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Article *in* International Journal of Engineering & Technology · August 2018

DOI: 10.14419/ijet.v7i3.27.17756

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International Journal of Engineering & Technology, 7 (3.27) (2018) 182-185

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Research paper

Automatic Rice Leaf Disease Segmentation Using Image Processing Techniques

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Abstract

Agriculture productivity mainly depends on Indian economy. Hence, Disease prediction plays a important role in agriculture field. In image analyzing the symptoms is an essential part for feature extraction and classification. However, some of the challenges are still lacking to predict the disease. To meet those challenges, the proposed algorithm focuses on a specific problem to predict the disease from early symptoms. Bacterial Leaf Blight and Brown Spot are a major bacterial and fungal disease respectively in rice (Oryza sativa) crops, it causes yield loss and reduce the grains quality. This research work focused on automatic detection method for image segmentation on rice leaves under wide range of environmental condition for further analysis. Various hybrid techniques for image segmentation and classification algorithms were analyzed and an automatic detection method has been proposed for identifying the specified diseases in rice leaves under different environmental condition.

Keywords: *Agricultural crops, rice plant, image processing, color model and segmentation.*

1. Introduction

Rice is an important food crop and is a most stable food for majority of the world's population [1]. To raise demand, productivity must be enhanced. However, plant disease has been a major yield loss in the production of rice crops [2]. In this context, accurate diagnosis of crop at early stage is very important. The disease caused in rice plant is very difficult to identify by using traditional method like naked eye observation [3]. Image processing technologies have been widely used in agriculture for plant disease identification. So the plant images could be processed through computer vision from early symptom to predict the disease. MATLAB software is used to analyze image for predicting the disease in rice plant through the leaf images.

Leaves of Rice plant may be infected by several diseases, such as, Bacterial Leaf Blight caused by bacteria Xanthomonas oryzae, Brown Spot caused by fungus Helminthosporiose, Leaf Blast caused by fungal Pyricularia grisea [4]. This could cause serious damage which leads rice quality and yield loss. It is difficult to diagnose effectively and accurately through naked eye observation. So automatic detection of computer vision enables the farmers to predict the disease effectively as well as time consuming on large farms. Eather cannot be controlled by the farmers since they lost control of most farming practices. If the farm is affected by a pest or a disease, it is to be rectified with immediate effect without any delay. Most of the disease/deficiency in plants can be identified by monitoring the leaves. Farmers used to monitor the plant at definite time intervals and if they are unable to identify the symptom of a disease, they will apply approximate quantity of fertilizer or pesticide. But normally the farmers are not in a position to identify the actual disease deficiency. This results in the application of wrong fertilizer and finally it will affect the plant as well as the soil. The solution for this problem is to automate the process of detection of disease deficiency. It can be done with the help of various image processing techniques.

2. Related Work

[5] proposed a method to recognize Frog Eye disease of Soybean plant. According to author, the infected area is separated between infected region and healthy leaves by using segmentation method. In the following, the features are extracted through shape, color and textures are extracted by using statistical and spectral methods . Those features feed to SVM for final classification.

[6] tries to identify the infected plant leaves by two different types of diseases respectively. First, the image is converted from RGB to HSV color space. To improve the quality of image preprocessing techniques are applied. Then, color co-occurrence method was used to extract the features from the diseased image. At last, the extracted features of shape, color and textures were submitted to SVM for classification.

A new automatic plant leaf segmentation through the early symptoms proposed by [7] in various plant leaves taken by using digital camera. In most approaches, the algorithm starts by segmenting the image by using Otsu's threshold to separate the background. Those images were used to feed for feature extraction methods for final classification.

[8] proposed a algorithm for disease prediction in various plant from early symptoms. In that study, automatic detection identification accuracy was 58% in segmentation process and manual segmentation approach was 63%. Due to poor capture condition automatic approach was very poor. So capturing

condition should be very clear to increase accuracy. This study motivated researcher to investigate the severity measurement. So texture information also very important to predict the disease efficiently and accurately [9].

This paper mainly focuses five sections which describe different techniques and algorithms to segment the diseases in rice plant. Section 1 describes the simple introduction about image preprocessing. Section II describes different techniques for image preprocessing. Then section III and section IV describes about symptoms and signs of rice plant and various algorithms for image preprocessing and image segmentation. Section V and section VI contains Results and conclusion of this paper.

3. Description of Rice Diseases

The disease occur in rice can reduce grains quality. It can be caused by bacteria, viruses, or fungi [10]. The severity of the plant has different symptoms and signs, described below

Brown Spot: Brown spot is caused by fungal pathogen *coleoptiles*. Infected starts by small, circular, yellow brown or brown lesions on leaf. In severe infection it caused 45% yield loss [11].

