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Article

Classification of Mint Leaf Types Using Euclidean Distance and K-Means Clustering with Shape and Texture Feature Extraction

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A B S T R A C T

Mint is a plant that has many benefits and uses. However, some people are not familiar with the types of mint leaves because they cannot tell the difference. Actually, if you look closely, mint leaves have their own characteristic shape and texture. However, most people judge mint leaves to have a shape similar to other leaves so it is difficult to tell them apart. This paper aims to classify the types of mint leaves using the Euclidean distance algorithm and K-Means clustering with shape and texture feature extraction. The K-Means Clustering Algorithm functions as a segmentation so that the image to be classified can be separated from other objects. In the feature extraction process, metric and eccentricity parameters are used. Meanwhile, for texture feature extraction, use the parameters in the Gray Level Co-occurence Matrix (GLCM). Furthermore, the classification process uses the Euclidean Distance algorithm which has a function to represent the level of similarity between two images by taking into account the distance value from the identified image. Based on the results of the evaluation using a confusion matrix by calculating precision, recall and accuracy, the precision value is 82%, recal is 84% and accuracy is 83%.

I. INTRODUCTION

Mint is one of the herbal plants that is very famous for its fresh aroma. The fresh aroma of mint leaves often makes this plant a processed food and drink, even just a sweetener for dishes in food. In addition, it turns out that mint leaves have benefits for the body to improve health. Mint leaves create a menthol or mint flavor that we can usually feel in candy or cough drops. Basically, mint leaves are not native to Indonesia but come from the subtropical region, near the Mediterranean (Mediterranean Sea). The mint leaf spread in Asia is thought to have come from Europe, where the plant was originally distributed by the Spaniards in peninsular Malaysia and

Singapore. But now mint leaves have been widely cultivated in Indonesia because of the usefulness and benefits needed. However, based on several studies, the leaves have almost the same characteristics, making it difficult to identify [1][2][3]. Moreover, the mint plant is not native to Indonesia, so the general public is not familiar with this plant [4]. Actually, if you look closely, mint leaves have their own characteristic shape and texture. For this reason, we need a system that can classify the types of mint leaves by looking at their shape and texture characteristics.

Digital image processing conducts studies and studies related to the formation, processing, and analysis so that images can produce information that can be utilized [5]. With image processing technology will produce a system that can help human work [6]. There are many implementations of digital image processing, one of which is used for image classification. Image classification can be defined as the process of grouping image pixels into classes of the same type, so that these classes can describe certain characteristics that can be distinguished from other classes [7]. One of the parameters that can be used for image classification is the Euclidean distance. Euclidean distance is an image matching technique that can identify other images that are similar or have similarities [8]. Euclidean distance represents the degree of similarity of two images that takes into account the value of the distance, the smaller the Euclidean distance, the more similar the image [9]. Euclidean distance is calculating the distance from two points in the image space, which can be used to identify the relationship pattern between distances [10]. This process is carried out by comparing the value of the proximity of the two variables, namely between the test image and the reference image to find the value of the shortest distance..

Prior to image classification, image segmentation and feature extraction were performed. The image segmentation process aims to divide the image into several parts or regions, which aims to isolate or find an object in the image [11]. The K-Means clustering algorithm can be used for the segmentation process. Because K-Means clustering has the ability to partition so that it gets the desired object. Meanwhile, feature extraction is a feature that is a process of quantizing image characteristics into a group of appropriate feature values [12]. To get the shape and texture features, you can use shape and texture feature extraction. Shape is one of the recognizable characteristics of an object to find the difference between the object and other objects. Meanwhile, texture is a feature of an image that can be used to explore the characteristics of an image because the surface arrangement of the image contains information that can be utilized.

This study aims to classify the types of mint leaves using the Euclidean distance algorithm and K-Means clustering with shape and texture feature extraction. The K-Means Clustering Algorithm functions as a segmentation so that the image to be classified can be separated from other objects. In the feature extraction process, metric and eccentricity parameters are used. Meanwhile, for texture feature extraction, use the parameters in the Gray Level Co-occurence Matrix (GLCM). Furthermore, the classification process uses the Euclidean Distance algorithm which has a function to represent the level of similarity between two images by taking into account the distance value from the identified image.

