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Measurement of the Severity of Rice Blast Disease by using Image Processing

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Abstract

Rice blast disease is one of the main factors influencing crop yield. This researchis conducted to automatically measure the severity of rice blast disease that appears on the rice leaf by using image processing. The symptoms of this disease can represent the severity of the disease, which is used to select a suitable method for disease control. The severity of the disease is divided into four levels, such as no lesions, slight, moderate, and massive lesions. Different severity levels require the different techniques for controlling the disease, for example, the farmer should use the chemicals when the disease severity is at least at the moderate level.Rice leafs images were collected andput into image processing system for identifying the severity of rice blast disease by using K-Nearest Neighbor algorithm. This method can accurately identify around74.17%. Healthy leaf identification gives the best performance while the little lesions leaveshas appearance similar to healthy leaves. This work will be useful especially for farmers to estimate the disease severity and to select appropriate approaches for real-time disease management.

Keywords: *Image Processing, Disease Grading, The Level of Disease Severity, K-Nearest Neighbor*

1. Introduction

Rice (*Oryza sativa L.*) is a unique plant because it can grow in moist environments that other plants cannot survive. It is a staple food for the human population (Paraiso, Dela Pena, &Capacao, 2019). So, rice is an important economic crop and export product of many countries. Since in the present is modern agriculture, which focuses on management and technology. It is using the innovation to control the production to obtain higher yields and make farming more lucrative. However, there is another factor that causes decreased yields is the disease of rice. Rice blast disease is a common disease because it can be found in every region, and it can cause damage to the yield. If the disease has high severe, it will make rice dry and eventually die. So, rice blast disease is an important factor in reducing the quality and quantity of yield.

Rice blast disease is caused by the fungus *Pyriculariaoryzae* (*P.oryzae*). It is a significant problem with extensive distribution and destructiveness under favorable conditions that affect the decrease of rice yields. The fungus *Pyriculariaoryzae* can easily spread by wind, water, soil, seeds, or plant parts. Rice plant is infected by conidia, which can disperse in the atmosphere (Airborne). The symptoms of rice blast disease are similar to being burnt by fire, and the lesions are elliptically shaped with brown margins and gray spots. Their characteristics, such as shape,color, and size, vary depending on varietal resistance, environmental conditions, and the age of the lesions (Aziiba Emmanuel, Qiang, & Jeffrey A, 2019) and (Ghani et al., 2019).

The rice blast disease can occur in all parts of the plant above the soil in the seedling, tillering, and heading stage. It can threaten rice plants in every stage in the growth cycle. The destruction of blast disease often occurs during the night, which is quite cold temperatures around 22-25 degrees Celsius and high humidity. If the condition is appropriate to the disease, then the outbreak of rice blast disease will have occurred in a high severity

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level (Wen Ching, Tai Ying, Aileen L, &Chien Sen, 2019) and (Hussain et al., 2018). There are several solutions for prohibiting the rice blast disease, such as reducing nitrogen fertilization, burning stubble in the field, and using chemicals. However, the use of fungicide chemicals can pose a negative impact on product quality and the environment in the long term. In the present, although some rice varieties have properties quite a disease-resistant. Nevertheless, this fungus can create new descent (races) that more severity, can destroy resistance varieties increasingly. The symptoms of blast diseases imply the severity of the disease. If the severity of the disease is different, dealing with the disease will also be different. It is also needful to preliminary diagnose the disease accurately to avoid the great harm of the rice. The treatment of rice diseases by applying disproportionate pesticides increases the cost and environmental pollution, the use of pesticides must be minimized. So, if we can know and measure the severity level of the blast diseases that appears on the rice leaf. We will have a way to protect and settle with the disease quickly by taking the leaf of rice that has a blast disease to image processing.

