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Brown Spot Disease Severity Level Detection using Image Processing

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Abstract: In this research project, the primary aims is to create an algorithm that will assist individuals, particularly young farmers, in detecting the disease early, and resulting in excellent quality and quantity of rice production. The paddy field data images are then processed in the MATLAB software. Image enhancement was performed on the sample image to increase the image quality. The image background is then segmented using the MATLAB image segmenter tool. Following the removal of the image background, the procedure was proceeded using a colour detection method in which a masking process was performed to the segmented image of the binary and RGB image. To continue with area detection, the pixel values from those images are used to calculate the pixel intensity difference between infected and non-infected regions. Horsfall and Heuberger's severity level table is then used as a reference to identify the severity level of Brown Spot disease. A graphical user interface (GUI) is developed to determine the Brown Spot disease automatically. According to the findings of the research, the detection accuracy is 90%.

Keywords: Brown Spot, Disease Severity, Paddy, Image Processing

1. Introduction

Agriculture is one of the largest contributors to Malaysia's economic resources, and one of them is paddy cultivation. In Malaysia, government initiatives have promoted numerous research and technology development, including data processing and analysis. For example, EPPs should be carried out in several sectors, including universities. One of the EPP's significant initiatives is to work with the Ministry of Agriculture to enhance agriculture information and communication technologies. Computer vision and AI technology integration can assist in discovering the plant problem in real-time. The envisaged system will be able to link data and give solutions for addressing and managing issues [1].

The Kedah-Perlis plain contains the largest coastal alluvial plain planted with rice on the west coast of Malaysia's Peninsular and the largest of the eight granaries and the Muda Agriculture Development Authority's irrigation scheme. Kedah State owns approximately 104,205 ha of the peninsular's total

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paddy planting area of 265,046 ha (main season). The Muda Agriculture Development Authority has 92,047 ha of planted land and control over the two most enormous rice granaries in Peninsular Malaysia's northwestern and northeastern plains. The Muda Agriculture Development Authority region has been an important region in the paddy sector because it covers the largest granary on the Peninsular and produces 940,561 tons, accounting for approximately 41.5% of total rice output Peninsular Malaysia's eight granary areas. This prior study took place at the central rice granary in the Sungai Petani sub-granary, Kedah State, using personal interviews with small paddy farmers [2].

Also, people are very concerned about paddy production and its quality since they are the food they commonly consume. However, paddy plants are easy to get infected with diseases. To prevent the disease, most farmers use pesticides too frequently, resulting in high levels of residues in food commodities. It would jeopardize the quality of the paddy plants and the volume of their production. Besides, the profit could be decreased, and the losses could increase because the chemicals used require a lot of money. Therefore, early detection is so important to control the use of chemicals on paddy plants to avoid losses of the quality and the quantity of paddy production. This will help with the increase in profits for the agricultural industry. This study will use an acceptable technique to ensure the accuracy of the information provided. In the future, the results of this study will be providing in important information on everything from crop planting through final product processing [1]-[3].

2. Literature Review

Agriculture in Malaysia includes planting crops, fishing, and rearing livestock. The core point of sustainable agricultural activities is that the government is active in several other development stages. In addition, it remains an integral aspect of society to be an operational instrument for disabling hunger and providing food to the rural community. Therefore, for the above function, agriculture and the evergreen section were considered [4].

In the broad area of research in the scientific field, plant diseases in agriculture have emphasized the biological characteristics of diseases. The plant diseases prove that to be difficult and need special care and early detection. Bacteria, fungal, viruses, and nematodes are the most common symptoms of plant damage, which cause spots either on the leaf's surface or stem, the brown or black color of lesions, and withered at the lower part of the leaf. However, different type of diseases has different kind of technique to prevent the disease. The usual techniques used to prevent the diseases are the use of chemicals and disease-resistant varieties. This is the cultural tradition of a technique used in order to avoid infections from attack the leaf [5].

