Implementation of Sobel method to detect the seed rubber plant leaves

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Abstract. This research was conducted to develop a system that can identify and recognize the type of rubber tree based on the pattern of leaves of the plant. The steps research are started with the identification of the image data acquisition, image processing, image edge detection and identification method template matching. Edge detection is using Sobel edge detection. Pattern recognition would detect image as input and compared with other images in a database called templates. Experiments carried out in one phase, identification of the leaf edge, using a rubber plant leaf image 14 are superior and 5 for each type of test images (clones) of the plant. From the experimental results obtained by the recognition rate of 91.79%.

1. Introduction

Today, various technologies have been developed to assist human life, one of them is digital image processing. Digital image processing has been widely developed to assist various fields, including the fields of law, engineering, medicine and agriculture. In the development of digital image processing needs, various methods have been developed by many researchers, one of which is edge detection method.

Edge detection is fundamentally important for image analysis like segmentation, registration, and identification of scene’s objects. It is the most used form for detecting the useful discontinuities in gray level image. Edges are significant local changes of intensity in an image. Edges typically occur on the boundary between two different regions in an image. An image is measured to exist a meaning of two genuine variables. It can be demonstrated with an example, a (x,y) where a as the amplitude known as brightness of the image at the real match up position (x,y). The image might be measured to hold sub-images now and again referred to as region of awareness or simply regions [1].

Currently, many methods are often used on performing edge detection in digital image processing, included Robert Method, Prewitt Method, Sobel Method, and Laplace Method. Among the methods often used in (edge detection), the authors using a Sobel method to control smoothness of image, which not only efficiently removes image noise but also simultaneously retail information [2]. It has been found that for lower value of relaxation coefficient we are able to extract edges accurately [3].

Based on the above exposure, and in relation to the use of digital image processing, researchers are interested in discussing how edge detection methods work in the identification of superior seeds with leaf margin detection.
In a mathematical point of view, the image is a continuous function of the intensity of light in a two-dimensional plane. The Light source illuminates the object, the object reflects back part of the beam. Basically, the idea is to superimpose a regular grid on an analog image and to assign a digital number to each square of the grid, for example the average brightness in that square. Each square is called pixel, for picture element, and its value is the gray-level or brightness [4]. A recognition of plant species will be useful for botanical students in their research for plant species identification. From this perspective, the current paper proposes the design of a system which uses feature extraction and shape recognition techniques to recognize the plants based on the shape of their leaves. Kaur L states that there has been increasing demand pattern for more specific and sophisticated image [5]. Edges are useful for the process of segmenting and identification of objects within the image. The edge detection of an image has the objective of marking the part of the image detail, and fixing the blurred image due to error or effect of the acquisition process [6].

2. Methods

2.1 Research Areas
The research was conducted at Research Center of Sungei Putih Rubber Research Center, where currently there are 14 species which become the recommendation to obtain maximum sap production. Clones of rubber plants that are recommended must have different specifications both the amount of sap production and the size of the stem. This is influenced by various factors, one of which is the height of plain where it’s planting from the sea surface [7].

2.2 Sample Determination
For the determining of sample size (clone) of type of rubber planting seeds into recommended and the production potential of each species, the researchers are using Slovin method, with the following equation.

\[
n = \frac{N}{1 + \varepsilon^2N}
\]

where

- \( n \) number of sample
- \( N \) population
- \( \varepsilon \) fault tolerance limit (error tolerance)

2.3 Data Collection and Data Analysis
Data collection techniques were conducted by interviewing farmers and rubber entrepreneurs using structured questionnaire. Secondary data: data obtained from the Research Center of Sungei Putih Rubber Research Center, where currently there are 14 clones of superior rubber seedlings. The method of data analysis which Sobel edge detection method which two kernels measuring 3x3 pixels for Gradient calculation so that the approximate gradient is right in the middle of the window. The Sobel detector is very sensitive to image noise and effectively shines it as an edge [8]. At each point in the image, the Sobel can find the texture edge directly [9], and the results represent the norm corresponds to vector gradient [10].

The gradient quantities calculated which the Sobel operator are given as:

\[
G = \sqrt{S_x^2 + S_y^2}
\]

where

- \( G \) Gradien of Operator
- \( S_x \) Sobel gradient of horizontal direction
\( S_y \) Sobel gradient of vertical direction

\( G \) is the gradient quantity at the midpoint of the kernel and the partial equation is calculated using the following equation.

\[
S_x = (a_2 + ca_3 + a_4) - (a_0 + ca_7 + a_6)
\]

\( S_y = (a_0 + ca_1 + a_2) - (a_6 + ca_5 + a_4) \)  \hspace{1cm} (3)

And \( c \) is a constant of value 2. \( S_x \) and \( S_y \) implemented to be:

\[
S_x =
\begin{array}{ccc}
-1 & 0 & 1 \\
-2 & 0 & 2 \\
-1 & 0 & 1 \\
\end{array}
\]

\[
S_y =
\begin{array}{ccc}
1 & 2 & 1 \\
0 & 0 & 0 \\
-1 & -2 & -1 \\
\end{array}
\]

![Fishbone Diagram](image)

**Figure 1.** Fishbone Diagram

This research is divided into three stages of research work. The first stage is doing process of the reference image and second stage is doing process of identification and determination the level of recognition superior leaf pattern and the third stage is modeling and simulating the introduction of superior seed pattern. The first stage includes the research related to the composition and variation of the test image leaf, grey image level, image size change, image refinement, Sobel edge detection, leaf striation thinning, image retention as a template. Research on the second stage is the input of any leaf image, grey level image setting, image size change, image smoothing, Sobel edge detection, leaf streaking, image matching with template, correlation coefficient and third step is modelling and simulating the recognition of superior seed pattern as illustrated in Figure 1.
3. Result and Discussion
The superior clones of rubber plants can be grouped into 2 parts, i.e., clones that produce only latex (latex) and clones that produce geta (latex) along with wood as can be seen in Table 1.

