An Algorithm for Plant Diseases Detection Based on Color Features

MOSBAH EL SGHAIR
John Naisbitt University
Graduate School of Computer Sci.
Bulevar umetnosti 29, Belgrade
SERBIA
musbah.bellid@gmail.com

RAKA JOVANOVIC
Hamad bin Khalifa University
Qatar Env. and Energy Research Inst.
PO Box 5825, Doha
QATAR
rjovanovic@qf.org.qa

MILAN TUBA
John Naisbitt University
Graduate School of Computer Sci.
Bulevar umetnosti 29, Belgrade
SERBIA
tuba@ieee.org

Abstract: Digital images enabled great improvements in many different areas and biology and agriculture are some of them. Plant diseases detection and classification is very important task and further more automatic detection of plant diseases is an important analysis topic because it could help in observation of giant fields of crops, and therefore mechanically find the symptoms of diseases as shortly as they appear on the plant leaves. In this paper we proposed an algorithm for automatic detection of plant leaf diseases. The proposed method consists of several steps including median filter, thresholding, and uses of different color models for segmentation. Our proposed method provides quicker and more accurate detection and classification compared to other state-of-art.

Key–Words: CIELAB, HSI, YCbCr, Plant leaf disease detection, Image processing

1 Introduction

Digital images became part of everyday life. Digital image processing and analysis represents a rather popular scientific research topic. It was used in many different fields such as astronomy [1], biology [2], medicine [3], [4], etc. One of the areas where digital image analysis brought a great benefits is agriculture.

Plant diseases have become an important issue because they cause important reduction in each quality and amount of agricultural products. It was calculated that in 2007 in Georgia, USA losses due the plant disease was close to $539.74 million where around 185 million USD was spent on finding the diseases, and also the rest is that the worth of harm caused by the diseases. The eye observation of specialists is that the main approach adopted in apply for detection and identification of plant diseases. However, this needs continuous observation of specialists which could be prohibitively big-ticket in giant farms. Further, in some developing countries, farmers could have to be compelled to go long distances to contact specialists, this makes consulting specialists too big-ticket and time intense. Automatic detection of plant diseases is an important analysis topic because it could prove edges in observation giant fields of crops, and therefore mechanically find the symptoms of diseases as shortly as they seem on plant leaves. Therefore, searching for quick, automatic, more cost-effective and correct technique to find disease cases is of great significance. Machine learning primarily based detection and recognition of plant diseases will offer clues to spot and treat the diseases in its early stages. Relatively, visually distinguishing plant diseases is inefficient and troublesome. Also, it needs the experience of trained plant scientist. Some researchers have used image processing techniques for quick and correct detection of plant diseases. The accuracy of result depends on technique used for disease spot detection. The biggest obstacle in disease spot detection is noise, that is introduced by camera flash, modification in illumination, droning background and presence of vein within the plant leaf. Thus a technique that wipes out the noise and provides higher disease spot segmentation is required.

Kurniawati et al [5] introduced a technique for detection and classification of paddy disease. Otsu threshold method was employed for disease spot detection and unessential spots are removed by median filter. In [6] the tactics of image pre-processing for detection the diseases was studied.

Veins color is the same as plant leaf color solely intensity differs. On the opposite hand, disease spot color is totally different from plant leaf color. Thus first if image is reworked from device dependent color area to device separate color aperture and threshold is applied on color element, one might improve detection of disease spot. Some researchers first convert RGB image into HSI model and then apply threshold on H element for segmenting infected areas from plant leaves. Cui et al. in [7] developed a quick man-

Figure 1: Examples of a plant stem that are infected with white mold disease

ual threshold-setting technique supported HSI color model to section the disease spot. Kai et al. in [8] convert RGB image into YCbCr color aperture to discover the disease spot. In this paper the impact of YC_bC_r, HSI and CIELAB color area within the method of disease spot detection are compared. Experiments were carried upon various families plant leaves with each noise free (white) and clamorous background to induce the strategy that is individual of background signal and plant sort.