Image processing is taking an image to evaluate or calculated by using a computer to get the information in terms of quality and quantity. With essential steps are making the sharper image by eliminating noise from images, segmentation of the object that interests us from the image. To take a picture of the object to analyze for quantitative data such as the size, shape, and direction of movement of the object in the image. Then we can analyze these quantitative data and create a system to use in various fields (Gowthami, Pratyusha, Somasekhar, Hemanth & Nag, 2017). The algorithm that used to classify the severity level in this study is the K-Nearest Neighbors algorithm(KNN). Since K-Nearest Neighbors is a straightforward implementation forasmuch simple 'instance-based' learning algorithm (Padraig & Sarah Jane, 2007), but it can offer better performance for some classification. Therefore, this research aims to study the methods for measurement of the severity level of rice blast disease by using image processing. We use the K-Nearest Neighbors algorithm(KNN) to classify the severity level of blast disease.

2. Proposed methodology

The proposed methodology uses image processing techniques to classify rice blast disease images into four different classes: no lesion observed, slighly lesion area, moderately lesion area and massively lesion area. We acquired image dataset of rice blast disease for 200 images in total, 50 for each class. Fig. 1. Represents the severity of the disease that are different such that classified by its severity levels and management method.

The system process shown in Fig. 2. Consists of image preprocessing, image segmentation, feature extraction and classification. In image preprocessing process, an image is converted from RGB to HSI color and remove a noise of image. A binary threshold and Otsu threshold are used in image segmentation process to extracting a part of disease area and healthy area. Area feature is used in feature extraction process to count the diseased area pixels and all areas for calculate the disease severity.In classification process, we use K-Nearest Neighbor algorithm to create a model for the prediction.:

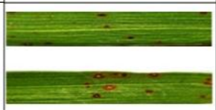
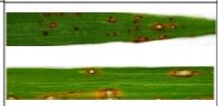
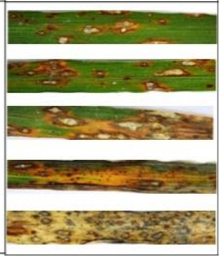
Level	Lesion	Scale
0	No lesions observed.	
1	A slightly lesioned area but can still be neglected.	
2	A moderately lesioned area which can be treated by spraying the chemical.	
3	A massively lesioned area which must be further exterminated.	

Figure 1: The severity level of Rice Blast Disease base on IRRI.

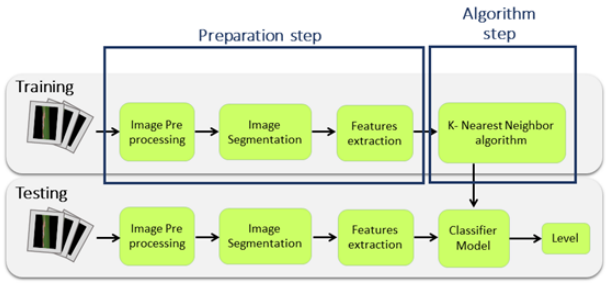


Figure 2: Image processing diagram.

Image preprocessing

In preprocessing, an RGB image converted to suitable color space, i.e., HSI color, which the algorithm can be more efficiently worked.Sincean HSI color transformation is used to convert RGB color into pure color and this helps to adjust the saturation and intensity to see the lesion more clearly. To convert an image from RGB to HSI color, the image should be normalized to the range [0, 1]. By applying the following equations:

$$Hue = \cos^{-1}\left[\frac{\frac{1}{2}\left[(R-G)+(R+G)\right]}{(R-G)^2+\left[(R-B)\times(G-B)\right]^{0.5}}\right], \quad (1)$$

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$$Saturation = 1 - \left(\frac{3}{R+G+B}\right) \times \min[R,G,B], \quad \textbf{(2)}$$

$$Intensity = \left(\frac{R+G+B}{3}\right), \quad \textbf{(3)}$$

where Ris Red, Gis Green, Bis Blue, His Hue, Sis Saturation, and Iis Intensity. The results of conversion RGB color to HSI color are shown in Fig. 3.

