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STUDY OF IMAGE PREPROCESSING AND PIXEL IDENTIFICATION FOR CITRUS LEAF DISEASED PORTION

PARMAR D. K[1], KATHIRIYA D.R[2]

[1]Research Scholar, Rai University, Ahmedabad, Gujarat, India
Anand Agricultural University, Aannd (Assistant Professor)
[2]Research Supervisor, Rai University, Ahmedabad, Gujarat, India
Anand Agricultural University, Aannd (Professor)

ABSTRACT

visually estimation of disease and use of camera or other imaging technologies (like scanner) to map disease can be counted as remote sensing. Here presents a study on methods that use digital image processing techniques to detect plant diseases from digital images. While disease symptoms can visible in any part of the plant, only methods that explore visible symptoms in leaves are to be considered. Because disease can be present at roots, seeds and fruits also and that will require a separate study. The selected proposal is only talking about detection and severity of diseases. This paper is projected to be useful to researchers working both on plant pathology and image processing specially for object/pattern recognition, giving an ample and accessible indication of this important field of research. This is also considered for reduction of environmental pollution and for environmental safety.

Keywords-Processing of Image, Pixel Identification, HSI, RGB, Image threshold

INTRODUCTION

Most diseases, conversely, generate some kind of symptom that is visible. In the huge majority of the cases, the disease identification function is done visually by humans. Skilled persons can be proficient in identifying diseases, but they have associated some disadvantages that may problematic the efforts in many cases [1]. [2] has given some of the drawbacks are as under:

- The skilled persons are in some impression and forgot to continue with diseased leaves.
- No any standard for area measurement is available for disease measurement.
- When the samples are collected and if later analyzed in the laboratory then some samples might be destructed.
- Among the person and inter person measurement are subjectively differs.
- Educating the skilled persons is required.
- It is expensive also.
- They got tired and can't concentrate so the accuracy will be decreased.
- For rural area the skilled persons are not always available.
- No one person is 100% accurate for every plant so more personnel are required.

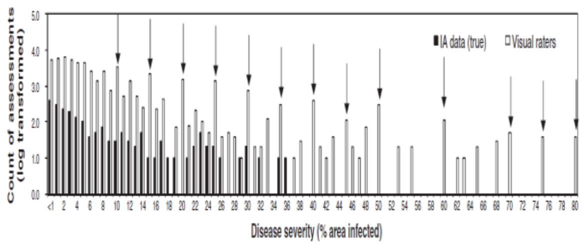


Figure 1. The frequency of preferred values with twenty-eight skilled persons assessing 200 leaves for the percent area infected bycitrus canker. Arrows mark when the severity measurement deviates greater than 10% (after Bock et al., 2008b).

Due to disease there is loss in photosynthetic area and fruit quality and decreases fruit price. Disease assessment is important to various aspects of studying plant disease and other plant pathogens. Good-quality disease evaluation data is needed to make suitable decisions in disease management, compare treatments, observe epidemic progress, and measure cultivar resistance in plant breeding. [2]

Disease severity called the proportion (in percentage (%)) of the leaf area having visual disease symptoms. Now the disease-percent area infected is being anticipated, it is enviable to ensure the estimate is in close concurrence with the true disease. Previous studies presents visual (by eyes) assessment of disease severity is error-prone. Bock and others used image analysis to measure correct values on a leaf-by-leaf basis to find error in visual measurement of citrus canker by comparing the data with measurement by skilled persons. Image analysis, which offers an objective way of assessing disease severity, can be automated and has been used in various pathosystems to quantify disease. [2]

There are number of image analysis systems have been used over last several years of studies. Computerization saves time, allowing many images to be processed at a time. With image analysis, in some cases have found that automated systems provides measurements with good agreement to correct values. However, all the time it is not true and some examples of image analysis are not so accurate. This is due to restrictions in the software used, the lighting, and/or the setting of thresholds for recognizing symptoms on particular leaves. Leaves can vary in color due to available variety, growing environment, or ambient lighting conditions at the time of image acquisition called illumination. The differences among images can be found with automated image analysis by using various algorithms, and maybe by image preparation or processing to improve consistency, so providing more precise and accurate measurements of disease severity [2].The main goal objective of this research is to use image analysis, to determine the distinctiveness of automated, high performance assessment of diseased plant leaves compared to visual assessment. Inherent in this goal is to determine any benefit to be gained in objectivity, uniformity, or time taken among methods. [2]

MATERIALS AND METHODS

Collection of leaves and image acquisition

First of all decide how many samples you want to collect for analysis. Leaves should be selected randomly to reflect the frequency and range of disease severity at the time. The time of plucking leaves should also different because leaves photographed under different ambient light. Sometimes the light conditions are not proper so we have to use the artificial light conditions like bulbs or tube lights. But try to capture the photos at day time. Finally the leaves should be sampled arbitrarily from survey bags and photographed under the same conditions. Sometimes incomplete leaves, or leaves exaggerated by symptoms of other diseases (not desired) would not be used.