An automatic system that detects leaf disease automatically is built with the aid of the image processing process along with further analysis. This intently recognizes diseases at an early stage and provides valuable knowledge to monitor them [6]. The image processing techniques used for disease identification include image acquisition, image pre-processing, image segmentation, colour detection, area detection, and eventually level classification. It is a beneficial technology for the agriculture sector. Some of the previous researchers have used the image processing technique for the description and plant species recognition. The identification technique is purposely for the study f pathological stress conditions and the classification of fruit or plant leaves. Using an image processing technique as an alternative to the conventional manual approach offers a more precise diagnosis. These procedures will be done on the exterior appearances of the infected plant [7]-[8].

In most plants, leaves are typically the primary source for the identification of plant diseases. Sheath Rot, Leaf Blast, Leaf Smut, Brown Spot, and Bacterial Blight are the most common diseases in the paddy plant [9]. The current technique for plant disease detection is by observing using naked eyes by experts. A large team of experts and continuous expert supervision is needed, which is very costly when fields are large. In the meantime, the farmers do not have proper facilities, tools, or even the notion of contacting any experts in some countries. Because of this, the expense of consulting experts is often high and time-consuming. In this case, the proposed technique helps monitor large crop fields, and automatic disease detection by only seeing the signs on the plant leaves makes it both simpler and cheaper [10].

3. Research Methodology

The process of the analysis begins with taking a picture of paddy plants that are infected by BS disease using a 24 Megapixel camera with an Optical Image Stabilization (OIS), the process begins with taking a picture of paddy with a distance approximately 30cm. If the output image does not turn out to be in good condition, the image will be enhanced before proceed with the identification of BS disease. The process will be done in MATLAB. As a result, BS disease will be identified and the classification level of BS disease can be done by MATLAB analysis.

3.1 Project Implementation Structure

Figure 1 shows how the BS disease detection process is performed on paddy leaves. The technique starts with the acquisition of an image and store it in MATLAB. Then, in the pre-processing step, the aim of this stage is to improve the image quality by suppressing the unwanted distortions. There will be a few steps that need to be taken, such as noise filtering and image enhancement. The background image will be removed using the image segmenter tools in MATLAB leaving only the leaves Region of Interest (ROI). Next, colour detection technique will be used to identify the Brown Spot disease on the leaf, where a masking process is applied on the segmented images of binary and RGB. So the process continues with the area detection, where the value obtained from the previous process is used to calculate the intensity pixels of the infected and non-infected area. Here, we classify the infected area on the leaves and determine the level of infection on the basis of Disease Severity Scale Developed by Horsfall and Heuberger [11].

3.2 Table of Severity Level

The severity level of the infected area is classified according to the Disease Severity Scale Developed by Horsfall and Heuberger as shown in Table 1.

Table 1: Disease Severity Scale Developed by Horsfall and Heuberger [11]

Level	Severity
0	Apparently infected
1	0-25% leaf area infected
2	26%-50% leaf area infected
3	51%-75% leaf area infected
4	>75% leaf area infected