In this paper median filter is used for image smoothing. Threshold technique is employed to convert filtered image into binary image Mistreatment on top of techniques disease spot is detected in totally different plants, during which largely veins are parallel and fewer visible.

This paper is organized in four sections. Methodology and our proposed algorithm are defined in Section 2 Experimental results are showed in Section 3. Conclusion of the paper is given in the last section.

2 Methodology

The flow chart in Fig. 2 shows the steps of an algorithm for the leaf disease detection. All the images in compilation are in JPEG format. These images are color convert from RGB image to at least one of the color area named by YC_bC_r, HIS and CIELAB color areas. The color converted images are gone through median filter to get rid of spare spots. In the last step Otsu threshold is applied on RGB image, A element of CIELAB color area, H element of HSI color area and C_r element of YC_bC_r color area is employed to discover the disease spot. The disease spot divided images, obtained by all the three strategies are compared to induce the most effective methodology for disease spot detection.

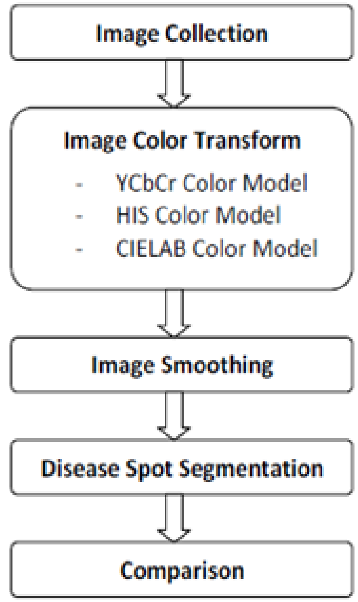

Figure 2: Flow chart for plant disease detection

In plants, leaf vein is totally different in intensity and disease spot is different in color, as compared to plant leaf. Therefore if Otsu threshold is applied on grayscale image, vein will be gift in binary image with the disease spot. However the region of interest is simply disease spots, not vein. For minimize the effect of presence of vein, RGB image might be color reworked before segmentation. once then Otsu threshold are often applied on color element to discover disease spot accurately. during this paper 3 color models are compared.

This color model is wide employed in digital video. In YCbCr color model, Y indicates brightness level element and C_b, C_r indicates color element. Cb is that the distinction between the blue elements and Cr is that the distinction between the red elements [4] [13]. Using following formulas RGB image is reworked into YC_bC_r color model.

$$\begin{aligned} Y &= 0.299 * R + 0.587 * G + 0.114 * B \\ C_b &= -0.168 * R - 0.331 * G + 0.500 * B \\ C_r &= 0.500 * R - 0.418 * G - 0.081 * B \end{aligned} \quad (1)$$

Color model HSI is device dependent color model and primarily based upon human color perception. during this color model H indicates hue, that describes a pure color and is mostly associated with the wavelength of light. Component S indicates saturation, that measures the colorfulness in HSI color Model. I indicates intensity, that shows the amplitude of the light.

$$H = \begin{cases} A_{CF}(1) & \text{if } f(X_{CF}(t)) = f(X_{CF}(t-1)), \\ C_r A_{CF}(t-1) & \text{if } f(X_{CF}(t)) = f(X_{CF}(t-1)), \\ C_a A_{CF}(t-1) & \text{if } f(X_{CF}(t)) < f(X_{CF}(t-1)) \end{cases}$$

$$S = cos^{-1}\{\frac{\frac{1}{2}[(R-G)+(R-B)]}{[(R-G)^2+(R-B)(G-B)]^{1/2}}\}$$

$$I = \frac{1}{3}(R+G+B) \quad (2)$$

CIELAB system is device freelance that is outlined by the CIE to classify color consistent with the human vision. Within the conversion method of an image from RGB color element to CIELAB color element, first RGB image is transform into CIEXYZ by the following equation:

$$\begin{aligned} X &= 0.4124 * R + 0.3576 * G + 0.1805 * B \\ Y &= -0.2126 * R + 0.7152 * G + 0.7220 * B \\ Z &= 0.0193 * R + 0.1192 * G + 0.9505 * B \end{aligned} \quad (3)$$

