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Disease Detection Based on Colour and Lesion Range on Leaves

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Abstract: The fundamental goal of this study effort is to assist persons, particularly young farmers, in detecting the disease early and producing rice of great quality and quantity. The data images taken at the paddy field are then processed in Python software. Image enhancement was done on the data image to increase image quality. The image background is removed by using the background removal tool in the Fotor application. After the background is removed, the process was continued with the colour extraction technique and lesion detection technique where a masking process is applied to the sample image. The pixel intensity between infected and non-infected areas is calculated using the pixel values obtained from those photos. The Bacteria Leaf Blight (BLB) disease is calculated by subtracting the green pixel of the image from the total image pixel. The severity level table developed by Caudhary CP is then used as a reference to classify the severity level of Brown Spot disease while the accuracy of the Bacterial Leaf Blight (BLB) disease detection is evaluated by comparing the results with the severity level verified by MARDI Pathologist on each sample images. From the study conducted, the detection accuracy is 82.9%.

Keywords: Paddy, Bacteria Leaf Blight, Fotor Application, Colour Extraction, Lesion Detection, Python Software

1. Introduction

Paddy cultivation is one of Malaysia's most important contributors to the country's economic resources. In general, a plant becomes diseased when its normal structure, growth, function, or other activities are interrupted on a continuous basis by some causal agent. Plant diseases are characterised as infectious or noninfectious according to the nature of the casual. A pathogenic organism, such as a fungus, bacterium, mycoplasma, virus, viroid, worm, and others, causes infectious plant diseases. An infectious agent has the ability to replicate on its host and move from one susceptible host to the next [1].

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Rice is one of the most important cash crops in the world, particularly in Malaysia and other Asian countries. In recent years, paddy rice production has dropped drastically as it is even difficult to meet the national target of 10 tons per hectare. There are several factors that contribute to paddy-rice production being less productive. One of the causing factors is plant disease. Plant disease is known as an abnormal condition that occurs on the plant [2]. Initially, there are many types of plant diseases faced by paddy plants throughout their lifetime such as Brown spot disease, Blast disease, Narrow Brown spot disease, Brown spot Disease and so on. Early prevention of plant diseases can improve the health of the paddy and meanwhile increase the production of rice which will also improve the income of the country [3].

People are particularly concerned with paddy output and quality because it is the meal that they eat on a daily basis. Paddy plants, on the other hand, are easily affected by diseases. Most farmers apply pesticides too frequently to avoid illness, resulting in high residue levels in food commodities. It would risk the rice plants' quality as well as the volume of their output. Furthermore, because the chemicals utilised are expensive, profits could be reduced and losses could increase. As a result, early detection is essential for controlling the use of chemicals on rice plants and avoiding losses in paddy quality and quantity. This will assist the agricultural business in increasing earnings.

In this project, image processing techniques are used to detect the disease based on the colour and lesion range of the paddy leaves. The image processing technique is the best alternative compared to the traditional manual method as its faster, more accurate, cheaper and consistent. PYTHON software will be used in disease identification and classification [4]. To assure the accuracy of the data presented, this study will employ an accepted technique. The findings of this study will provide significant information on everything from crop planting to final product processing in the future.

2. Literature Review

Planting crops, fishing, and raising livestock are all part of Malaysian agriculture. The government is involved in various different stages of development, which is at the heart of sustainable agricultural activities. Furthermore, it continues to be an important part of society as an operational tool for preventing hunger and delivering food to the rural population. As a result, agriculture and the evergreen part were examined for the aforesaid purpose [4].

Plant diseases in agriculture have emphasised the biological aspects of diseases in a large area of scientific studies. Plant diseases are tough to deal with and require careful attention and early detection. Bacteria, fungal, viral, and nematode infections are the most prevalent causes of plant damage, which result in patches on the leaf's surface or stem, lesions that are dark or black in colour, and wilted lower leaves. Various types of diseases, on the other hand, require different approaches to disease prevention. Chemicals and disease-resistant cultivars are the most common methods for preventing illnesses. This is the cultural history of a procedure used to protect the leaf against illness [5]. With the help of the image processing process and further analysis, an automatic system that identifies leaf illness is constructed. This method accurately detects diseases at an early stage and gives useful information for monitoring them [6]. The image processing techniques used for disease identification include image acquisition, image pre-processing, image segmentation, colour extraction, area detection, and eventually level classification. It is a technology that is advantageous to the agricultural sector. For the description and recognition of plant species, some prior studies have used image processing techniques. 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].