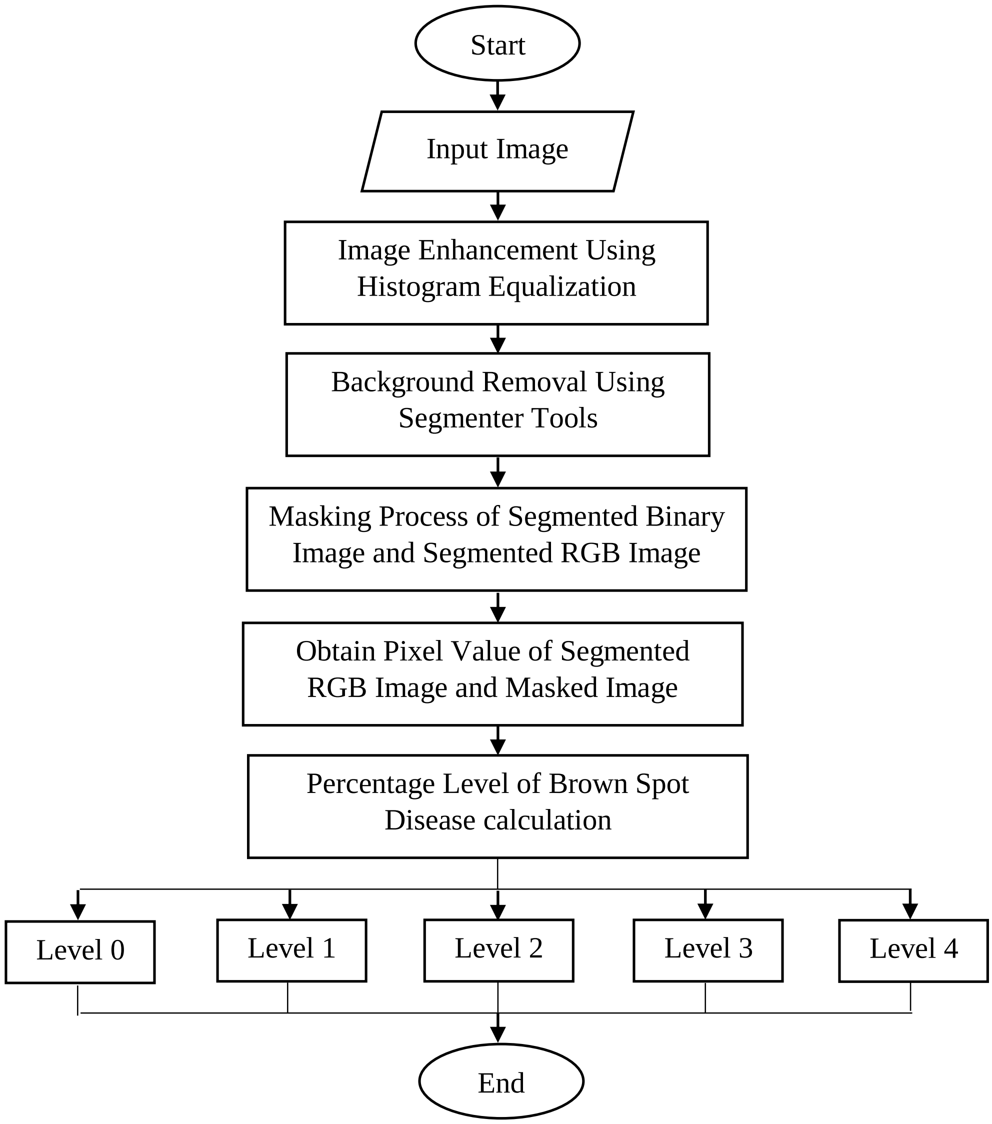


Figure 1: Flowchart of the detection technique on paddy leaves

3.3 Equations

Based on journal [11], the disease severity of the plants leaves is measured by the lesion area and leaf area ratio. The technique used can be expressed as below,

$$\begin{aligned} S &= Ad/Al \\ &= P\sum 1\,/P\sum 1 \\ &= (x,y) \in Rd\ (x,y) \in Rl \qquad Eq.1 \end{aligned}$$

$$\begin{aligned} S &= Pd/Pl \\ &= \sum 1/\sum 1 \\ &= (x,y) \in Rd\ (x,y) \in Rl \qquad Eq.2 \end{aligned}$$

where;

S is severity extent,

Pd is total pixel in diseased area,

Pl is total pixel of leaf,

Ad is diseases leaf area,

Al is total leaf area,

Rd is diseased region,

Rl is leaf region.

4. Results and Discussion

A few experiments have been carried out in MATLAB to study and prove the technique that had been done on the paddy leaf. The 40 sample images collected is stored in MATLAB system. The process continues with enhancing the quality of the image, followed by image segmentation where two segmented images are obtained. Next, colour detection of the Brown Spot disease is done where a masking process is applied. To detect the infected area on the paddy, the pixel values are obtained. The Brown Spot disease severity level is calculated to determine the percentage level of the infected region.

