Leaf Disease Detection Using Image Processing Techniques - The Study.

Miss. Neha Gopalrao Kurale
M Tech IT
(Assistant Professor)
Gramin College Of Engineering
Vishnupuri Nanded 431606.

Mr.Jadhav Santosh B.
ME CSE
(Sr. Lecturer)
Gramin Polytechnic Vishnupuri
Nanded 431606.

Miss. Nishigandha Gopalrao Kurale
(M Tech IT)
SGGS IE&T
Vishnupuri Nanded 431606.

Abstract— Leaf diseases are the disorder, issues that affect the plants. In this paper, the problem of leaf dis- eases like the difficulties encountered while classifying the diseases in agriculture can be solved or reduce. In this paper, we propose features extraction techniques for classification of leafdisease. A combination of Tex- ture, Shape Feature and Pixel value are developed for classifying the images of leaf diseases. The proposed system can classify leaf images automatically as normal, image, affected. The proposed framework contains four steps. In the first step, the images are pre-processed. In the second step, the images are segmented by Thresholding and Edge Detection. In the third step, the texture, shape and pixel value are calculated using the Gray Level Co-occurrence Matrix, Moment Invariant and Walsh Hadamard Transform are computed over the segmented image and combined to form the single descriptor. In the final step, the K-NN, Multiclass- SVM and Decision Tree classifiers are used for classification of leaf images. The total datasets contain 5000 images, 1000 images of each disease like the Normal, affected, Anthracnose, wilt and Bacterial blight. The 2800 images are used for Training and 1200 images are used for Testing. The classification accuracy for Deci- sion Tree is 89.5%, Neural Network 91.70%, SVM is 90.70%, K-NN 96.90%. The K-NN classifier can be used for classifying the images and also reduces time as compare to the other classifiers.

Keywords- Image processing, SVM, KNN, Neural Network, leaf disease.

I. INTRODUCTION

India is land of farms and almost 71% of the income source comes from agriculture. Farmers have huge amount of options to select which crop to cultivate and pesticides to use for plant. The caliber and mass of agricultural products is directly affected due to the various disease. By studying plant diseases, we study distinct patterns on the plants. For successful cultiva- tion of crops monitoring of wellbeing and illness on plant is essential. Earlier it was done by the expert personality in that field. This takes huge amount of work as well as additional processing time. The im- age processing techniques can be utilized and suc- cessfully applied in the detection of plant disease with symptoms seen on stem, leaf and fruit. The plant leaf shows the disease symptoms which is then used for detection of disease [1].

II. IMAGE PROCESSING TECHNIQUES

a) IMAGE ACQUISITION

The images of the plant leaf can be captured through various types of cameras. Images are in RGB form. We have acquired images from Cotton Research cen- ter, Nanded by mobile as well as DSLR. Both were of the good quality. We have acquired the images of cotton leaf with three different types of diseases named as Bacterial blight, Alternaria, Normal, affect- ed, Anthracnose, wiltand Grey mildew. The database contained healthy leaves as well as disease affected leaves. The affectedleaves containmajorly as well as majorly affected areas. These images are taken in sunlight on white background [2].

b) PRE-PROCESSING

One of the simplest piecewise linear function is a contrast stretching transformation.So, what is con- trast stretching? We have found that in many cases, the images that we get from an imaging device is very dark and this may happen because of various reasons. One of the reasons is when you have taken the image of certain object or certain scene, the il- lumination of the object or the illumination of the scene is very poor. That means the object itself was very dark. So, naturally the image has become dark. The second reason why an image may be dark is that dynamic range of the sensor on which we are imag- ing is very small. Now, what we mean by dynamic range is it is the capacity of the sensor to record the minimum intensity value and the maximum intensity value. So, the difference between the minimum inten- sity value and the maximum intensity value is what the dynamic range of the sensor is. So, even if our scene is properly illuminated but our sensor it is not capable of recording all those variations in the scene intensity that also leads to an image which is very

dark. The another reason which may lead to dark images is that when we have taken the photograph, may be the aperture of the lens of the camera was not properly set, may be the aperture was very small so that a small amount of light was allowed to pass through the lens to the imaging sensor. So, if the ap- erture is not properly set, that also leads to an image which is very dark. So, for such dark images, the kind of processing techniques which is very suitable is called the contrast stretching operation.

Fig 1.Original image

Here, we show an image which is a low con- trast image. So, here obviously we can find that the contrast of the image or the intensity of the image is very poor and overall appearance of this particular image is very dark and the purpose of contrast stretching is to process such images. So, that the dy- namic range of the image will be very high, will be quite high so that the different details in the objects present in the image will be clearly visible.