The major source for identifying plant diseases in most plants is the leaves. The most prevalent diseases in paddy plants include Leaf Smut, Sheath Rot, Brown Spot, Leaf Blast and Bacterial Blight

[8]. Plant disease detection is now done by professionals viewing with their naked eyes. When fields are big, a large team of experts and continual expert monitoring are required, which is quite expensive. Meanwhile, in certain countries, farmers lack sufficient facilities, instruments, and even the idea of contacting any professionals. As a result, the cost of consulting specialists is frequently exorbitant and time-consuming. In this scenario, the proposed technique aids in the monitoring of huge crop fields, and automatic disease detection based solely on plant leaf characteristics makes it both simpler and less expensive.

3. Research Methodology

The analysis begins with taking a picture of rice plants infected with BLB disease using a 24 Megapixel camera with an Optical Image Stabilization (OIS), the process begins with taking a picture of a paddy at a distance of approximately 30cm. If the output image does not appear to be of acceptable quality, it will be enhanced. The procedure will be carried out using the Fotor application. As a result, BLB disease will be detected, and Python analysis will be used to determine the disease's classification level.

3.1 Project Implementation Structure

Figure 1 shows how the BLB disease detection process is performed on paddy leaves. Paddy leaf is selected in this project because there are many rice-growing places in Malaysia and easy to do research. In this research, a mobile phone camera is used to capture the leaf image to do analysis. Python is a medium software to analyse the image. The first step of analyzing the data is “start” by storing the captured input image. Then the second step is image acquisition. This step is to increase the reliability of an inspection including cropping, resizing and colour conversion. The image enhancement step is to enhance the image quality of the sample image. Then it is continued with the most important step which is the colour extraction step which helps in identifying whether the paddy leaves are infected with Bacterial Leaf Blight Disease or not. Through analysis by Python, the infected lesion of the leaves can be detected. The infected paddy leaves will continue to the lesion detection process. In this process, the disease is identified by the lesion area to obtain the level of Bacterial Leaf Blight Disease. There are 6 levels of Bacterial Leaf Blight Disease which are Level 0, Level 1, Level 3, Level 5, Level 7 and Level 9. Based on the Disease Severity Scale developed by Caudhary CP, we classify the infected area on the leaves and determine the level of infection. The system comes to an end once the scale of Bacterial Leaf Blight Disease is determined.