Table 1 Type (clones) of Rubber Plants Recommendation

| No | Type (clones) | Cumulative Production (kg/ha) | Average (kg/ha/th) |
|----|---------------|-------------------------------|--------------------|
|    |               | 5th  | 10th  | 15th  |
| 1  | IRR 104       | 9938 | 21860 | 41240 | 2083  |
| 2  | IRR 112       | 10973| 21770 | 32242 | 2149  |
| 3  | IRR 118       | 9856 | 19985 | 30860 | 2057  |
| 4  | IRR 220       | 10511| 20086 | 32865 | 2191  |
| 5  | BPM 24        | 8942 | 20423 | 30007 | 2000  |
| 6  | PB 260        | 9989 | 21996 | 30946 | 2063  |
| 7  | PB 330        | 9699 | 19306 | 29180 | 1945  |
| 8  | PB 340        | 10900| 19220 | 30074 | 2005  |

| No | Type (clones) | Range (interval)   |
|----|---------------|--------------------|
| 9  | IRR 5         | 8046 - 18370       |
| 10 | IRR 39        | 7273 - 15485       |
| 11 | IRR 42        | 8488 - 15924       |
| 12 | IRR 107       | 9080 - 17370       |
| 13 | IRR 119       | 8350 - 16870       |
| 14 | RRIC 100      | 6690 - 21010       |

Data source: Research Center of Sungei Putih in Galang sub-districts
After being test done a leaf image of superior rubber plant which is categorized by leaf image of rubber plant which is also categorized as superior, hence obtained the range (interval) of rubber plant leaf resemblance level, and we can take the interval of each species (clone) of rubber plant leaves. The ranges of rubber plant leaf similarity level based on the test are shown in Table 2.

Table 2 Similarity Rates

| No | Type (clones) | Range (interval)   |
|----|---------------|--------------------|
| 1  | BPM 24        | 69.161% - 90.8071% |
| 2  | IRR 5         | 75.5037% - 90.274% |
| 3  | IRR 39        | 67.6535% - 89.7926%|
| 4  | IRR 42        | 83.3956% - 91.2476%|
| 5  | IRR 104       | 82.2882% - 88.7573%|
| 6  | IRR 107       | 74.346% - 91.2816% |
| 7  | IRR 112       | 73.8355% - 88.0452%|
| 8  | IRR 118       | 68.9941% - 83.6589%|
| 9  | IRR 119       | 74.204% - 88.3568% |
| 10 | IRR 220       | 68.6003% - 86.7628%|
| 11 | PB 260        | 87.8593% - 91.7967%|
| 12 | PB 330        | 77.5523% - 90.7178%|
| 13 | PB 340        | 65.4765% - 91.1939%|
| 14 | RRIC 100      | 78.5532% - 91.3244%|

After identification testing, the range (similarity level) of each type (clone) of rubber plant leaves is obtained. From Table 2, obtained the similarity level interval of rubber plant leaves. It can also be stated that if a test has conducted when no sample image reaches the lowest level of similarity of 65.4765%, it can’t be categorized as a superior rubber plant. Because the lowest similarity level of the experimental result is 65.4765% and the highest similarity rate is 91.7967%.
Based on the tests that have been done, there are several conditions that can affect the work of the system. Some of these conditions are as follows: 1. Damage to the leaves can have a major effect on the identification process. Usually, small defects that are not visible at first glance can have a major effect on the level of similarity. Therefore, the processed leaf object must be in a healthy condition without damage. 2. The leaf image of a processed rubber plant at a glance will look very much like the shape of its leaf edge. However, if viewed more carefully a difference can be seen in the shape leaf edge of rubber plant. 3. Leaf image obtained is strongly influenced by the process of taking it, where the angle of shooting and also the shadow will affect the formation of the shadow behind the object. The shadow formed will affect the edge shape of the processed image. Shooting angle will affect the image results to be processed. 4. This study has used the characteristic of leaf edge. Though there are several other characteristics that can still be used to identify the type of rubber plant leaves. For examples size, colour, a shape of bone leaves, and so forth.

4. Conclusions
Based on the tests performed and the results of the analysis, it can be concluded as follows:
At leaf margin test the highest resemblance level is type (clone) of PB 260 with similar rate of 91.79% and the smallest similarity level is type (clone) PB 340 with the similarity level of 65.47% Identification errors can be caused by damage to the processed leaves in the system, resulting a decrease in the similarity level of the reference leaf image (template) with the leaf image to be tested. Leaf edges of rubber plants that look very similar at a glance, but if viewed more thoroughly will look different in the shape of the tip of the leaf and the shape of the leaf curvature itself.

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