Categories Leaf Healthiness using RGB Spectrum and Fuzzy Logic

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ABSTRACT

In this paper, a general approach is to classify of the green leaf healthiness. Fuzzy logic tool (FuzzyLite 3.2 software) and color features (RGB Spectrum) are used in this experiment. Mean values of primary colors (Red, Green and Blue) channels as input to FIS (Fuzzy Inference System). FIS gives decision whether this part of leaf is healthy, unhealthy or dying. Experimentation is conducted on our own dataset for determining knowledge base, consisting of 40 images of leaves for each category; 20 for training and 20 for testing. The experiment has 4 phases which were data preparation, features extraction, features selection and classification. The experimental results indicate that proposed model achieves a good average classification accuracy which are 85% healthy, 95% unhealthy and 100% dying.

Keywords: leaf, healthiness, fuzzy logic, RGB spectrum.

I   INTRODUCTION

Hundred million people in the world will not have enough food in year 2050 if a plantation production does not achieve to increases by 50% (Chakraborty & Newton, 2011). One of the factors causing the lost of plantation production is due to plant disease. The plant disease can be identified by using level of leaf severity. Leaf severity is percentage of seriousness of a leaf. For a green leaf, green color on the leaf surface slowly changes to yellow color if it has disease and then changes to red dark color if the leaf is dying. Leaf severity diseases can be divided into five category, grade 0 (apparently infection-free), grade 1 (0 – 25% leaf area infected), grade 2 (26 – 50% leaf area infected), grade 3 (51 – 75% leaf area infected), and grade 4 (>75% leaf area infected) (Horsfall & Heuberger, 1942).

Lately, the researchers measure the level of severity by calculating the area of the lesion and the leaf. These measurements of the severity level are very well accurate only for leaf has disease(Chen, 2005; Ahmad et al., 2010). However, this method cannot classify the healthy leaf and wither leaf. It is because the healthy leaf do not has the lesion on leaf surface and wither leaf has many lesions to detect or sometime do not have lesion on leaf surface. The color is important features to classify the level of healthiness and wither of the leaf.

According to Abdul et al. (2013) the level of severity can be determined using color features. A tool like Leaf Color Chart (LCC) is used manually by farmer for classifying the grade of leaf severity. However this tool has limitation on time and also inaccurate. Then the researchers overcome this problem using many computer methods such as fuzzy logic, k-mean, clustering, histogram matching, wavelet decomposition, neural networks (Dadwal & Banga, 2012; Arivazhagan, Shebiah, Ananthi, & Varthini, 2013). Besides, features color or is also important to identify the level of ripeness of the fruit such as tomato (Patil, 2011), oil palm fruit (May & Amaran, n.d.), mango (Teoh, Abu Hasan, & Sauddin Sa duddin, 2013) and pineapple (Badrul Adrul Hisham, Asnor Juraiza, Rosnah, & Wan Zuha, 2013). Those studies were conducted by using color features and fuzzy logic method.

For a leaf study such as in Guru and Mallikarjuna (2010) have used features color of green leaf in their studied. They analyzed the greenness leaf to classify three categories of tobacco leaf such as ripe, unripe and over-ripe. They only use Laplician Filter and Sobel method in their studied. However, Fuzzy logic method and color features were used in (Zhang & Zhang, 2011) and (Sannakki, Rajpurohit, Nargund, R., & Yallur, 2011) to category the green leaf into different grade but fuzzy logic just applied for measuring the area of lesion and also to find membership function and weight of the features. Other studied by (Sannakki, Rajpurohit, Nargund, & Arunkumar, 2013) not only using color features; Hue, Saturation but also use other features which is text features; constrain, energy and entropy . They only produce two grades which are healthy and unhealthy green leaf. Thus, in this study will conducting only using color features such as red channel and green channel for producing three categories grade of the leaf.

Fuzzy logic is an artificial tool that is use for uncertain problem. Fuzzy logic is suitable for analysis of color features. It is because a color features have uncertain value. In experimenting fuzzy logic, there are a few stages to be considered which

includes fuzzification, inference (knowledge base) and defuzzification.

This study is focusing on classifying the leaf into three categories. They are healthy, unhealthy disease and dying. Fuzzy logic tool was used with mean red channel value and mean green channel value to determine the three categories; healthy, unhealthy, dying of green leaf.