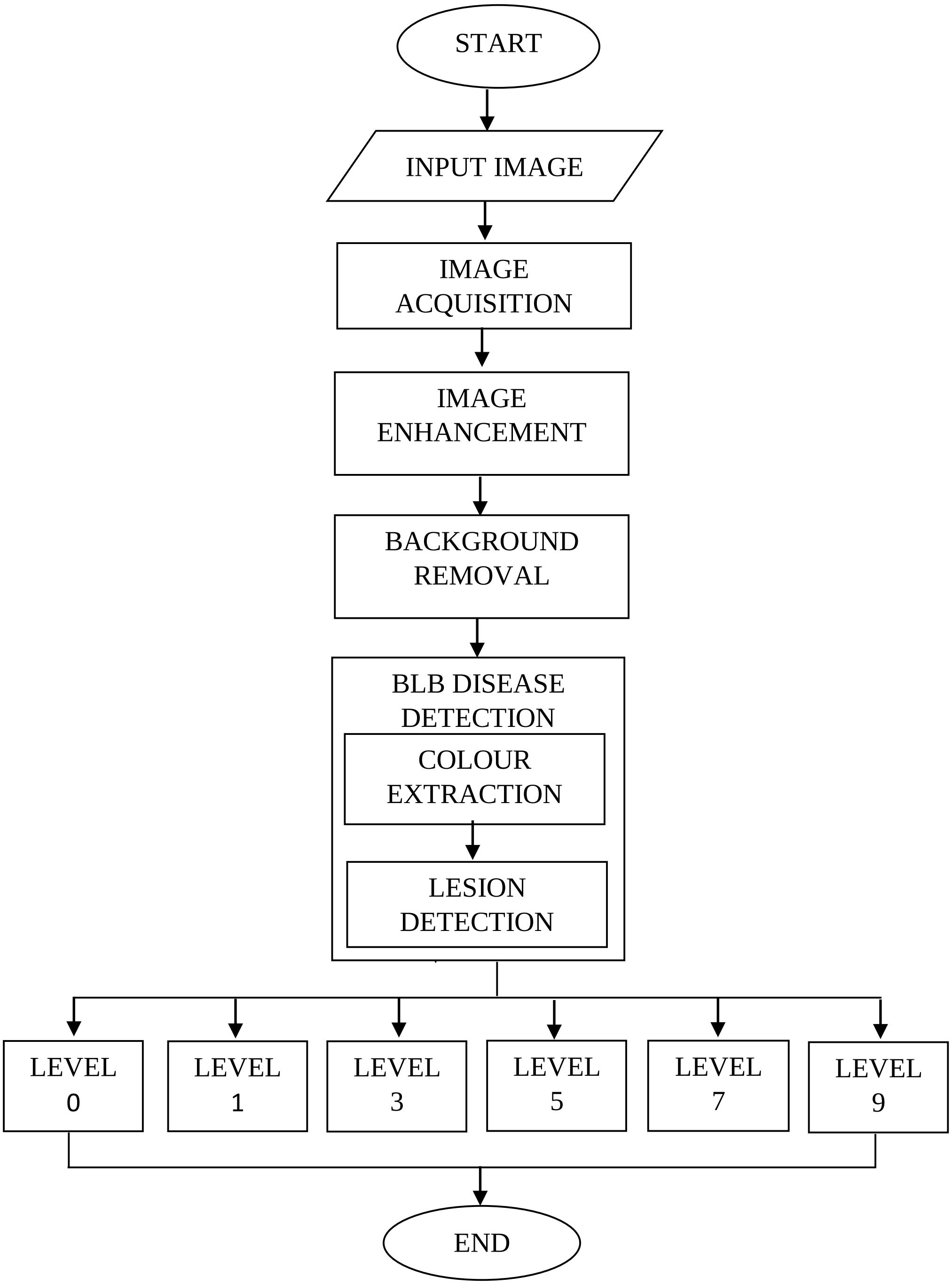


Figure 1: Flow chart of Disease Detection System.

3.2 Table of Severity Level

As shown in Table 1, the severity level of the infected area is classified using the Caudhary CP Disease Severity Scale.

Table 1: Disease Severity Scale Developed by Caudhary CP [9].

Disease score	**Lesion area (%)**	**Disease Reaction**
0	0	Highly Resistant (HR)
1	1-10	Resistant (R)
3	11-30	Moderately Resistant (MR)

5	31-50	Moderately Susceptible (MS)
7	51-75	Susceptible (S)
9	76-100	Highly Susceptible (HS)

The disease severity of the rice leaves is calculated by the lesion area of the leaf. The technique used can be expressed as below,

$$Diseased\ region = \frac{Not\ green\ pixel}{Total\ pixel} \times 100$$

4. Results and Discussion

A few experiments have been carried out in Python to study and prove the technique that had been done on the paddy leaf. In this experiment, 35 sample photos are used. The method begins with image enhancement, followed by background removal with the Fotor application. Next, colour extraction and lesion detection of the Bacterial Leaf Blight is done where a masking process is applied. The pixel values are obtained from the image to identify the contaminated region on the paddy leaf and finally the Bacterial Leaf Blight disease severity level is obtained.

4.1 Image Enhancement

The resized images then undergo image enhancement. Image enhancement is done by using an application named Fotor. The process is very important as most of the original images have lighting effects and have low quality. Table 2 shows the comparison between the original image and the enhanced image after the image enchantment process is applied.

Table 2: Comparison Between Original Image and Enhanced Image.

No.	Original image	Enhanced image
1		

4.2 Background Removal

The second step carried out was background removal. Background removal is very important as it helps to remove all the unwanted objects from the image. Removing unwanted objects enables to focus on the leaf to be detected. In this project, an online application named Fotor is used to remove the background of the leaf images that were taken at MARDI. In the Fotor application, the original images have to be uploaded and the background removal tool has to be chosen to remove the unwanted background. Other than that, the Fotor application provides various background colour. Table 3 shows the images that have been removed from its background.