4.1 Image Processing Process

Figure 2 shows a few sample images for each process in detecting the Brown Spot disease on Paddy leaf. The process begins by producing an enhanced version of the original image and continue with a segmented image of binary and RGB. In the last part, a masking process is applied to the segmented images resulting in a masked image.

(a) (b) (c) (d) (e)

Figure 2: Result of each step in detecting Brown Spot disease – (a) original image, (b) enhanced image, (c) segmented RGB image, (d) segmented binary image, (e) masked image

4.2 Evaluation on Detecting Brown Spot Disease

In this project, 40 sample images of the Brown Spot disease on paddy leaf is used to evaluate the result. Table 2 shows analysis result of the Brown Spot disease detection of using the proposed technique.

Table 2: Analysis result of Brown Spot disease detection

	Sample Image	Detected/Not Detected
Number of Image	36	4
Percentage	90%	10%

By referring Table 2, clearly can be seen that the proposed technique can successfully detect 36 out of 40 sample image affected with Brown Spot disease on paddy leaf. So, it can be concluded that the accuracy of the proposed techniques is 90%.

4.3 Evaluation on Brown Spot Severity Level Detection

The percentage level of the Brown Spot disease severity level is calculated based on the Disease Severity Scale developed by Horsfall and Heuberger [11]. In this technique, it is compulsory to get the total pixels of leaf and the total pixel of Brown Spot affected area first. To get the pixel value of the Brown Spot affected area, the not black pixel is obtained from masked image while for total pixel of leaf is obtained from subtracting the not black pixel of masked image and the not black pixel of binary image.

In order to obtain the Region of Interest (ROI) are, the value of the not black pixel for the segmented RGB image and segmented binary image is calculated. Here, the Horsfall and Heuberger method[11], is applied to calculate the severity level of the Brown Spot disease on the paddy leaf. The equation for Horsfall and Heuberger method is as follows,

$$S = Pd/Pl \qquad Eq. 3$$

$$S = 100 \times ((B - K)/B) \qquad Eq. 4$$

where;

S is Severity extent,
B is the not black pixel of the segmented RGB image,
K is the not black pixel of the masked image,
Pd is total pixel in diseased area,
Pl is total pixel of leaf.

4.4 Evaluation on Detecting the Severity Level of Brown Spot

The input images will be inserted into the MATLAB system. The image will be enhanced first to perform the segmentation process. Then, in the image segmentation part, the image background is removed and keep only the object of interest. The next step will be area identification process to detect the affected area on the paddy leaf. As shown in Table 3, the segmented RGB image and the masked image is obtained to calculate the percentage of affected area on sample image.

After all the pixel value needed is obtained, by using Eq. 4, the Brown Spot severity level is calculated automatically using the MATLAB code.

Based on Table 4, it is found that 2 sample image is affected with Brown Spot disease with Level 1, 5 sample images with level 2, 32 sample images with level 3 and 1 sample image with level 4.

Table 3: Example calculation for a sample image with its description

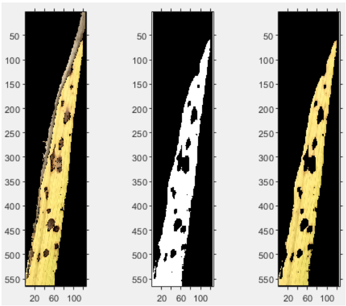
Input Image	Calculation	Description
	The not black pixel of the segmented RGB image, B = 74226 The not black pixel of the masked image, K = 19836 Affected area $=100\times((B-K)/B)$ =100*((74226-19836)/74226) =73.28%	Affected area = 73.28% Severity Level = 3

Table 4: Brown Spot Disease Severity Level Classification

Level	Number of Image	Percentage
0	0	0%
1	2	5%
2	5	12.5%
3	32	80%
4	1	2.5%

4.5 GUI Interface

Here shown in Figure 3, the GUI Interface is designed to detect the Brown Spot disease on paddy leaf and classify each severity level of the disease that has affected the paddy leaf. There are 11 features provided in this interface. Each segment has a different purpose.

