Algorithm for Detection Brown Planthopper Using Image Processing

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Abstract **- This paper presents an image process for detecting brown planthopper (BPH) in simulation rice fields. The smart phones are used to capture images of brown planthoppers that are stuck on the rice stem. In the first step, transformation a color model from RGB to HSV and use the Hue color to separate the brown planthopper from the backgroung with the otsu algorithm. In the second step, The 5 properties consist of Orientation, Major Axis Length, Minor Axis Length and Eccentricity are identify brown planthoppers. As a result, this system achieves 91.38% accuracy of brown planthopper classification on the simulation rice fields.**

Keywords **- Color Space, Image Processing SVM, Brown Planthopper (BPH)**

I. INTRODUCTION

Brown Planthopper (BPH) or Nilaparvata lugens (Stål) is an important insect pest of rice that causes severe damage to rice plants. The larvae and adults will suck water from the leaves of rice and causing the rice plant to grow slowly and showing yellow leaves. If the outbreak is severe, the rice will show dry burns, similar to a scalding hot water, called hopperburn. The BPH is cause of sooty mold and an important insect carrier in the transmission of Rice Ragged Stunt Virus (RRSV) and Rice Grassy Stunt Virus (RGSV) to rice plants that is the stunted and the leaves are dark green, narrow and short, The rice plant has less grain [1].

The monitoring of BPH populations can be done by using light traps, yellow sticky traps, yellow pan trap and sweep net and then inspect and count the population of BPH by a manual identification which the insect sampling techniques is used to monitor population of migration and outbraek of BPH.

The image processing has been used for detect insect pests (whitefly, aphid and thrips) in greenhouse. The data collection of insects by yellow sticky traps and using classification methods for color space (RGB) and size of insect which results in the ability to distinguish aphids well [2] similarly, Chunlei et al. [3], using color space (YCbCr) to separate from the background with watershed algorithm that result is 93.50% accuracy of insect and YAo et al. [4], proposed the method for counting whiteback planthoppers (Sogatella furcifera) on rice plant images detection is the SVM classifier based on HOG features and achieved 85.2% detection rate and 9.6% false detection rate. Brinda and Pushparani [5] present an method for classification of the insect that cause damages to early detection of pest in leaves using the SVM classifier.

II. THEORY

A. HSV Color Model

H: Hue represents color in this model, hue is an angle from 0 degrees to 360 degrees as shown in Figure 1.

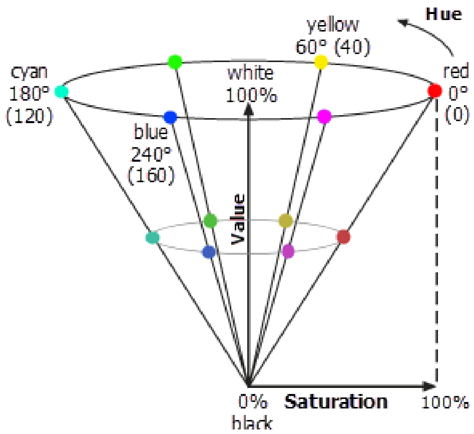


Figure 1. The HSV Color Model

S: Saturation indicates the range of grey in the color space. It ranges from 0 to 100%. Sometimes the value is calculated from 0 to1. When the value is '0,' the color is grey and when the value is '1,' the color is a primary color.

V: Value is the brightness of the color and varies with color saturation. It ranges from 0 to 100%. When the value is '0' the color space will be totally black. With the increase in the value, the color space brightness up and shows various colors [6].

B. Threshold

Threshold methods are divide the image pixels with respect to their color intensity level that are used over images having lighter objects than background. The threshold of image intensity is set manually at a specific value or automatically set by an application. Pixels below that set threshold value are converted to black (bit value of 0), and pixels above the threshold value are converted to white (a bit value of 1). The threshold process is sometimes described as separating an image into foreground values (black) and background values (white) as: (1)

$$f(x,y) = \begin{cases} 0, & f(x,y) \leq T \\ 1, & f(x,y) > T \end{cases} \qquad (1)$$

III. SYSTEM DESIGN

The concept is the analysis of Brown Planthopper with color space that it use the color model to separate the parts of the brown planthopper image from the background, rice, soil and water droplets as shown in Figure 2. Subsequently, the feauter extraction method is specific characteristics of the object were Brown Planthopper, which is classification the Brown Planthopper. The system design to reduce errors while the system works and save time and cost. The structural system has divided into 5 components which are described below;

A. Input Data of Image

The data collection of rice from the Prachinburi Rice Research Center, simulated with the size of the experimental field being 10 x 5 inches and using the non-photosensitive rice variety that is RD7.