Table 3: Background removed image

Sample Image	Original image	Background removed image
1		

4.3 Bacterial Leaf Blight Disease Detection

Process image is the first function as it is getting the image and pre-processing the image using RGB. The system gets the diseased pixel of the leaf by subtracting all the green pixels of the leaf from the total pixel of the original sample image inserted in the system. The Bacterial leaf blight disease on a leaf is detected by using a masking concept. The procedure starts with masking the enhanced image. A masked image will appear as a result of the previous action. The comparison between the enhanced image and the masked image is shown in Table 4. The Bacterial Leaf Blight disease area is detected after a masking process is applied. The total image pixel is subtracted by the green pixel of the image which is equal to the value of the diseased area. The value obtained will be the affected area of the Bacterial Leaf Blight disease. The step is continued by obtaining the percentage value and disease level of the Bacterial leaf blight disease. From there, we can classify the Bacterial Leaf Blight disease severity level that has affected the paddy leaf. The disease percentage is rounded off to two decimal places.

Table 4: Comparison of the enhanced image and masked image

Enhanced image	Masked image
	

4.4 Evaluation of Detecting Bacterial Leaf Blight Disease

To evaluate the results, 35 sample images of Bacterial Leaf Blight Disease on paddy leaves were used in this project. The results of the Bacterial Leaf Blight Disease detection utilising the proposed technique are shown in Table 5. Table 5 clearly shows that the proposed technique can successfully detect all 35 sample photos of paddy leaves affected by Bacterial Leaf Blight Disease. As a result, the proposed techniques can be determined to be 100 per cent accurate.

Table 5: Analysis of results of Bacterial Leaf Blight Disease Detection

	Detected	Not detected
Number of Images	35	0
Percentage	100%	0%

4.5 Evaluation of Bacterial Leaf Blight Spot Severity Level Detection

The input images will be inserted into the Python system. To detect the affected areas on the paddy leaf, the image will be subjected to an identification process. The masked image is used to calculate the percentage of the sample image that is affected. Then the system calculates the percentage of Bacterial Leaf Blight disease and is followed by the severity level of Bacterial Leaf Blight disease. The output will show us the level of severity of each sample image. Table 6 shows the output of the system which is the masked image and an output table which consists of the Bacterial Leaf Blight disease percentage and the severity level.

Table 6: System output of detecting Bacterial Leaf Blight disease

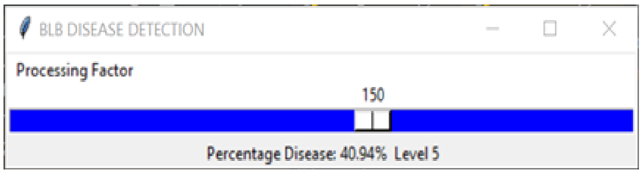
No	Input image	Masked image	Output table
1			

Table 7 shows the accuracy of the classification of Bacterial Leaf Blight disease severity level. There are 29 samples with accurate Bacterial Leaf Blight disease severity levels while 6 samples are inaccurate. The proposed technique has 82.9% accurate and 17.1% inaccurate detection of Bacterial Leaf Blight disease.

Table 7: Accuracy of Bacterial Leaf Blight disease classification.

	No of Sample	Percentage
Accurate	29	82.9%
Inaccurate	6	17.1%

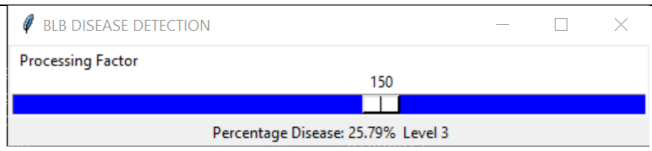
4.6 Factors Affecting the Efficiency of Disease Detection

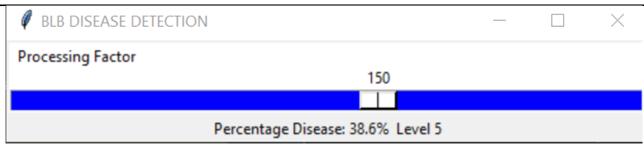
There are three (3) factors affecting the efficiency of disease detection as follows;

4.6.1 Quality of the Sample Image

The quality of the sample image plays an important role in the detection of Bacterial Leaf Blight disease. This is because if the picture has low quality the system faces difficulty to detect the infected area of the paddy leaf. Table 8 shows the comparison of results between low-quality sample images and enhanced sample images. The low-quality sample image has gone through image enhancement in the Fotor application. The sample image in Table 8 is affected with level 5 of Bacterial Leaf Blight disease as per verified by the MARDI pathologist where the percentage of disease should be between 30% to 50%. The output of the original image produces level 3 of Bacterial Leaf Blight disease. However, after the picture is enhanced, the Bacterial Leaf Blight disease percentage produced is 38.6% which is level 5 of Bacterial Leaf Blight disease.