The organization of the paper is as follows. Section 2 describes the methodology of the study. Section 3 presents analysis of results and discussion. Conclusions and recommendations are presented in Section 4 and 5 accordingly.

II   METHODOLOGY

The research was conducted in 4 phases; Data preparation, Features extraction, Features selection and Classification.

PHASE 1: Data preparation

This phase involves two steps: convert images from JPEG or GIF to TIFF and perform data cleansing. The steps for the phase are described below.

Step 1: Convert images from JPEG or GIF to TIFF

The data used in the study were taken from www.forestryimages.org and it about 10 images (data) for testing. However, 20 data provided in are used for training. It consisted of four green color images that are in GIF and JPEG format. The images were converted to TIFF format using Microsoft Paint software. Original image is stored in JPEG, a significant change occurred during conversion from an original image to JPEG and this causes some image distortion. However, when an image is stored in TIFF, the change is very minimal. This results to a less distorted image. Therefore, images in TIFF are sharper than images in JPEG.

Step 2: Data Cleansing

The aim of this step is to remove images from noises such as dust, blurriness, and unwanted spots. This will produce sharper, smoother and cleaner images (Rajan, 2012). For this process, Gaussian technique was used. This processed was done by using ImageJ software.

PHASE 2: Feature Extraction

Feature extraction is used to obtain the required information from an image using several techniques. Feature extraction will reduce the storage size that will result to a decrease in computing time. The features that are extracted will be in the form of two color channels which are in the RGB spectrum. In this study, the image will be convert-

ed into a red channel and a green channel. From these two channels, the image will reduce the number of colors to one. Each pixel in the red and green channels will have a value in the range of 0 to 255. The conversion was done by using ImageJ software.

PHASE 3: Feature Selection

In this section, each item of data that been extracted will be analyzed to meet the needs of this project. Each pixel will contain data of RGB space and each color component will be in the range of [1 255]. Therefore, a specific range will be a target to obtain a specific color. The colors of interest will be the red and green color. The specific range of the red channel will be [1 100] and the range for green channel will also be [1 100]. Blue channel will be ignored as it not containing information needed. The mean values of red and green channel layers are calculated using the following equations:

$$Mean\ R = R\ /\ No.\ of\ pixels\ Mean$$

$$Mean\ G = G\ /\ No.\ of\ pixels\ Mean$$

Where
Mean R = Mean value of Red layer
Mean G = Mean value of Green layer
R = Red pixel
G = Green pixel

After the value for red and green have been collected from an image, the value will be used for classification using fuzzy logic. This will be explained in the next section.

PHASE 4: Classification

In this phase, fuzzy logic will be used to categorize each parameter from the feature extraction to produce an output. For classification, color features from 40 images of each category were used to develop a database and 20 of each category images as training and 20 for testing images.
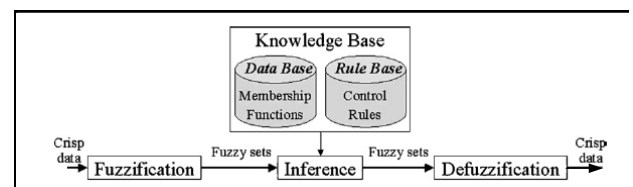

Figure 1. Components fuzzy logic control

Components for classification in this fuzzy logic are illustrated in Figure 1. Membership functions are used to transform crisp inputs into fuzzy sets in the process of fuzzification and fuzzy sets back into crisp outputs in the process of defuzzification. The fuzzy logic control incorporates human knowledge into their knowledge base through

fuzzy rules and fuzzy membership functions for classification process.