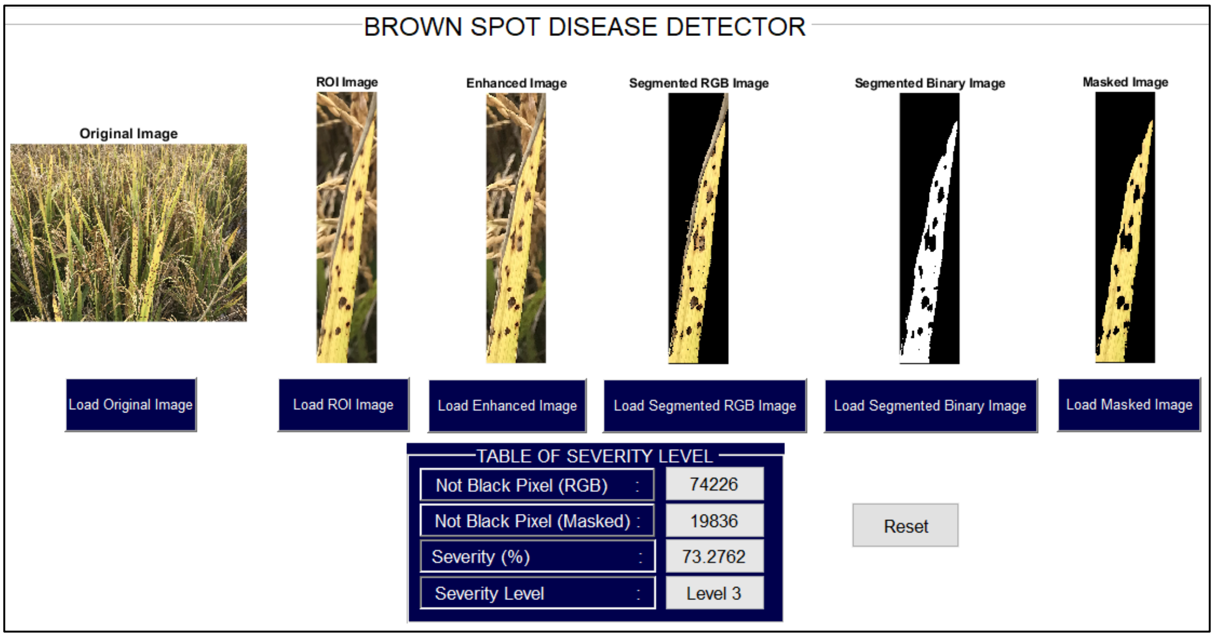


Figure 3: The GUI Interface with inputs

The load original image is to load an image used before undergoing any process on it. The load ROI image is to load the cropped image, which focuses on the Region of Interest of the paddy leaf. Next, the load enhanced image is to enter the improved version of the cropped image. After that, the segmented RGB image is to load the RGB image that has been segmented. Also, at the same time, the not black pixel value will appear in the box below. For load segmented binary image, it is to load an image that has been segmented in binary. The last load button is to load the masked image, which has been applied between the segmented RGB and binary image. At the same time, the not black pixel value of the masked image will appear in the table of severity level box below. The percentage of disease severity and its severity level will be calculated and appear in the segment below. Last but not least, the reset button will clear all the input data after the button is pressed.

However, this interface doesn't work automatically. The image processing process has been undergone manually to the sample images and stored in the external file. These features used a call-back function to call all the input manually.

5. Conclusion

Three main objectives of this project have been achieved. The first one is detecting the infected area of the paddy leaf caused by the Brown Spot disease using colour and area detection technique. In this process, a masking technique is applied to get a masked image of the paddy leaf. By using colour detection help to distinguish between the infected area and the non-infected area. Colour pixel is calculated to achieve the area detection technique and classify it Brown Spot disease severity level. Next, a GUI is designed to detect the Brown Spot disease area and its severity level to undergo the image processing technique on the sample images. Last but not least, the performance of the proposed technique is evaluated based on the disease severity scale developed by Horsfall and Heuberger. The percentage level in the range scale developed by Horsfall and Heuberger was obtained for all of the sample images used in the analysis.

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