After collection of leaves they will be photographed using either a digital camera or a flat bed scanner. I will use any standard digital camera of a good and well known company like SONY, SAMSUNG, NIKON etc. Standardize the Image size mostly from 2'X2' to 4'X4'. The image size is not fixed as the leaf size differ it differs simultaneously. All leaf images should be assessed for area and for diseased percent area. Also consult the plant pathologists for verification the working of the software. All image analysis measurements would be taken by an individual trained in the use of the image analysis software and familiar with disease symptoms. The specification of the camera and scanner is given below:

Table1. Scanner Specifications

SCANNER SPECIFICATIONS		
SCANNING ELEMENT	CMOS CIS	
LIGHT SOURCE	LED (red, green and blue) (CR-190iUV: LED and UV)	
SCANNING MODES	Black and White, Fine Text Filtering, Error Diffusion	
	Grayscale:	256-level, 16-level
SCANNING RESOLUTIONS	100 x 100dpi, 120 x 120dpi, 150 x 150dpi, 200 x 200dpi, 240 x 240dpi, 300 x 300dpi	
SCANNING SPEEDS (U.S. CHECKS,	CR-190i:	190cpm*1
	CR-	190cpm*1

200DPI, ALL MODE)	190iUV:	160cpm (UV scan mode)
MICR / OCR	MICR:	E13B / CMC-7
	OCR:	E13B / OCR-A / OCR-B / Check Writer / Universal Character
OS	Windows XP (32 bits / 64 bits), Windows Vista (32 bits / 64 bits), Windows 7 (32 bits / 64 bits), Windows 8 (32 bits / 64 bits)	
INTERFACE	Hi-Speed USB 2.0	
POWER REQUIREMENTS	AC220 - 240V (50 / 60Hz)	
POWER CONSUMPTION	CR-190i:	Less than 52.8W Sleep Mode: Less than 4.7W
	CR-190iUV:	Less than 47.1W Sleep Mode: Less than 3.8W

Table2. Camera Specifications

CAMERA SPECIFICATIONS	
SPECIAL FEATURES	**Tag & Go (NFC/Wi-Fi)** Photo Beam, AutoShare, Remote View Finder, Mobile Link, **SMART Mode** Landscape, Action Freeze, Silhouette, Sunset, Fireworks, Light Trace, Beauty Face, Night, Macro, Photo/Video Filter, Live Panorama
IMAGE SENSOR	**EFFECTIVE PIXEL** Approx. 16.2 Mega pixels **TOTAL PIXEL** Approx. 16.6 Mega pixels **IMAGE SENSOR TYPE** 1/2.3" (Approx. 7.76mm) CCD
LENS	**TYPE** 24mm Wide Angle, F3.1(W) ~ 6.3(T) **OPTICAL ZOOM** 12X Optical Zoom **DIGITAL ZOOM** Still Image mode : 1.0X ~ 2.0X (Optical * Digital : 24x), Intelli-Zoom : 2.0X (Optical * intelli :24X) **FOCAL LENGTH** Samsung 12x Zoom Lens f = 4.3 ~ 51.6mm (35mm film equivalent : 24~288 mm)
SHUTTER SPEED	**RANGE** Smart Auto : 1/8 ~ 1/2,000 sec., Program : 1 ~ 1/2,000 sec., Night : 8 ~ 1/2,000 sec., Fireworks : 2 sec.
EXPOSURE	**CONTROL** Program AE **ISO EQUIVALENT** Auto, 80, 100, 200, 400, 800, 1600, 3200 **METERING SYSTEM** Metering : Multi, Spot, Center-weighted, Face Detection AE, * Metering Range : EV 2~17 (Wide, ISO Auto), EV 4~19 (Tele, ISO Auto)
FOCUSING	**MODES** Type : TTL Auto Focus (Center AF, Multi AF, Tracking AF, Face Detection AF), Video Continuous Auto Focus RANGE Normal : 80cm ~ Infinity (Wide), 250cm ~ Infinity (Tele) Macro : 5cm ~ 80cm (Wide), 130cm ~ 250cm (Tele) Auto Macro : 5cm ~ Infinity (Wide), 130cm ~ Infinity (Tele)
FLASH	**MODES** Auto, Auto & Red-eye reduction, Fill-in flash, Slow sync, Flash Off, Red-eye fix
IMAGE STABILIZATION	OPTICAL IMAGE STABILIZATION
WHITE BALANCE	**MODES** Auto WB, Daylight, Cloudy, Fluorescent_H, Fluorescent_L,