Brightness and color data of research lab color model is independent of every different. In CIELAB color model, L describes color brightness, A describes the color starting from green to red while B describes the color starting from blue to yellow. Conversion formula for research laboratory color model is defined by the following equation:

2.1 Image Smoothing

During image assortment, some noise is also introduced due to camera flash. This noise might have an effect on the detection of disease. To remove unneeded spot, Image smoothing technique is required. During this paper median filter is employed for this purpose.

Median filter may be a higher order statistics filter. Median filter is nonlinear in nature, that replaces the worth of the central pixel by the median of the gray levels within the image area surrounded by the filter. The median of a numerical assortment is specified half the values in assortment area unit but or adequate median, and half area unit larger than or adequate median.

So as to perform median filtering, first window is rapt and every one the pixels enclosed by the window area unit shorted. Once then median is computed and this worth is assigned to center pixel. If the amount of components in K*K window is odd, middle value is assigned as average, else average of two middle values is assigned as average.

2.2 Disease Spot Segmentation

After image smoothing, a method to observe the disease spot is required. It is necessary to pick out a threshold of grey level for extract the disease spot from plant leaf. If the histogram has sharp and deep depression between two peaks, bottom of the depression may be chosen as threshold. However drawback happens once depression is flat and broad. In this case this method can not be accustomed separate objects from background. Therefore, Otsu technique is used during this paper to automatically choose the best threshold value. In Otsu methodology, the pixels area unit separated into two categories C (background and object), employing a threshold at level K. When then category means that (μ_0, μ_1) and sophistication variances (σ_B, σ_W) area unit calculated. Then a threshold K is searched, that maximizes one among the article functions (l, k, n).

$$l = \frac{\sigma_B^2}{\sigma_W^2}; \qquad k = \frac{\sigma_\tau^2}{\sigma_W^2}; \qquad n = \frac{\sigma_B^2}{\sigma_\tau^2} \quad (4)$$

3 Experimental results

In this paper, images of rice, corn, wheat, iris, cotton, soybean, mustard, magnolia, apple and cherry leaf are used to search out the most effective technique for disease spot detection, that is not suffering from background and kind of plant leaf. Four strategies are discussed during this paper.

In this paper, first was experimented with images in RGB model. Disease spots are divided by applying Otsu threshold on RGB image. In Fig. 3 are shown experimental results. As it can be seen, diseases were mostly discovered, but not completely correct.

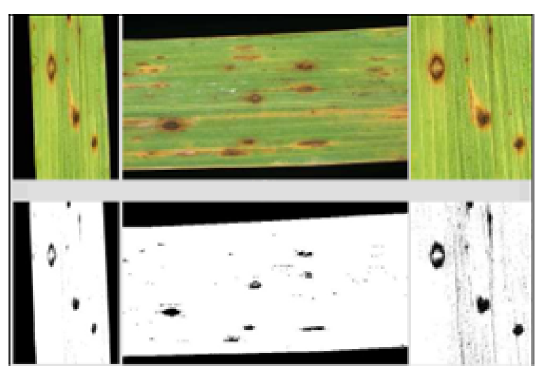

Figure 3: Plant diseases detection in RGB image

To improve detection further experiments were done. In second technique RGB image is initial regenerate into YC_bC_r color model by using color transform formula previously described. Then median filter is employed for image smoothing. Disease spots are detected by applying Otsu threshold on C_r component of filtered YC_bC_r color image. Experimental results are shown in Fig. 4. Diseases were more precise detected in this case comparing to the detection in RGB model.