II. LITERATURES REVIEW

In digital image processing, it is inseparable from the feature dimension reduction process or called feature extraction [13]. Feature extraction is the process of quantizing image characteristics into a group of appropriate feature values [14]. The feature extraction method is adapted to the needs. There are several feature extraction approaches, including first-order feature extraction. This feature extraction performs extraction by utilizing the values in the image histogram [1]. Several studies have

shown that feature extraction can help in image classification [15][16]. However, the first-order feature extraction only depends on the values generated in the image histogram, without considering other elements [17]. In addition, there is feature extraction based on its shape. Parameters used on shape features can take advantage of values from metrics and eccentricities. Metrics and eccentricities are considered to be able to recognize objects by paying attention to the shape of the object so that it can be recognized and distinguished from other objects [18]. The next feature extraction is feature extraction based on texture, where an image has a surface where information is stored to be utilized. Texture feature extraction using Gray Level Co-occurence Matrix (GLCM) with parameters contrast, correlation, energy, and homogeneity [19].

In image processing, dimensionality reduction of a group of features is included in the preprocessing process which is usually to recognize certain patterns and classifications [20]. Image classification is one of the most frequently used image processing functions. Because with this function images can be grouped into certain classes, so that each class describes characteristics that can be distinguished from other classes [21]. There are many methods for image classification. Euclidean distance is considered effective in classifying because of the simplicity of the algorithm and the efficiency of the computational process [10]. Several previous studies have shown that this method produces good accuracy in the application of image processing. Previous research related to the application of the Euclidean distance method for the identification of the Skelton distance [22]. In this study, the method used resulted in the percentage of success reaching 87.84%. Another research is about the identification of signature images using Euclidean distance [8]. In this study, the verification of the success rate of the method used reached 84.00%. Subsequent research on the classification of rhizome plant species using euclidean distance [7]. In this study, the performance of the model was tested using a confusion matrix with the results of 83% precision, 87% recal and 85% accuracy. The evaluation shows that the developed model can perform classification well.

The study carried out the classification of mint leaf species using the Euclidean distance algorithm and K-Means clustering with shape and texture feature extraction. The K-Means Clustering Algorithm functions as a segmentation so that the image to be classified can be separated from other objects. In the feature extraction process, metric and eccentricity parameters are used. Meanwhile, for texture feature extraction, use the parameters in the Gray Level Co-occurence Matrix (GLCM). Furthermore, the classification process uses the Euclidean Distance algorithm which has a function to represent the level of similarity between two images by taking into account the distance value from the identified image.

III. FRAMEWORK

The research carried out will run well, planned and structured if it goes through a planned research framework. The framework of the research carried out can be seen in Fig: 1 below.

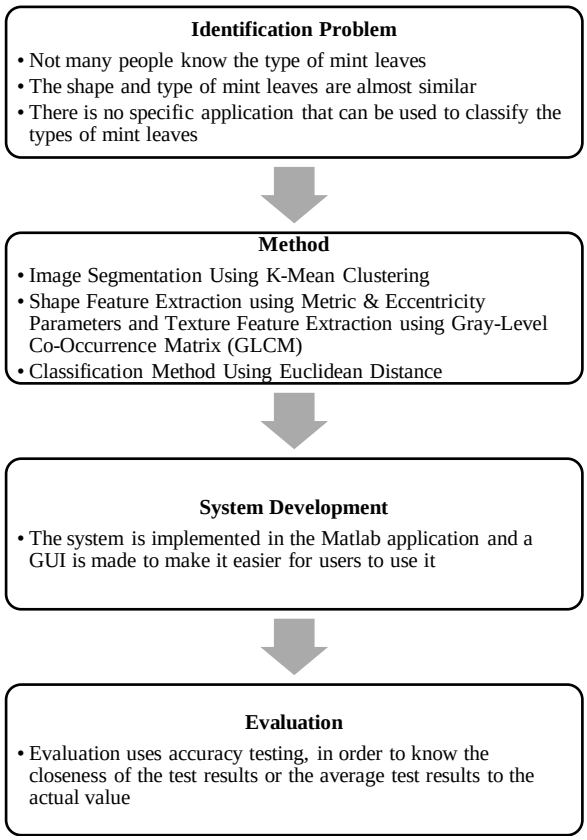


Fig 1: Research Framework

IV. METHODS

To classify the mint leaf image in this study using several methods. For the image segmentation process using the K-Means Clustering method. The feature extraction process uses feature and shape extraction. While the classification process uses the Euclidean distance method.