	Tungsten, Custom, K
STORAGE	**FILE FORMAT** Still Image : JPEG (DCF), EXIF 2.3, GIF Movie Clip : MP4(H.264), Audio : AAC
	IMAGE SIZE 16 M: 4,608 x 3,456 / 14 MP: 4,608 x 3,072 / 12 MW: 4,608 x 2,592 / 10 M: 3,648 x 2,736 / 5 M: 2,592 x 1,944 / 3 M: 1,984 x 1,488 / 2 MW: 1920 x 1080 / 1 M: 1,024 x 768
	INTERNAL MEMORY Approx 30MB Internal memory capacity may not match these specifications.
	EXTERNAL MEMORY (OPTIONAL) micro SD™ (2GB guaranteed), micro SDHC (up to 32GB guaranteed), micro SDXC (up to 64GB guaranteed) * Class 6 and above recommended
STILL IMAGE	**EDIT** Mode : *Smart Auto, Program, *Smart mode, Photo Filter, Live Panorama * Smart Mode : Landscape, Action Freeze, Silhouette, Sunset, Fireworks, Light Trace, Beauty Face, Night, Macro * Smart Auto: Portrait, Night Portrait, Night, Backlight Portrait, Backlight, Landscape, White, Macro, Macro Text, Tripod, Action, Macro Color, Natural Green, Blue Sky, Sunset Sky, Lowlight, Spotlight, Spotlight(Macro), Spotlight(Portrait) * Continuous: Single, Continuous, Motion Capture, AEB * Photo Filter : Miniature, Vignetting, Cross Filter, Fish Eye, Classic, Retro * Self timer: Off, 10 sec., 2 sec., Double(10 sec., 2 sec.) * Edit : Rotate, Smart Filter, Brightness, Contrast, Saturation, ACB, Face Retouch, Red-eye Fix, Resize, Trimming
POWER	**DC POWER INPUT** 5.0V
	POWER SOURCE Rechargeable battery : BP70A Connector Type : micro USB (5 pin)
	BATTERY BP70A
SYSTEM REQUIREMENTS	**WINDOWS** Power Mac G3 or later Mac OS 10.5 or higher Minimum 256MB RAM 110MB of available hard-disk space USB port CD-ROM drive

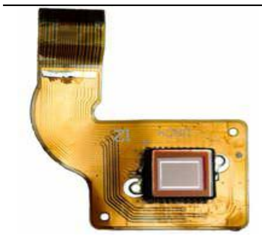
Several digital images are taken using visible light as the energy source; the advantage of being safe, cheap and easily processed with relevant hardware. For production of digital images, two methods are very popular, one is Digital camera and other is with Flat-bed Scanner. Usually, the image acquisition phase involves preprocessing, such as scaling.

Digital cameras have a lens, an LCD / LED display, and a light responsive screen (like retina in human eye) where the light from the image comes. The screen has a bunch of photo sensors that measures the concentration of the incoming light. The screen types are of two types. The CCD (charge coupled device) and the CMOS (complementary metal oxide semiconductor) presented in figure 2.

Processing of Image

After image acquisition, it can be edited in a range of ways in a lot of different image study and image processing software. Color and contrast can be managed, images smoothed, rotated, sharpened, flipped or more manipulated. Programs like Adobe Photoshop are influential software that tenders many options for enhancing images. Most image analysis software offers image expurgation and alteration including enhancing boundaries and geometric modifications.

Table3. Comparison of CCD and CMOS technology

CCD	CMOS
	
More expensive	Cheaper
Noise - Less	Noise – More
Slower for capture	Faster for capture
Generate Analog output so Analog to Digital conversion is required.	Directly generate output in Digital form so no any conversion is required.
Complexity of system - High	Complexity of system – Low

Now for color images the image is made of three colors and every pixel in the image has a specific value for each of the main colors Red, Green and Blue based on the RGB model. From these three basic colors we can generate any color and that is explained in the figure. The each pixel color is denoted by Hue, Saturation and Intensity (HSI). Pure color of the pixel is equal to Hue; the amount of the color pixel is saturation, and the intensity of the pixel that is related to its brightness.