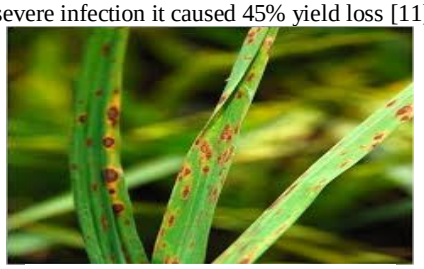

Fig. 1: Infection of the diseases brown spot

Bacterial Leaf Blight: Bacterial blight is caused by bacterial Xanthomonas oryzae. This symptoms can be appear as Water-soaked and yellowish stripes in wavy margins. Once severe infection occurs it kills entire leave [12].

Fig. 2: Infection of the diseases bacterial leaf blight

4. Materials and Methods

Image Acquisition of Rice Leaves

The images of rice leaves can be affected by various diseases like brown spot and bacterial leaf blight [13]. Those diseases are taken by canon digital camera with high resolution [14]. Two different types of rice leaves were collected for this research work to predict the disease. The selected samples of Bacterial Leaf Blight (*bacteria Xanthomonas oryzae*) and Brown Spot (*fungus Helminthosporiose*) were taken from rice plant for further analyze. For further processing the images were stored in RGB and changed to JPEG format. Finally the images were processed to predict the disease using MATLAB Toolbox [6].

Analysis of Image to Segment the Infected Leaves

Some of the images are have weakness such as blurred or poor contrast. To make the quality, the images to be enhanced by mapping the pixel of lower threshold value and upper threshold value to new pixel value [15]. To improve the visual impact pixel brightness can be improved for further processing and analysis task. Next, brightness value is calculated by using corresponding neighbor pixels. According to the size of the image the new pixel value to be calculated for brightness transformations. The following master formula used to calculated brightness conversion

$$I(x,y) = N[O(x,y)]$$

Sometime a poor illumination occurs on images due to poor environmental condition. To improve the quality of image Due to very poor illumination or improper setting the contrast of the image can be improved. Then, the image in adjusted from dynamic range pixel values to grey-scale image.

$$I(x, y)=I1+(I2-I1/I2-I1)[O(x, y)-O)$$

To brightness of the image is adjusted through by adding minimum and maximum value of input gray level image from corresponding deserved levels.

$$I (x, y) = M * O (x, y) + N$$

Combining both bias [O1,O2] and gain for [I1,I2] values to increase brightness of an image. Another type is removing blurred image.

Color Transformation

The purpose of color transformation is to segment the meaning full information from RGB color format to Hue Saturation Intensity (HSI) color space to representation to detailed information to visible [16]. The input image can be transformed from standard RGB color space to HSV LAB color. The equation for RGB value normalization is

$$R= Rn / Rn +Gn+Bn ; G=Gn/ Rn +Gn+Bn ;$$
$$B=Bn/ Rn +Gn+Bn ;$$

And the maximum RGB coordinates ranging from

$$Rn=Rn / Rmax ; Gn =Gn/ Gmax ; Bn =Bn / Bmax$$

Resulting combined to detailed color information. The hue, saturation and intensity (HSI) define pixel color used to separate areas of interest that share common information of image, a process for further processing called segmentation method [17]. Next, Image segmentation has been a important role in research field of image processing. Image segmentation used to portion the image into multiple region of pixel to draw something more meaningful and easier to analyze, explained in Fig 4. In most cases, the target region and histogram has been double the pixel. So the segmentation has not been clear for further analysis. Edge detection also a important role take part in image segmentation. So, the fundamental tools to partition the image in edge detection method.

$$\text{argmin}c\sum i=1k\sum x\in cid(x,\mu i)=\text{argmin}c\sum i=1k\sum x\in ci\|x-\mu i\|22$$

It separates object and background image.Gray level segmentation method can be used to obtain binary image. Otsu algorithm is used to calculate the threshold value. Next, k-means clustering can be used to segment the infected portion from unwanted background by automatic detection method.

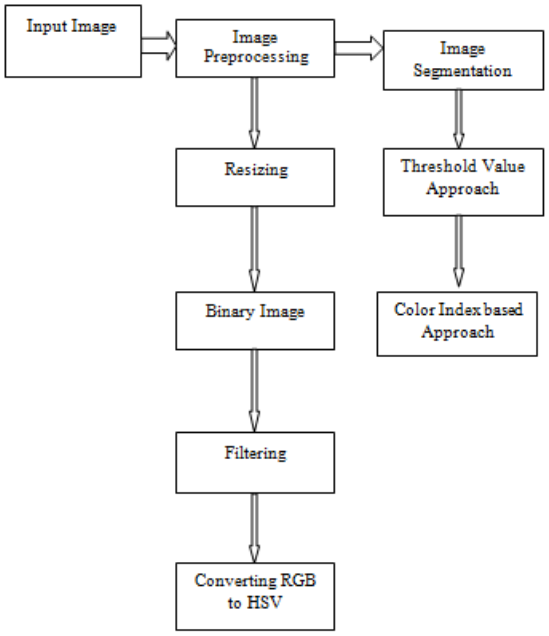

Fig. 3: Automatic leaf detection of plant disease using image preprocessing and segmentation

5. Results and Discussion

As discussed in materials and methods, the solution is composed by four phases.