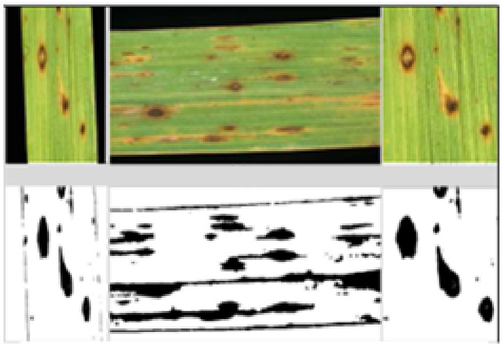

Figure 4: Plant diseases detection using YC_bC_r color model

In next experiment RGB image was transformed into HSI color model and disease spots were detected like before by applying Otsu threshold but on H component of filtered HSI color area. Detections of plant diseases by our proposed method by HSI color model are shown in Fig. 5.

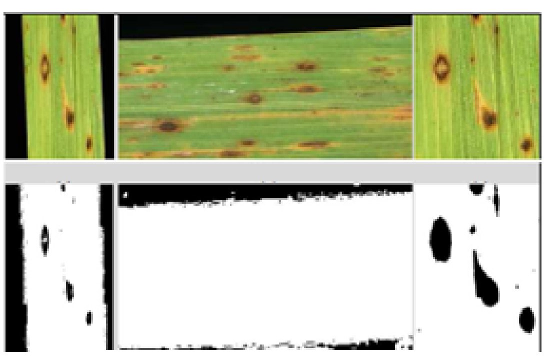

Figure 5: Plant diseases detection using HSI color model

Once more the same algorithm was used but with CIELAB color model. Disease spots are segmental by applying Otsu threshold on component A of filtered laboratory color area and the results are presented in Fig. 6.

As mentioned before, noise can be introduced as a result of camera flash, droning background and veins in plant leaf. So as to search out the most effective technique among these four strategies, analysis is

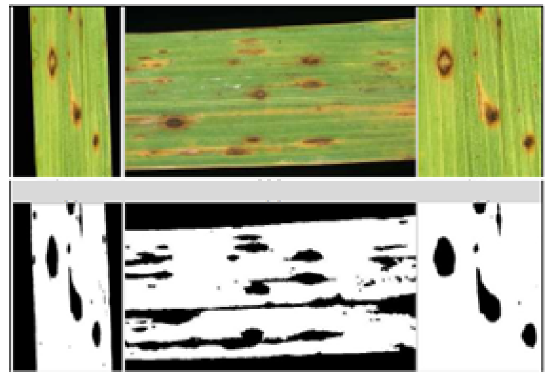

Figure 6: Plant diseases detection using $CIELAB$ color model

classified into three elements. Through these results we are able to conclude that:

- Using threshold on RGB image disease spot might not be detected accurately.
- Using threshold on H element of HSI color model and C_r element of YC_bC_r color model, disease spots may be detected in some cases however not altogether. Therefore, results are addicted to sort of background.
- Results show that exploitation threshold on A component of CIELAB color model altogether cases disease spots are detected accurately and results are freelance of background.

Next, experiments included images of plants such as cotton, soybean, mustard, magnolia, apple and cherry. In these noise is introduced as a result of longer and thicker veins. Experimental results for disease spot detection of some of named leafs suffering from different diseases are shown in Fig. 7. In the first column are results for blueberry, in the second soybean and in the third column are results for cotton leaf. In the first row are the original images. In the second row are shown results of our proposed method by using RGB color model, in the third YC_bC_r model, in the forth row are shown detection when HSI color model was used and at the last, fifth row are results for CIELAB color model.