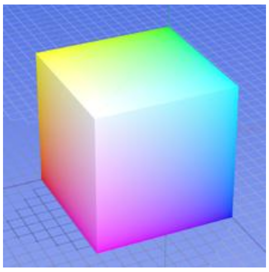


Figure 2.
The RGB color model mapped to a cube. The horizontal x-axis as red values increasing to the left, y-axis as blue increasing to the lower right and the vertical z-axis as green increasing towards the top. The origin, black, is the vertex hidden from view. [8]

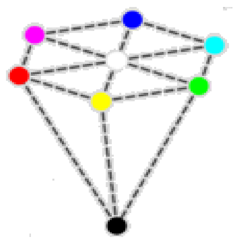


Figure 3.
The hue is the pure color; when we want to make color more vivid we have to increase the saturation. by increasing intensity will make the colorbrighter without affecting the color or saturation. Saturation and Hue are themost generally used phenomenon for distinguishing leaves and diseased areas. [7]

Here I have presented an image of a citrus diseased leaf and separated the RGB channel as well as HSI channels.

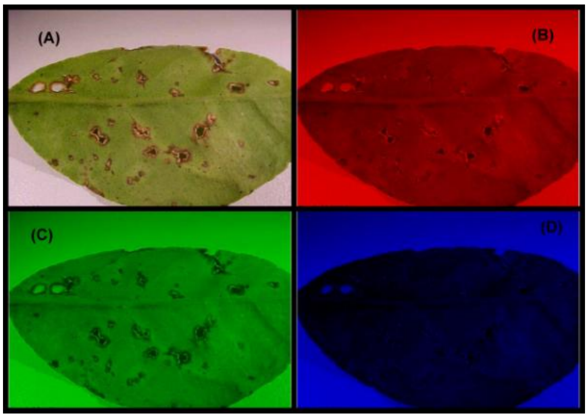


Figure 4. Here an original image (A). (B)ispresenting only Red component. (C) is presenting only Green component. (D) is presenting only Blue component.

Code = red = img(:,:,1);green = img(:,:,2);blue = img(:,:,3);

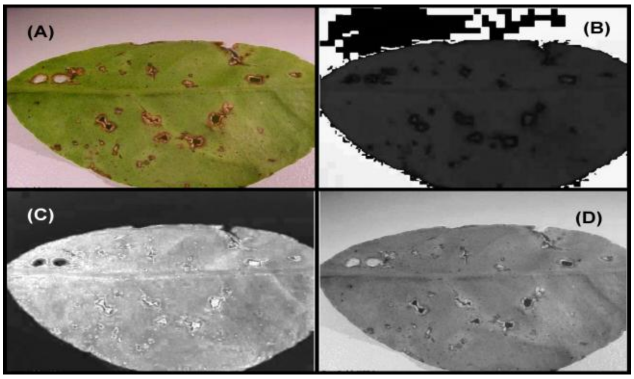


Figure 5. Here an original image (A). (B)ispresenting only Hue component. (C) is presenting only Saturation component. (D) is presenting only Intensity component.

The action of separating areas of interest (Region of interest) by using this fundamental is called segmentation. After removal of the background the hue and intensity part are best suitable for finding the dots and diseased portion if the image. (Lamari, 2002; Steddom et al., 2005b). [3]

Pixel Identification

Leaf image will be captured using digital camera. Here, the leaf image will be captured in white background and that is fixed. The image will be converted to matrix that contains RGB value of every pixel. Now for identification background, leaf and diseased portion we have to classify each and every pixel in the image. One thing is to remember that restrict the image of minimal size and don't add more background in the image as well. Now for background pixel we have to find the intensity of red, green and blue color, in one example they have taken above 130, as defined like:

```
if(min(r, g, b) >=130
then
        is_equal_to_bg
else
        is_equal_to_else
```

If the pixel is not a background, it will be examined again to be classified as diseased pixel or as a leaf pixel. First we will see for diseased pixel:

```
if r>g && r>b
then
is_equal_to_yellow
else
is_equal_to_else
```

Just like this for green pixel we have to analyze the surrounding pixels of green color and then we will justify. By these ways we can bifurcate the three classes of the pixels.