K-Means is an approach to group n objects that are affected by the attributes entered in k partitions, where k is less than n [7]. The steps in the K-means Clustering algorithm begin by counting the number of groupings, and continue with counting the number of centroids. In calculating the centroid value at the beginning of the iteration, the centroid results are obtained randomly. To get the centroid value which is the iteration stage, the formula is used:

$$\overline{V_{ij}} = \frac{1}{N}\sum_{k=0}^{n_i} x_{kj} \qquad (1)$$

Where, V_{ij} is the average in clusters i to j (centroid). Ni is the number of data that is a member of i. Then N_i, k is the index of cluster j. While x_{ij} is the value of the k-th data in the cluster for the j-th variable.

After segmenting the image, the next step is to perform feature extraction. Where feature extraction is a process to identify an object by getting features that can be a differentiator [5]. The features obtained then become inputs or parameters used for the classification process [23]. One of the characteristics that can be extracted is the shape feature. In this study, the extraction of shape and texture features was used. For the extraction of shape features, the metric and eccentricity parameters are used. Metric is looking for the value of the ratio between the area and perimeter of an object. While eccentricity is looking for a comparison value between the focal distance of the minor ellipse and the focus of the major ellipse of an object. Metric and eccentricity values can be found by the following equation:

$$M = \frac{4\pi \times A}{C} \qquad (2)$$

$$e = \sqrt{1 - \frac{b^2}{a^2}} \qquad (3)$$

Based on the equation, a is the minor axis and b is the major axis. Whereas A is the area and C is the perimeter.

Meanwhile, the texture feature extraction process utilizes the existing parameters using GLCM (Gray-Level Co-Occurrence Matrix). The following is an explanation of each parameter:

1. *Contrast*
   Contrast is the result of a calculation related to the amount of variation in the intensity of gray in the image. To find the contrast value can be calculated using the following formula:

$$Contrast = \sum_i \sum_j (i-j)^2 \, pd(i,j) \qquad (4)$$

2. *Correlation*
   Correlation is a representation of linear relationship to the degree of grayscale

image. Correlation ranges from -1 to 1. To find the correlation value can be calculated using the following formula:

$$Correlation = \sum_i \sum_j \frac{(i-\mu_i)(j-\mu_j)\,p(i,j)}{\sigma_i \sigma_j} \quad (5)$$

3. *Energy*
   Energy is the result of calculations related to the amount of variation in the intensity of gray in the image. To find the energy value can be calculated using the following formula:

$$Energy = \sum_i \sum_j p_2^d(i,j) \quad (6)$$

4. *Homogenity*
   Homogeneity is a representation of the size of the value of the similarity of variations of the intensity of the image. If all pixel values have a uniform value, then homogeneity has a maximum value. To find the value of homogeneity can be calculated through the following formula:

$$Homogenity = \sum_i \sum_j \frac{pd(i,j)}{i+|i-j|} \quad (7)$$

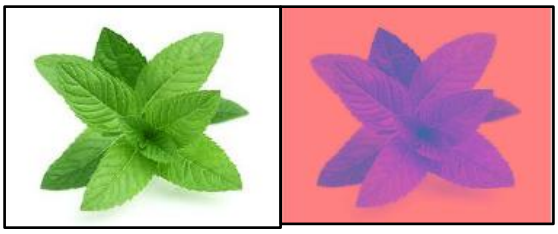
At the classification stage, the Euclidean distance approach is applied. This is a popular matrix approach for calculating the similarity of two vectors. Distance is the root of square differences between two vectors. Then, the two vectors will be compared with each other by calculating the distance between them, or vice versa, determining the degree of similarity. There are techniques and ways to perform distance calculations used in image classification. If there are vectors with characteristics a and b, then you can use the equation to measure the distance at the Euclidean distance with the following formula:

$$d_e = \sqrt{\sum_{i=1}^{n} (a_i - b_i)^2} \quad (8)$$

Where, a_i is the input image vector and b is the comparison image vector.