In the first phase, the input image of different infected rice leaf is selected from dataset folder. Under natural light condition it must be enhance the contrast of image so that it will produce the contrast image and again it will convert into gray scale image. Next, color transformation drawn by RGB to HSV image format to analysis image segmentation.[18]

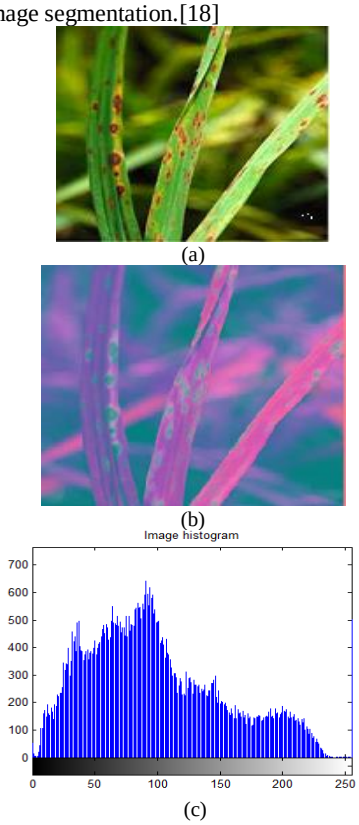

Fig. 4: Rice leaf infected with brown spot at various stages of infection (a) input image (b) HSV color Model (c) image histogram

Fig. 5: Various segmentation stages using k-means clustering of finding brown spot infection in rice plant

Those colors were extracted by color models HSV (Hue, Saturation and value). Hue component is used for further analysis from the color space transformation. Then, the disease spot region is extracted by image segmentation. K-means clustering can be used for image segmentation method shown in Fig 5. So, k-means clustering method used to partition the collection of object into k groups. The algorithm starts by calculating the mean values through each cluster and compute the distance of each cluster to corresponding mean. Finally assign the point to nearest cluster.

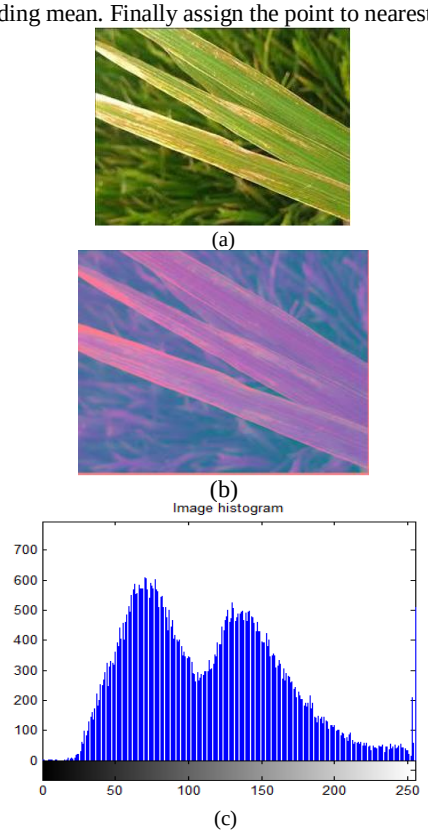

Fig. 6: Rice leaf infected with bacterial leaf blight at various stages of infection (a) input image (b) HSV color model (c) image histogram

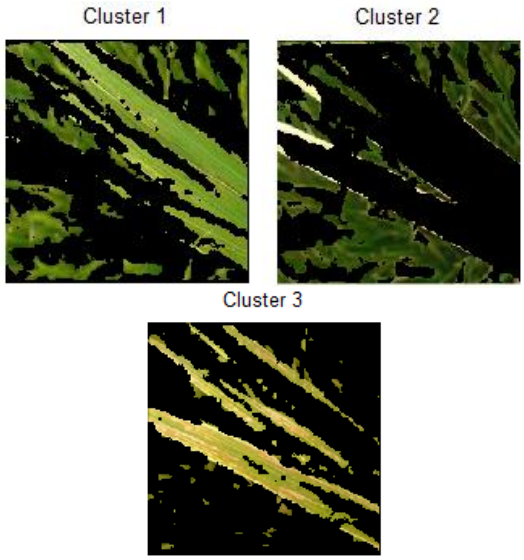

Fig. 7: Various segmentation stages using k-means clustering of finding bacterial leaf blight infection in rice plant

The result of various clustering segmentation showed in Fig 6, which presents different cluster using k-means algorithm in image segmentation. The proposed method shows full automatic and good efficiency.

6. Conclusion

In crop diseases management fast and accurate disease prediction plays a important role in rice plant recognition. The algorithm separates leaf color, sign color and illumination from different color channel. Many existing segmentation cannot meet automatic rice disease identification. So newly developed but widely used segmentation algorithm plays a important role to separate the spot region from busy background. The result indicates that an algorithm made easy for final feature analyzes. In Future, there should be a new proposed method to the extract pigment through feature analysis and to differentiate the type of diseases from image classification.

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