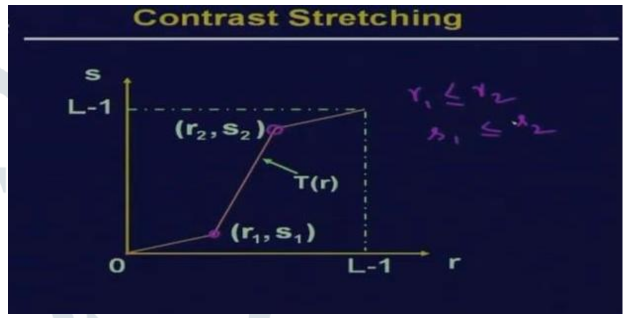


Fig 2. Contrast Stretching Transformation Graph

Now, a typical transformation which may be applied for contrast stretching operation is shown in this par- ticular figure. So, here you find that in this particular transformation, we have indicated 2 different points;

one is (r_1, s_1) that is this particular point and the other 1s point (r_2, s_2) that is this particular point. Now, it is the locations of these points (r_1, s_1) and (r_2, s_2) which controls the shape of this transformation function and accordingly, it influences upon that what are the dif- ferent types of contrast enhancements that we can obtain in the processed image.

Now, the locations of this (r_1, s_1) and (r_2, s_2) are very important. We can find that if we make r_1 equal to s_1 and r_2 equal to s_2, then the transformation function becomes a straight line with a slope equal to 45 de- gree. That means that whatever 1s the intensity image that we have in the processed image, we will have the same intensity level. That means by applying such a transformation where r_1 equal to s_1 and r_2 equal s_2 in this transformation function that we have said, by applying that kind of transformation, the processed image does not undergo any variation from the origi- nal image.

For other values of other combinations of (r_1, s_1) and (r_2, s_2), we really get some variation in the processed image. So, the values which are mostly used is here we find that if we make the other extreme, if we make r_1 equal to r_2 and s_1 equal to s_2 and if we make sorry r_1 equal to r_2 and s_1 equal to 0 and s_2 equal to L minus 1, then that leads to thresholding operation. So, the corresponding transformation generates the bina- ry image which is the processed image. Now, for enhancement operation, usually what is used is r_1 less than r_2 and s_1 less than s_2 which gives us a transfor- mation function as given in this particular figure and this transformation function generally leads to image enhancement.

Now, the condition that r_1 less than or equal to r_2, that is very important. So, the condition, we have just said that r_1 less than or equal to r_2 and s_1 less than or equal to s_2; now, this particular condition is very important as you find that if this condition is maintained, then the transformation function that we get becomes a single valued transformation function and the trans- formation is increasing. So, that is very important to maintain the order of the intensity values in the pro- cessed image that is an image which is dark in the original image will remain darker in the processed image and image which is brighter in the original that will a point which is brighter in the original image, that will remain brighter in the processed image.

But what difference we are going to have is the dif- ference of intensity values that we have in the origi- nal image and the difference of intensity values we get in the process image. That is what gives us the enhancement. But if it is reversed, if the order is re- versed; in that case, the processed image will look totally different from the original image. And, all the transformations that we are going to discuss except the negative operation that we have said initially, all of them maintain this particular property that the or- der of the intensity values is maintained. That is the transfer function is monotonically increasing and we will have our transfer function which is single valued transfer function.

Now, using this particular transfer function, let see what kind of result we can obtain.

Fig 3. Enhanced Image

So earlier we have shown an image which is a low contrast image. This is original image which is a low contrast image and by using the contrast enhance- ment operation, what we have got is an image which is the processed image shown in the right hand side and here, you can clearly observe that more details are available in the processed image than in the origi- nal image.

So the contrast of the processed image has become much higher than the contrast in the original image. So, this is a technique which is called contrast stretching technique which is mostly useful for imag- es where the contrast is very poor and we have said that we can get a poor contrast because of various reasons; either the scene illumination was poor or the dynamic range of the image sensor was very less or the aperture setting of the camera lens

Was not proper and in such cases, the dark images that we get that can be enhanced by using this con- trast stretching techniques.

Now, there are some other kind of applications where we need to reduce the dynamic range of the original images. Now, the applications where we need to re- duce the dynamic range is say for example I have an original image whose dynamic range is so high that it cannot be properly reproduced by our display device. See, normally we have a gray level display device or a black and white display device which normally uses bits. That means it can display intensity levels from 0 to 255 that is total 256 different intensity levels.

But in the original image if I have a mini- mum intensity value of say 0 and the maximum in- tensity value of say few thousands, then what will happen that because the dynamic range of the origi- nal image is very high but my display device cannot take care of such a high dynamic range; so the dis- play device will mostly display the highest intensity values and the lower intensity values will be in most of the cases suppressed and by that, a kind of image that we will get usually is something like this [7] [2].

c) IMAGE SEGMENTATION

The partition of image into various part of same features or having some similarities is known as segmentation. The main purpose of subdividing an image into its constituent parts or objects present in the image is that we can further analyze each of these constituents or each of the objects present in the im- age once they are identified or we have subdivided them. So, each of this constituents can be analyzed to extract some information so that those information’s are useful for high level machine applications.