Now I have collected some of the citrus diseases and shown in the table that how different disease spots have RGB and HIS values. [4]

Table4. RGB and HIS values of various citrus diseased portions in leaves

	R	G	B	H	S	I
	38	26	4	26	194	20
	87	50	24	17	136	52
	132	87	0	26	240	62
	147	88	46	17	126	91
	197	132	92	15	114	136
	228	224	187	36	104	195

RGB and HSI values of various citrus diseased portions in leaves

Now I have listed various yellow and nearby colors and presented with chart so easily human being can identify with their eyes. They are considered as visual symptoms of the disease.

Figure 6. Various shades of diseased pixels extracted from table 2

RESULTS AND DISCUSSION

Grayscale image

In Grayscale images we are eliminating the hue and saturation information while retaining theluminance.8 bit color format is one of the most famous image format. It has 256 different shades of colors in it. It is commonly known as Grayscale image. The range of the colors in 8 bit varies from 0-255. Where 0 stands for black, and 255 stands for white, and 127 stands for gray color. Now as per weighted method or luminosity method, we have to decrease the contribution of red color, and increase the contribution of the green color, and put blue color contribution in between these two. So the new equation is:

New grayscale image =
$(0.3 * R) + (0.59 * G) + (0.11 * B)$.

Vol.3., Issue.4., 2015
(July-Aug)

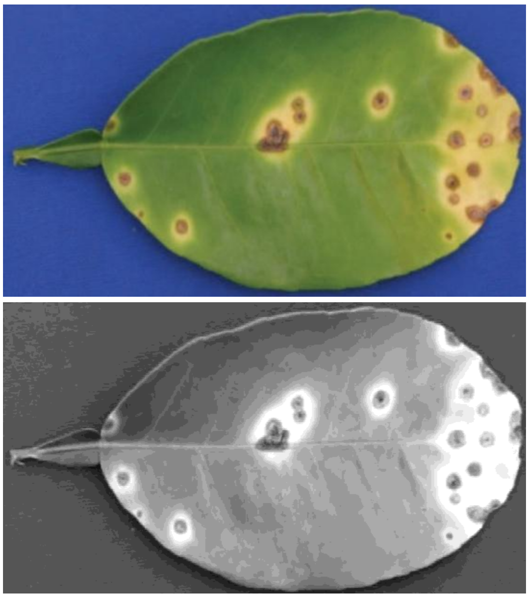


Figure 7. Original Image & Grayscale Image

In MATLAB for converting RGB to Gray the m-file is rgb2gray.m and here the equation is

New grayscale image = (0.2989 * R) + (0.5870 * G) + (0.1140 * B). [9]

According to this equation, Red has contribute 30%, Green has contributed 59% which is greater in all three colors and Blue has contributed 11%. [10]

Threshold the image

It is a function which makes a black and white version of a grayscale image by specifying a single threshold value; pixels are less than this value become black, and higher than this value they are white. Thresholding is the standard method of image segmentation. To generate binary image from original image the threshold method is used. Here I have taken an original image (refer image from Fig. 5.) and then I have applied various threshold algorithm and I have suggested the results. The detailed analysis of the thresholding methods have also been shown here.