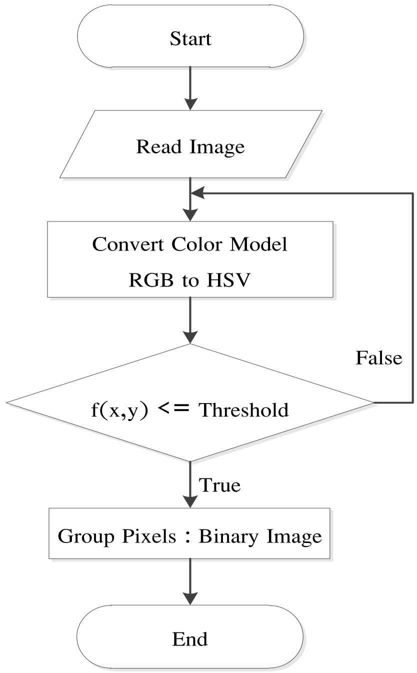


Figure 2. The Analysis of Brown Planthopper with Color Space

B. Transform a Color Model

The image is transform a color model RGB to HSV. The Hue will be analyzed for an average of gray for use as a threshold value as: (2)

$$Red_h \quad = R - \min(R,G,B)$$
$$Green_h = G - \min(R,G,B)$$
$$Blue_h \quad = B - \min\min(R,G,B)$$

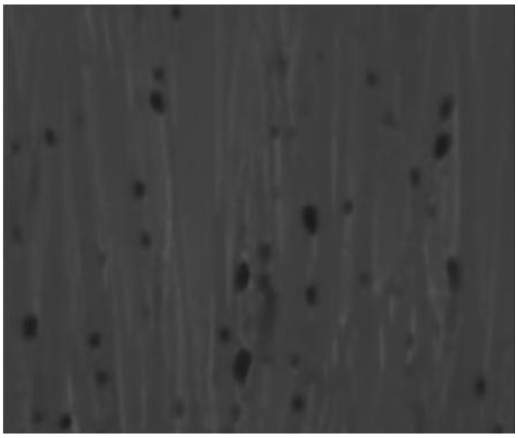
$$S = \frac{max(R,G,B) - \min(R,G,B)}{\max(R,G,B)}$$

$$V = \max(R,G,B) \qquad (2)$$

C. Image Segmentation

The separation of brown planthopper images from the background is rice, soil and water droplets that able to be calculate for finding the foreground and background variances for a single threshold from the Hue color value. The distribution of histograms into 2 groups using the Otsu algorithm, which is a method of finding variance between groups using k as the value of segmentation, k = 1 to k = 255, that can make both histograms minimum dispersion. The result will be a binary image that is considered to be a brown planthopper with a black color equal to 1, and the background or noise are white, equal to 0 as: (3)

$$\sigma^2 within\ (T) = n_D(T)\sigma^2{}_D(T) + n_B(T)\sigma^2{}_B\ (T) \qquad (3)$$



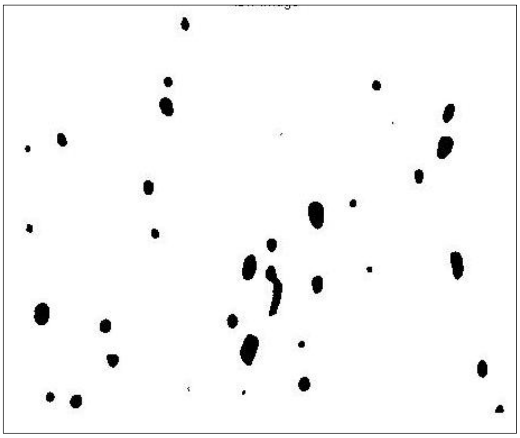


Figure 3. Image Segmentation
(a) Original, (b) Hue Color Model, (c) Binary Image

D. Features Extraction

The image feature extraction to find the distinctive features of the object in the image. The 5 features consist area, Orientation, Major Axis Length, Minor Axis Length and Eccentricity are calculated from each object and all values are used to train the modals for the corresponding image as shown in Figure 4 and Figure 5.

