-one approach[6]. One againts all is an approach to answering problems in multi-class in the support vector machine algorithm The approach used in this study is a one-against-all approach, using this approach, made k fruit SVM model (*k* is many classes)[7]. The one-against-all approach works in a one-on-all way [8].

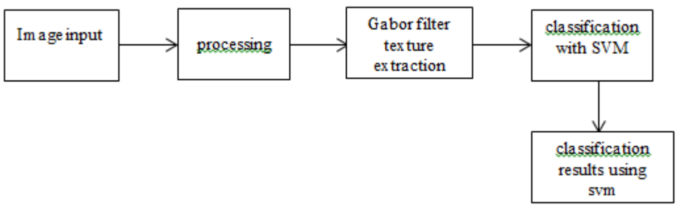


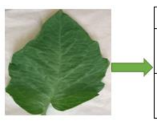
Figure 1. Planning chart

The image above is the flow of a system in doing classification using gabor filters and support vector machines. The process begins by inputting the image of the tomato leaves, then preprocessing the RGB in the input will be converted to grayscale. Then the extraction of the image through the gabor filter using frequency and orientation parameters then looks for the value of the image magnitude using the filter cork extraction calculation which will be the input for SVM for classification.

3. Result and Discussion

The implementation of matlab uses gabor filter to extract tomato leaf disease and support vector machine for the classification of tomato leaf disease, namely:

a) Input tomato leaf image



x\y	0	1
0	40 180 21	120 6 85
1	25 5 111	12 66 155

Figure 2. Pixel Value 2x2 Normal Tomato Leaf Image

b) Convert RGB Image to Grayscale

The next is to do grayscale calculated using the following equations:

$$(x, y) = (0.21 \times R) + (0.71 \times G) + (0.07 \times B) \quad (2)$$

Table 1. Pixel Value Results 2 x 2 Grayscale Normal Tomato Leaf Sample

x\y	0	1
0	136,35	9,58
1	30,06	50,47

Normal Tomato Leaf Mean = (136,35 + 30,06+ 9,58+ 50,47) / 4 = 56,61

a) Image Extraction Using Gabor Filter

Extraction of gabor filter coordinates

x,y = 0,0

Known:

Coordinates : x=136,35, y=136,35

$\theta = 30° \; atau \; (0{,}1667 * \pi)$

$B\theta = 30°$

$\mu_0 = F = 0{,}707 \; Hz$

The first step is to find the value σy with the equation

$$\sigma x = \frac{\sqrt{\log 2} \times (2^{BF+1})}{\sqrt{2\pi F} \times (2^{BF-1})}$$

$$\sigma x = \frac{0{,}5486 \times (2^{1+1})}{2{,}1071 \times (2^{1-1})}$$

$$\sigma x = \frac{0{,}5486 \times (4)}{2{,}1071 \times (1)} = 1{,}041$$

$\mu_0(x \cos\theta + y \sin\theta)$

$0{,}707((136{,}35 \times \cos 30°) + (136{,}35 \times \sin 30°))$

$0{,}707((136{,}35 \times 0{,}866) + (136{,}35 \times 0{,}5))$

$0{,}707(186{,}25) = 132$

$$G(x, y) = \frac{1}{2\pi}(\exp\left\{\frac{x}{\sigma x} + \frac{y}{\sigma y}\right\} + exp 2\pi\mu_0(x \cos\theta + y \sin\theta))$$

$$\frac{1}{2 \times 3{,}14}(\exp\left\{\frac{136{,}35}{1{,}041} + \frac{136{,}35}{0{,}971}\right\} + exp(2 \times 3{,}14 \times 132))$$

$0{,}159 \times (\exp\{271\} + exp\{827\})$

$0{,}159((271\, e + 0) + (827 e + 0))$

$0{,}159(271 + 827) = 174{,}638$

Mean/G(x,y)

56,61/174,638=0,324

And next do the same step until the coordinates x, y = 1. 1

Table 2. Results of Extraction Values of Normal Tomato Leaf Filter Gabor

x\y	0	1
0	0,324	1,471
1	4,615	0,875

Table 3. Image Data of Tomato Leaf Extraction Gabor Filter

Kor	**Normal Tomato Leaf**		**Kor**	**Tomato Leaf Spots**		**Kor**	**Rotten Tomato Leaves**	
x\y	**0**	**1**	**x/y**	**0**	**1**	**x\y**	**0**	**1**
0	0,324	1,471	**0**	0,679	0,473	**0**	0,71	0,48
1	4,615	0,875	**1**	2,178	0,92	**1**	1,9	0,879

Further classification is performed using SVM by looking for energy values and entropy.