Table 8: Comparison between Image quality.

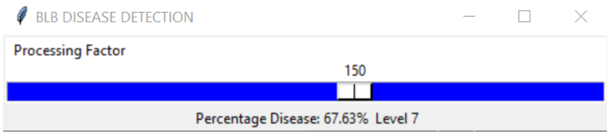
Original image			

Enhanced image			

4.6.2 Condition of the Paddy Leaf

To snap pictures of the paddy leaves, it needs to be cut from the paddy field. However, once the paddy leaf has been cut, the picture of it should be taken immediately as the paddy leaves will curl in less than 5 minutes. The curled-up paddy leaf has a narrow surface and the paddy leaf will not be visible completely. Thus, the proposed technique is not able to detect the Bacterial Leaf Blight disease on the paddy leaf accurately. Table 9 shows the output of Bacterial Leaf Blight disease detection on curled-up paddy leaf. The sample image is affected with level 5 of Bacterial Leaf Blight disease as per verified by the MARDI pathologist where the percentage of disease should be between 30% to 50%. However, the output of the sample image produces 67.63% of Bacterial Leaf Blight disease which is categorized as level 7 of bacterial leaf blight disease.

Table 9: Results of Curled up Paddy leaf.

Input image	**Masked image**	**Output table**
		

4.6.3 Position of the Paddy Leaf

All the sample images were straightened using an image editor. Some sample images that weren't able to straighten due to the position of the sample image were taken. The position of the paddy leaf in the sample images affects the detection as the proposed technique calculates the Bacterial Leaf Blight disease percentage by deducting the green pixels from the total pixels of the image. So, when the position of the paddy leaf is tilted, the background of the image sample gets bigger which will increase by a black pixel. Thus, the proposed system calculates the pixel of the background as well which results in a greater percentage of Bacterial Leaf Blight disease. The sample image in Table 10 is affected with level 5 of Bacterial Leaf Blight disease as per verified by the MARDI pathologist where the percentage of disease should be between 30% to 50%. However, the output of the sample image is categorized as level 7 of bacterial leaf blight disease. The sample image is then straightened using Fotor application has per shown in Table 11 where the output produced is accurate as it is categorized as level 5 of bacterial leaf blight disease.

Table 10: Results of Tilted Paddy Leaf.

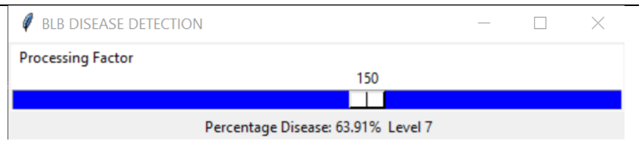
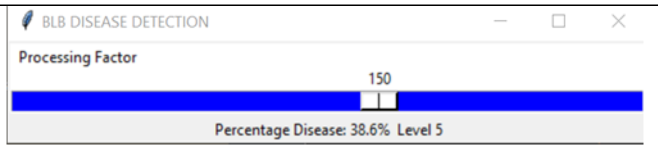
Input image	Masked image	Output table
		

Table 11: Results of Straighten Paddy leaf.

Input image	Masked image	Output table
		

5. Conclusion

Three main objectives of this project have been achieved. The first one is to detect the leaf disease using colour extraction techniques. Color detection is used to differentiate between infected and non-infected areas. The diseased pixel is calculated to achieve the percentage of Bacterial Leaf Blight disease and classify the Bacterial Leaf Blight disease severity level. Next, to analyze the lesion on the leaf based on area detection. A masking technique is used in this process to create a masked image of the paddy leaf that shows the diseased area of the paddy leaf. Last but not least, the proposed technique's performance is assessed using Caudhary CP's disease severity scale, and the accuracy of the system is evaluated by comparing the results to severity levels validated by MARDI Pathologists on each sample image.

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