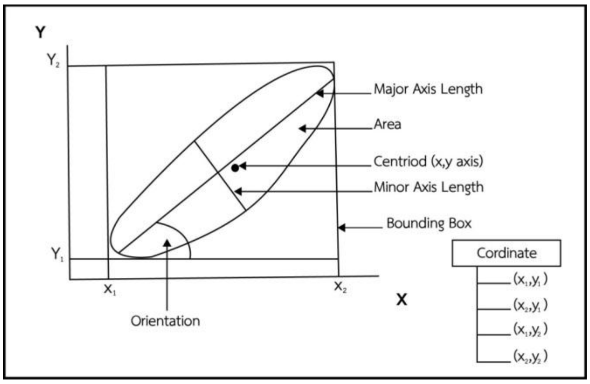


Figure 4. The Features to Find the Distinctive Features

$$Area = \pi \times a \times b$$

$$\arctan = tan^{-1}$$

when $y = \arctan x_1, -\frac{\pi}{2} < y < \frac{\pi}{2}$

$$\frac{(x-h)^2}{a^2} + \frac{(y-h)^2}{b^2} = 1$$

$$eccentricity = \frac{c}{a} \quad (4)$$

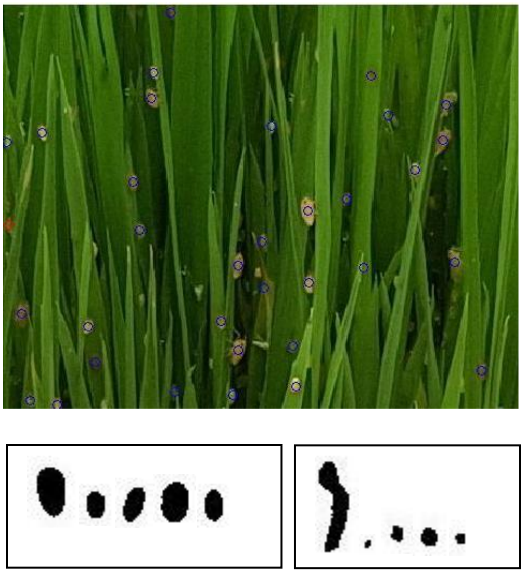


Figure 5. Example Object Separation
(a) Original, (b) The Object is BPH, (c) Other Objects

E. Classification

The Support Vector Machine (SVM) are supervised learning models with associated learning algorithms that analytical data used for classification and regression analysis which uses a linear classifier to classify data into two categories. The classifier is non-probabilistic binary linear classifier. The model form SVM training used to classify BPH which consist of 5 features that was classified into 2 classes such as BPH and Other objects.

In this paper, training and testing of analysis of Brown Planthopper 200 images from simulation rice fields were used in experiment. For the training system 120 images were used and 80 images were used testing system.

IV. EXPERIMENTAL RESULTS

In this experiment, that designed a system for analysis of Brown Planthopper with color space using the image of simulation rice fields 100 image. The image is changed from RGB to HSV that system segmented the image by threshold from Hue color value. The result will be a binary image that is object of brown planthopper and object other. After that, input various features to SVM to identify which objects are brown planthopper or other noise. The detection rates such as Accuracy Precision Recall and F-m are compared, as shown in Table I. The system can get the averaged Accuracy = 91.38%, Precision = 94.12%, Recall = 96.28, and F-m = 95.10%.

TABLE I
EXPERIMENTAL RESULTS BPH DETECT

Image	Num of BPH	BPH Detect	Accuracy (%)	Precision (%)	Recall (%)	F-m (%)
1	59	45	94.92	95.74	97.83	96.77
2	40	36	95.00	94.74	100.00	97.30
3	32	25	81.25	89.29	89.29	89.29
4	38	33	92.11	97.06	94.29	95.65
5	33	30	96.97	96.67	100.00	98.31
6	47	39	97.87	100.00	97.50	98.73
7	28	21	85.71	91.30	91.30	91.30
8	29	24	82.76	82.76	100.00	90.57
9	28	25	89.29	96.15	92.59	94.34
10	98	77	97.96	97.47	100.00	98.72
Total Average			91.38	94.12	96.28	95.10

V. CONCLUSION

This paper proposed an algorithm for detection Brown Planthopper using image processing, that used color space and five features (area, Orientation, Major Axis Length, Minor Axis Length, and Eccentricity) into SVM for classification Brown Planthopper. The system accuracy and F-m was satisfactory. Therefore, this method was better than a manual identification method, Thus saving time and labor.

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(Arranged in the order of citation in the same fashion as the case of Footnotes.)

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