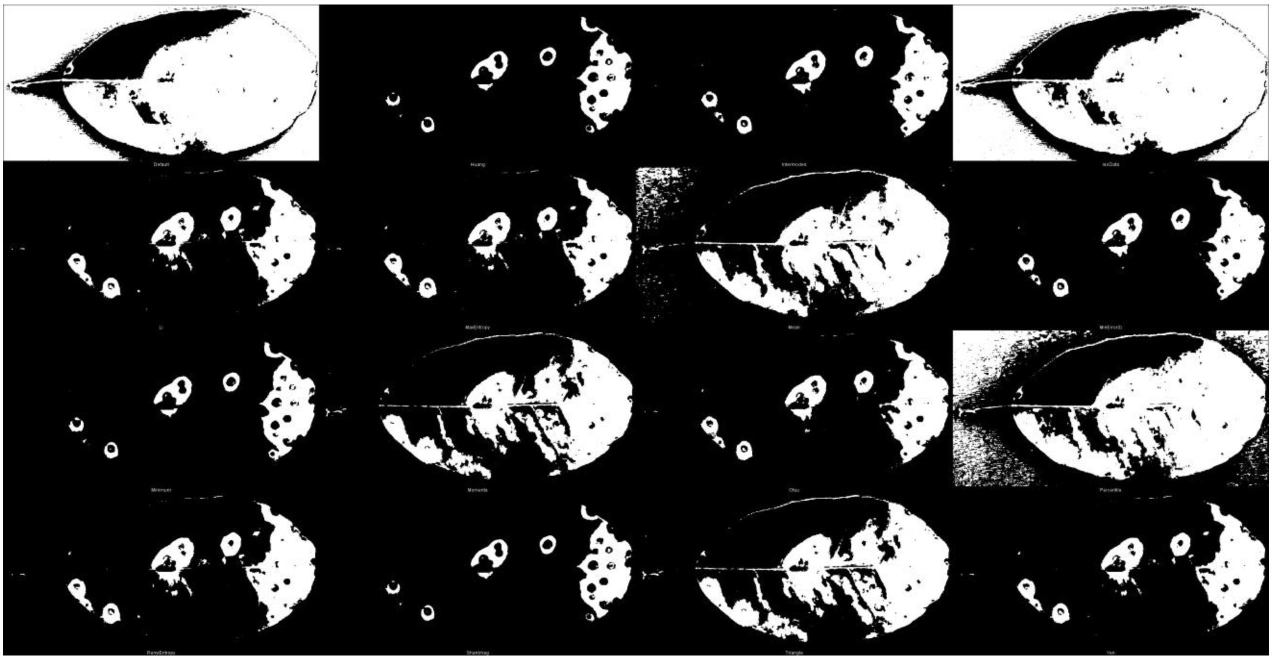


Figure 8. Thresholded image of the original image(threshold methods found from Imagej and then compared with MATLAB)

Order of theimage (Threshold): Default, Huang, Intermodes, IsoData, Li, MaxEntropy, Mean, MinError(I), Minimum, Moments, Otsu, Percentile, RenyiEntropy, Shanbhag, Triangle, Yen

Now from the results in table 3 we can see that the Otsu and Shanbhag are giving better results for image segmentation and are showing the almost correct areas of interest. Here the methods are differentiating foreground and background pixels to set up a best threshold. This method gives acceptable results when the numbers of pixels in each class are close to each other. The Otsu method and Shanbhag still remains the most referenced thresholding methods. So by this way we can find out the area of our interest and we can exclude the results they have no mean for disease processing purpose. Now the following table presents the threshold value for each of the method after the conversion from RGB to gray scale. When the pixel with value above the threshold then it will be black in binary image otherwise it will be considered as background. No any threshold method is always best possible, so manual correction is always required. [5]

Table5. Result of thresholdede image.

Default: 82	MaxEntropy: 88	**Otsu: 83**	Yen: 88
Huang: 84	Mean: 97	Percentile: 100	Default: 82
Intermodes: 84	MinError(I): 97	RenyiEntropy: 88	Huang: 84
IsoData: 82	Minimum: 72	**Shanbhag: 77**	Intermodes: 84
Li: 78	Moments: 91	Triangle: 87	

Pixel neighborhood

After successful completion of image thresholding (Image Segmentation), the next job is to fully identify the diseased portion, and this will be done by pixel neighborhood. First classify the diseased pixel and then find the surrounding pixels, and check out that these pixels contain the same disease or not? [6]

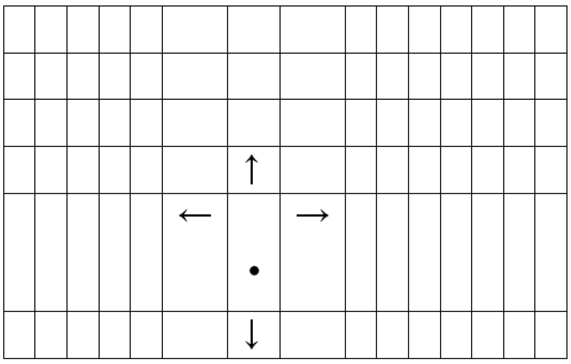


Figure 9. Pixel Neighbourhood

Here in the figure the pixel (dot has been found then we will search in all four direction that the pixel of this kind is available or not. Also we try to find the nearer intensity pixel in the surrounding for intensity of the disease.)

CONCLUSIONS

This paper presents the pixel calculation of the image and talks about the RGB and HSI space of the image as well. Also here I have explained how to segment the image by using threshloding and out of this we can find the ROI (Region of interest of the image). For collection of images leaves should be selected randomly to reflect the frequency and range of disease severity at the time. After image acquisition, it can be edited in a range of ways in a lot of different image study and image processing software. The pixels of the interest can be identified by various equations presented in the paper. Also we can find the best threshold technique for the image with the available results. Lastly for calculation of chain results we can refer the fundamental of pixel neighborhood and I have only introduced the same topic.

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