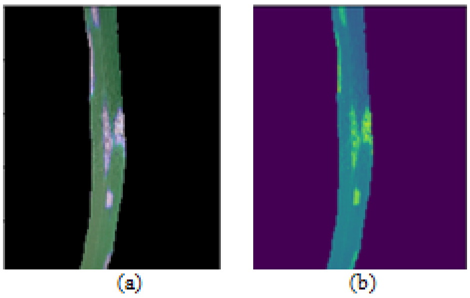

Figure 3: Conversion RGB color to HIS color, RGB (a), HSI (b).

Then remove a noise of image that may be caused by photograph. Since noise may cause the detection error. By using median filtering. It is replacing pixel by the median of all pixels in a neighborhood. By applying the following equation:

$$y[m,n] = median\{x[i,j],(i,j) \in w\}, \quad \textbf{(4)}$$

where w represent a neighborhood around location $[m,n]$ in image. The results of removing a noise by using median filtering. After removing the noise, it can be seen that the resulting image will have more smoothing color and brightness as shown in Fig. 4.

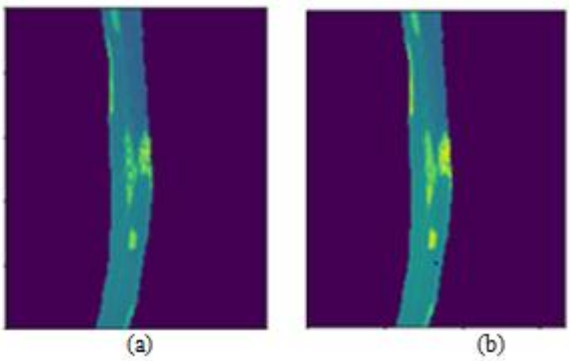

Figure 4: Removing a noise by using median filtering, HIS image (a), noise removing image (b).

Image segmentation

After entering the image preprocessing, the data will enter Image segmentation is a step for extracting a part of an image. In this section, the disease area is extracted by the binary threshold by selected binary thresholded value between 0 to 255 and the health area is extracted by the Otsu threshold, where threshold values must be considered as the following equation:

Consider the variance of the histogram:

$$\sigma^2 = \frac{\sum_{i=0}^{N}(x_i - \mu)^2}{N} \quad \textbf{(5)}$$

Within a class variance:

$$V_W = \sum_{i=0}^{N}\left(W_i \times \sigma_i^2\right) \quad \textbf{(6)}$$

Between a class variance:

$$V_b = V_T - V_W \quad \textbf{(7)}$$

where W_i is $\dfrac{pixels\ in\ class\ i}{total\ \ pixel}$,

V_T is the total variance,

x_i is the pixel value,

μ is the mean,

N is the number of pixels in one image.

So, within-class variance, the value of V_W must be minimal, but between-class variance, the value of V_b must be maximal. The results of extraction a part of image by binary threshold and Otsu threshold are shown in Fig. 5.

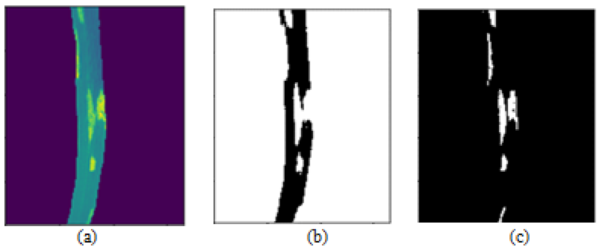

Figure 5: Image extraction, noise removing image (a), binary threshold image (b), Otsu threshold image (c)

Features extraction

After entering the image segmentation, the data will enter feature extraction is a step for converting the data from image data to numeric data. In this section, calculate the pixels number of diseased area and all areas by using the area feature. Then calculate the disease severity as the following equation:

$$Severity = \frac{disease\ area}{(disease\ area + healthy\ area)}. \quad \textbf{(8)}$$

K- Nearest Neighbor algorithm

In this section, the data will be obtained to isolate the severity of the disease by using K-Nearest Neighbor. Which has the principles steps in KNN classification are as follows:

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Step 1: Choose the K value,
Step 2: For each example in the data,
- Calculate the distance between testing data and training from the data

$$Euclidean = \sqrt{\sum_{i=1}^{N}\left(x_i - y_i\right)^2}\,, \qquad (9)$$

where x_i is testing data, y_i is training data and N is the number of feature.
- Add the distance and the index of the example to an ordered collection.