After getting color mean value red and green channel in phase 3, the knowledge base (membership function and rules function) had been developed. Membership functions for each two (red and green) colors channel were 3 (min, medium, max). The numbers of rules were 9 and the numbers of decisions for the output were 3 (healthy, unhealthy and dying). The rules were developed based on the healthiness of the leaf level. The examples of rules are illustrated as follows:

1. If (red is low) and (green is low) then (categories is dying leaf)

2. If (red is low) and (green is high) then (categories is healthy leaf)

3. If (red is medium) and (green is medium) then (categories is unhealthy leaf)

4. If (red is high) and (green is low) then (categories is dying leaf)

Mamdani type and A triangular membership function was used for the inputs and also for the output membership function. The two inputs for fuzzification were the number of green pixels and the number of red pixels respectively. For the defuzzification of the output value, the centroid method was used. The fuzzy logic classification was developed by using FuzzyLite 3.2 Toolbox. The rules input and output viewer from FuzzyLite 3.2 Toolbox is shown in Figure 2.
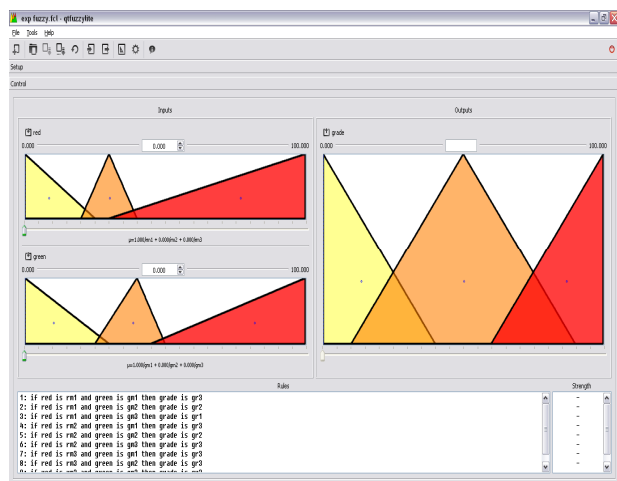

Figure 2. Membership function of input and output

III   RESULTS AND DISCUSSION

Figure 3 show the mean value for the pixel counters corresponding to the red and green channel

from the RGB spectrum color according to the respective levels of leaf healthiness. The result shows that there are slight differences for all grades level. For healthy and unhealthy green leaf, green channel is greater than red channel, but the differences between healthy and unhealthy are the difference value between red and green channel. If difference value between red and green channel value are more than 20, the leaf is in healthy. However, if difference value between red and green channel value are less than 10, the leaf is in unhealthy category. Leaf is in dying category if red channel is greater value than green value.
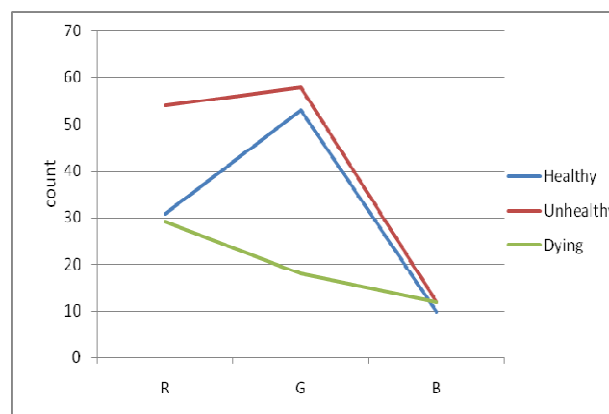

Figure 3. Mean value for each healthiness level

The result indicates an average accuracy for leaf healthiness of 93.33 % respectively. The highest accuracy achieved is for the fully healthiness classification where all images of the leaf tested show a result choose one of category if range between 0.55 and 1.0. Table 1 summaries the classification result using fuzzy logic which shows that using only one features colors, namely RGB has proved that all three healthiness levels are able to achieve a high precision of 100% for dying, 95 % for unhealthy and 85% accuracy for healthy.

Table 1. Fuzzy Logic Result

Healthiness	Number of test Images	Result	Accuracy
Healthy	20	17/20	85%
Unhealthy	20	19/20	95%
Dying	20	20/20	100%

IV   CONCLUSIONS

In this paper, an image processing technique has been developed to extract the required information to classify green leaf into three major groups of healthiness, namely healthy, unhealthy and dying. The data leaf images obtained for the classification shows that the healthy achieve 85% accuracy and unhealthy achieve 95 % accuracy and for the dying group the accuracy is 100 %. In conclusion, the image processing technique combined with

fuzzy logic classification is more than able to differentiate three major group of leaf healthiness.

V   RECOMMENDATIONS

Further experiments will be conducted to identify other artificial tool to improve accuracy of group healthy.

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