Table 4. Comparison of Energy Values and Entropy

No	Energi value (x)	Entropy value (x)	Class (y)	Description
1	20,32	3.103	0	Normal Tomato Leaf
2	6,273	1,056	1	Tomato Leaf Spots
3	5, 19	0,82	-1	Rotten Tomato Leaves

Based on the table above, it can be explained that the condition of normal tomato leaves has a higher energy and entropy value, due to the condition of the leaves that have the same texture due to the absence of decay or spotting on the surface of the leaves. The value of energy and entropy will be the value to perform the SVM classification one againts all. Before doing the classification using SVM first do training with Hyperlane search[9]. Because there are two features x, x_1 (enegri value) and x_2 (entropy value) will be used two weights w_1 and w_2. Further minimize margin with the formula:

$$y_i\,(w_1.x_1 + w_2.x_2 + b) \geq 1 \quad (3)$$

After the bias value (*b*), classification testing is carried out. Here is an example of the results of the classification of tomato leaves as follows:

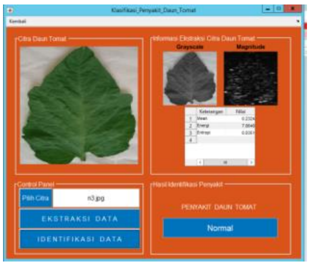


Figure 3. Normal Tomato Leaf Image Classification

Table 5. Overall Tomato Leaf Image Test Results

No	Image Name	Leaf Type	Classification Results	Description
1	n1.jpg	Normal Leaf	Normal Leaf	Right
2	n2.jpg	Normal Leaf	Normal Leaf	Right
3	n3.jpg	Normal Leaf	Normal Leaf	Right
4	n4.jpg	Normal Leaf	Normal Leaf	Right
5	n5.jpg	Normal Leaf	Normal Leaf	Right
6	n6.jpg	Normal Leaf	Normal Leaf	Right
7	n7.jpg	Normal Leaf	Leaf Spots	Wrong
8	n8.jpg	Normal Leaf	Normal Leaf	Right
9	n9.jpg	Normal Leaf	Normal Leaf	Right
10	n10.jpg	Normal Leaf	Daun Normal	Right
11	ber1.jpg	Leaf Spots	Leaf Spots	Right
12	ber2.jpg	Leaf Spots	Leaf Spots	Right
13	ber3.jpg	Leaf Spots	Leaf Spots	Right
14	ber4.jpg	Leaf Spots	Leaf Spots	Right
15	ber5.jpg	Leaf Spots	Leaf Spots	Right
16	ber6.jpg	Leaf Spots	Rotten Leaves	Wrong
17	ber7.jpg	Leaf Spots	Leaf Spots	Right
18	ber8.jpg	Leaf Spots	Leaf Spots	Right
19	ber9.jpg	Leaf Spots	Normal Leaf	Right
20	ber10.jpg	Leaf Spots	Leaf Spots	Right
21	b1.jpg	Rotten Leaves	Rotten Leaves	Right
22	b2.jpg	Rotten Leaves	Rotten Leaves	Right
23	b3.jpg	Rotten Leaves	Rotten Leaves	Right
24	b4.jpg	Rotten Leaves	Rotten Leaves	Right
25	b5.jpg	Rotten Leaves	Rotten Leaves	Right
26	b6.jpg	Rotten Leaves	Rotten Leaves	Right
27	b7.jpg	Rotten Leaves	Rotten Leaves	Right
28	b8.jpg	Rotten Leaves	Rotten Leaves	Right

No	Image Name	Leaf Type	Classification Results	Description
29	b9.jpg	Rotten Leaves	Leaf Spots	Wrong
30	b10.jpg	Rotten Leaves	Rotten Leaves	Right

$$Accuracy = \frac{number\ of\ correct\ classification}{amount\ of\ Data} x\ 100\%$$

$$Accuracy = \frac{25}{30} x\ 100\% = 83{,}33\ \%$$

Based on the results of the accuracy test, an accuracy value of 83.33% was obtained for the process of classification of tomato leaf desease based on 30 data images.

4. Conclusions

Based on the results of tests conducted by classifying tomato leaf disease based on the image of tomato leaves using the Gabor Filter and SVM methods, The application of the Gabor Filter method by extraction of tomato leaf imagery transformed into grayscale and magnitude images can be classified quite accurately using SVM. The application of the SVM method with the classification of tomato leaf classes by calculating the value of energy and entropy of extraction results can speed up the classification process, this is due to a simpler classification process with a high degree of accuracy. The process of classifying tomato leaf desease based from 30 data images the accuracy of 83.33% is achived.

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