Step 3: Sort the ordered collection of distances and indices from smallest to largest,
Step 4: Pick the first K entries from the sorted collection,
Step 5: Get the level of the selected K entries,
Step 6: Return the mode of the K level.

3. Experimental Results

The results of the measurement ofthe severity of blast diseases appear in the leaf of rice by using image processing. For the different severity level of the disease, infected leaf samples has been taken after the successful computation of the K-Nearest Neighbor algorithm in python software. In experimentation, we have taken 200 sample images of four different levels of disease by a researcher under chamber conditions, the accuracy of the proposed methodology for the measurement of the severity of blast disease will be illustrated in Table 1.

Table 1: The accuracy of K-Nearest Neighbor

Algorithm	**Training accuracy**	**Testing accuracy**
K-Nearest Neighbor	0.7625	0.7417

When measuring accuracy by a confusion matrix,the Confusion Matrix is a crucial tool for evaluating the prediction of models that we create in machine learning. It is a table that is often used to describe the performance of a classification model on the data set of tests for which known the true values (Santra, & Josephine Christy, 2012). The confusion matrix is relatively simple to understand. It can tell that classification model which level is the most accurate. Therefore, we use the confusion matrix to measure the performance of classification models.The results are shown in Fig.7. and Fig.8.

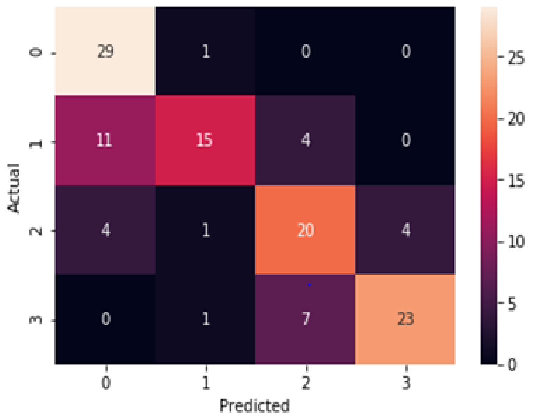

Figure 7: The result of the confusion matrix shows the number of images from prediction.

Actual \ Predicted	0	1	2	3
0	96.67%	3.33%	0	0
1	36.67%	50%	13.33%	0
2	13.33%	3.33%	66.67%	13.33%
3	0	3.33%	23.33%	76.67%

Figure 8: The result of confusion matrix shows percent of images from prediction

The confusion matrix shows the results for prediction of classification model.The best performace is shown in the level 0 at about 96.67% accuracy and the level results in the most error predicted was level 1 at about 50%accrucy.At level 0, it frequently is predicted to be in level 1 approximately at 3.33%. At level 1, it predicts to be level 0, about 36.67% and level 2, about 13.33%. Hence, the pattern of level 1 is similar to pattern level 0.

4. Conclusion

We propose an automated measurement of the severity of rice blast disease to classify the severity of disease from the leaf images. The disease severity can be catogorised differently along; similarly, to control disease is also varied. We use the blast disease dataset, containing 200 images of rice leaves and four different classes, each class represent the severity of the disease that are different such that classified by management. In the image processing process, there are four main steps for automated classification: image preprocessing, segmentation, feature extraction and classification. In preprocessing process,we convert an image from RGB to HSI color space and remove some noise in the image. Forsegmentation, we use a binary threshold and Otsu threshold to extracting a part of disease area and healthy area. The area feature is used in feature extraction process to count the diseased area pixels and all areas for calculating the disease severity level in classification process using K-Nearest Neighbor algorithm to create a model for the prediction. Our method can accurately identify the severity level of the rice blast disease approximately at 74% accuracy.

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