Based on this results, it can be concluded that:

- Exploitation threshold on RGB image neither disease spot is not detected nor disturbance due to vein is eliminated.
- Using threshold on Cr element of YCbCr color model, some disease spots area unit detected effectively, however disturbance due to vein is

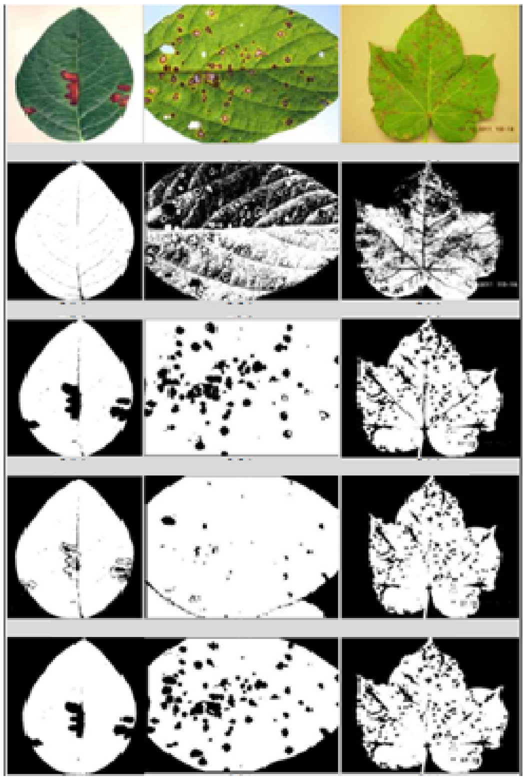

Figure 7: Diseases detection on blueberry, soybean and cotton leaf

present in result. Therefore, results depend upon sort of leaf and vein.

- Using threshold on H element of HSI color model solely few disease spots might be detected. Disturbance due to vein is additionally present in some cases. Therefore, results depend upon sort of leaf and background.

- Using threshold on A element of CIELAB color model disease spots may be detected accurately altogether.Cases Experiments show that results are freelance of sort of plant leaf.

Till currently it might be all over that using CIELAB color remodel noise is removed effectively, that is generated due to background, camera flash and veins. This technique is additionally checked with completely different colored disease spots and results are shown in Fig. 8.

Result shows that completely different colored disease spots like black, brown, grey and white colored disease brown, grey and white colored disease spots might be detected accurately using CIELAB color model. In some cases as a result of matter deficiency and imbalance pigment formation, vein is dissent in color in comparison to plant leaf. In these cases disease spots cant be detected accurately using this technique.

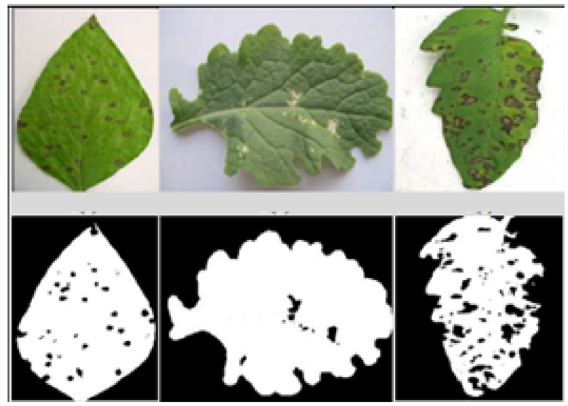

Figure 8: Diseases detection on images with noisy background

4 Conclusion

In this paper a method based on different color models and Otsu thresholding for plant diseases detection was proposed. During this paper YCbCr, HSI and CIELAB color models area unit studied. of these color models area unit compared and eventually A element of CIELAB color model is used. Color reworked image is competent median filter. In last, disease spots area unit metameric by applying Otsu threshold on A element of science laboratory color area. Experimental result shows that noise that is introduced due to background, vein and camera flash may be exhausted exploitation CIELAB color model (Method 4). Following this technique totally different disease spots are detected accurately and results do not seem to be laid low with background, sort of leaf, type of disease spot and camera. additional to the current it is required to calculate disease spot space for assessment of loss in agriculture crop. Disease may be classified by calculative dimensions of disease spot. During this work veins having color like the spot is not thought of. Additional work have to be compelled to be dispensed in those lines additionally.

Acknowledgments: This research is supported by Ministry of Education, Science and Technological Development of Republic of Serbia, Grant No. III-44006.

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