V. RESULT

In developing the mint leaf classification system, datasets were first collected. Actually there are many types of mint leaves, but in this study we used 5 types of mint leaves that are often found and which are popular. The types of mint leaves used are: Spearmint, Peppermint, Apple mint, Field mint and Chocolate mint. In theory, there is no minimum number in determining the number of datasets. For datasets with a good level of data distribution, the composition of the amount of training and testing data will not provide fluctuating accuracy values [24]. For test cases and prototyping a small number of datasets can be used [21]. The process of dividing the dataset is using the trial-and-error method, where the dataset is divided into 50% training and 50% testing [25]. The dataset collected is 100 mint leaf images. Then the dataset is divided into two, namely training data and test data. The amount of training data used is 50 image data and 50 training data, or 50% versus 50% of the total image. After the dataset is collected, the next step is to prepare for the training. Training and testing is carried out using the Matlab application. The initial stage is the color space transformation process from Red, Green, Blue images to L*a*b images. This is done so that the color content can be identified digitally. The transformation process from RGB to L*a*b images in the Matlab application can be seen in Fig: 2 below.

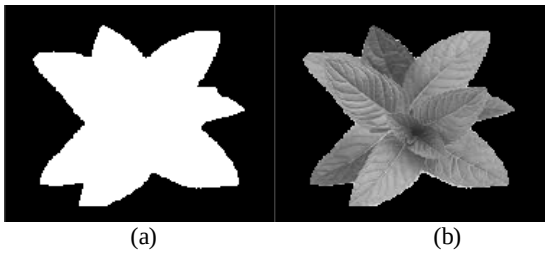


(a) (b)

Fig 2: (a) RGB Image; (b) Transformed L*a*b Image

Furthermore, after changing the image into an L*a*b image, so that the segmentation process becomes easier, the image will be converted into a binary image

format. The result of this stage is a binary image, which is an image that has been separated between the object and its background. Where the object will be white (value 1) and the background will be black (value 0). The results of the image transformation into a binary image format will be separated from the object from the background, this can be useful for the next process. Furthermore, the resulting binary image is transformed into a grayscale image. It aims to simplify the image so that it is easy in the image processing process. Fig: 3 below is the result of binary and grayscale image transformation.



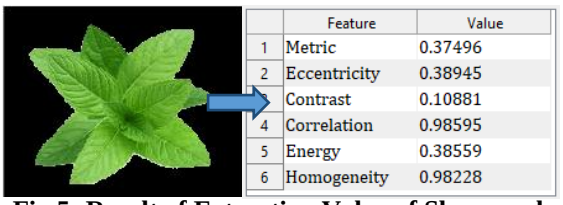
(a) (b)

Fig 3: (a) Binary Transformation Result, (b) Grayscale Transformation Result

The next step is image segmentation using K-Mean Clustering. This step is done in order to be able to partition the data into several cluster regions. The results of image segmentation with K-Mean Clustering can be seen in Fig: 4 below.

Fig 4: Image Segmentation Results With K-Means Clustering

The next stage is feature extraction which is useful for extracting information from the identified object characteristics. Feature extraction will be carried out based on the shape and texture. Features that have been extracted can be used for input parameters used to identify the characteristics of the object to be classified. In this study, the extraction of shape and texture features was used. For the extraction of shape features, the metric and eccentricity parameters are used. Metric is obtained from the ratio between the area and the circumference of an object. While eccentricity is obtained from the comparison between the focal distance of the minor ellipse with the focus of the major ellipse of an object. For texture feature extraction using Gray-Level Co-Occurrence Matrix (GLCM) with parameters contrast, correlation, energy and homogeneity. Fig:5 follows the results of the feature and texture extraction values implemented in Matlab.



	Feature	Value
1	Metric	0.37496
2	Eccentricity	0.38945
3	Contrast	0.10881
4	Correlation	0.98595
5	Energy	0.38559
6	Homogeneity	0.98228

Fig 5: Result of Extraction Value of Shape and Texture Characteristics

Next is the identification stage with Euclidean distance, an image matching technique that can identify other images that are similar or have similarities. Euclidean distance represents the level of similarity of two images that take into account the distance value from Euclidean, if the smaller the Euclidean distance, the more similar the image. The process is carried out by comparing the proximity of the distance values of two variables, namely between the test image and the reference image to find the closest distance value. The developed model is then implemented in the Matlab application to create a mint leaf classification system with a GUI so that users can use it easily. Fig: 6 shows the application display using Matlab.

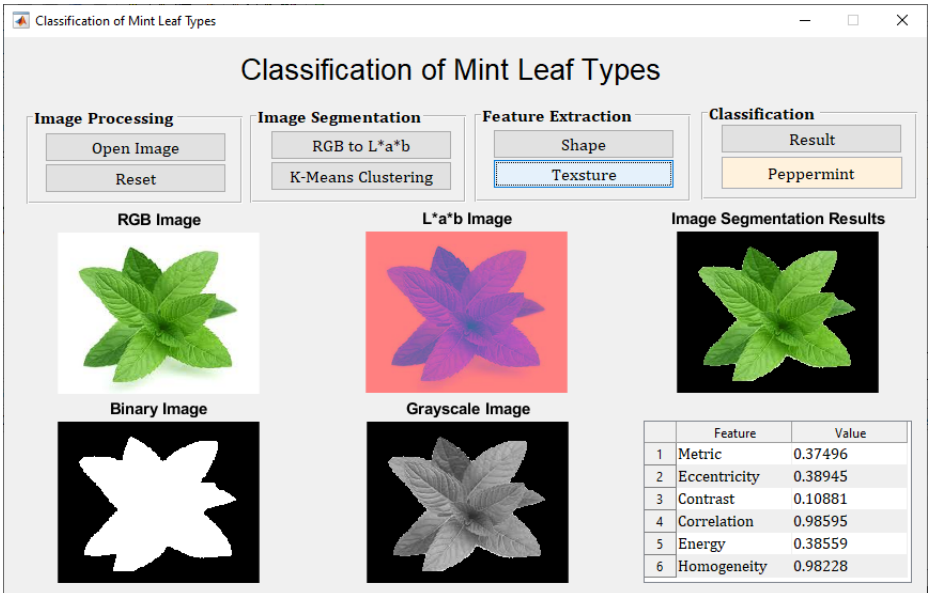


Fig 6: Mint Leaf Type Classification System GUI with Matlab

VI. DISCUSSION

After the model is implemented in Matlab, the next step is evaluation. For evaluation, a confusion matrix is used, where the calculations performed include precision, recall, and accuracy. The test results are then entered into the confusion matrix. The confusion matrix consists of true positive, false positive, true negative, and false negative to calculate precision, recall and accuracy. The test data used were 50 test data. Table 1 below is the results of the precision, recall and accuracy tests carried out.

Table 1. Precision, Recall and Accuracy Test Results

	Precision	Recall	Accuracy
Result	0.82	0.84	0.83

Based on Table 1, it shows that the precision value is 0.82 or 82%. This means that the level of accuracy between the information provided is 82%. While recall got a value of 0.84 or 84%, meaning that the success rate of the system in retrieving an information is 84%. Furthermore, for the accuracy of getting a value of 0.83 or 83%, it means that the level of closeness between the predicted value and the actual value is 83%. These results are converted into classification accuracy criteria with the following guidelines: Good, the value ranges between 76% to 100%; Enough, the value ranges between 56% to 75%; Less Good, the value ranges between 40% to 55%, and Less Good, if the result is below 40%[26]. When viewed from the average accuracy obtained is in the good category. These results show that the developed model is capable of classifying mint leaf species well. Extraction of shape and texture features can provide optimal information so that it can support the identification process. However, based on the tests that have been carried out, the average error value reaches 16%. From the results of the trials that have been carried out, this error rate is caused by the following factors: 1) the shape and texture of mint leaves are almost the same which makes it difficult for some system test data to distinguish them; 2) the number of datasets used as training data and test data is still relatively small, so it is not optimal in the learning system; 3) in the case of images with various object backgrounds, it can affect the classification results.

VII. CONCLUSION

This study identified mint leaves using the Euclidean distance method and K-Means clustering with shape and texture feature

extraction. K-Means clustering can perform image segmentation, where objects are successfully separated from their backgrounds. The feature extraction process utilizes parameters such as metrics and eccentricity. These parameters have the ability to recognize objects based on their shape so that they can be recognized. Meanwhile, for texture feature extraction, the parameters in the Gray Level Co-occurence Matrix (GLCM) are used. Then, to perform the classification used the Euclidean Distance algorithm. This algorithm has the ability to calculate the similarity distance of two or more images. Based on testing using the confusion matrix, the results obtained precision values of 82%, recal of 84% and accuracy of 83%. These results show that the developed model can perform mint leaf classification well. To improve further research, there are several suggestions that can be made. The improvements made are to increase the training data and test data, modify and improve the Euclidean Distance algorithm and can try the deep learning algorithm so that the classification results are much more optimal.

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