Now, when we say that segmentation is nothing but a process of subdivision of an image into its constituent parts; a question naturally arises that at which level this subdivision should stop? That is, what is our lev- el of segmentation? Naturally, the subdivision or the level of subdivision or the level of segmentation is application dependent. Say for example, if we are interested in detecting the movement of vehicles on a road; so on a busy road, we want to find out what is the movement pattern of different vehicles and the image that is given that is an aerial image taken either from a satellite or from an from a helicopter.

So in the case of leaf segmentation, our interest is to detect the moving vehicles on the road. So, the first level of segmentation or the first level of subdivision should be to extract the road from those aerial images and once we identify the roads, then we have to go for further analysis of the road so that we can identify every individual vehicle on the road and once we have identified the vehicles, then we can go for vehi- cle motion analysis.

So, as we said that this segmentation or level of sub- division is application dependent; now for any auto- mated system, what we should have is automatic pro- cesses which should be able to subdivide an image or segment an image to our desired level. So, you will appreciate that image segmentation is one of the most important task in machine vision applications. At the same time, image segmentation is also one of the most difficult tasks in this image analysis process and we will easily appreciate that the success of the im- age analysis operations or machine vision applica- tions is highly dependent on the success of the auton- omous segmentation of objects or segmentation of an image. So, this image segmentation, though it is very difficult but it is a very important task and every ma- chine vision application software or system should have a very robust image segmentation algorithm [7].

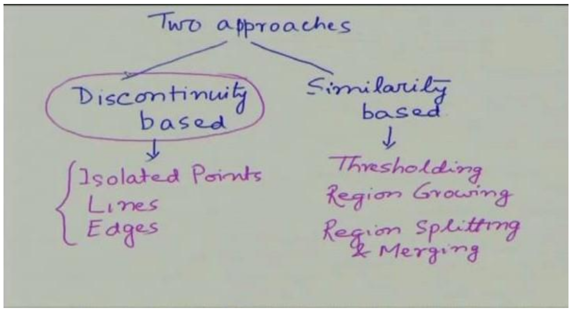


Fig 4. Types of approaches

Now, as we have just mentioned that image segmentation approaches are mainly of two different types, so we have two different approaches of image segmentation; one of the approach as we have just said is the discontinuity based approach and the sec- ond approach is what is called similarity based ap- proach.

In discontinuity based approach, the partition or sub-division of an image is carried out based on some abrupt changes in intensity levels in an image or ab- rupt changes in gray levels of an image. So, on the discontinuity based approach, our major interest, we are mainly interested in identification of say isolated points or identification of lines present in the image or identification of edges. So, under discontinuity based approach, we are mainly interested in identifi- cation of isolated points or identification of lines or identification of edges.

In the similarity based approach, the approach is slightly different. Here, what we try to do is we try to group those pixels in an image which are similar in some sense. So, the simplest approach under this sim- ilarity based technique is what is called thresholding operation. So, by thresholding what we mean is as we have already said that if we have images where every pixel is coded with 8 bits, then we can have intensi- ties varying from 0 to 255 and we can decide a threshold following some criteria, say we decide that we will have a threshold level of say 128; so we de- cide that all the pixels having intensities of having an intensity value greater than 128 will belong to some region whereas all the pixels having intensity values less than 128 will belong to some other region. So, this is the simplest thresholding operation that can be used for image segmentation purpose.

The other kind of segmentation under this similarity based approach can be a region growing based ap- proach. Now, the way this region growing stuff works is suppose we start from any particular pixel in an image, then we group all other pixels which are connected to this particular pixel. That means the pixels which are adjacent to this particular pixel and which are similar in intensity value.

So, our approach is that you start from a particular pixel and all other pixels which are adjacent to this particular pixel and which are similar in some sense; in the simplest cases, similar in some sense means we say that the intensity value of that adjacent pixel is almost same as the intensity value of the pixel from where we have started growing the region. So, start- ing from this particular pixel, you try to grow the region based on connectivity or based on adjacency and similarity. So, this is what the region growing based approach is.

The other approach under this similarity based tech- nique is called region splitting and merging. So, un- der this region splitting and merging, what is done is first we split the image into a number of different components following some criteria and after you have split the image into a number of smaller size sub images or smaller size components, then you try to merge some of those sub images which are adjacent and which are similar in some sense.

So, our first approach is the first operation is you split the image into smaller images and then try to merge those smaller sub images wherever possible to have a larger segment. So, these are the different segmenta- tion approaches that we can have and in today's dis- cussion and in subsequent discussion, we will try to see details of these different techniques. So first, we will start our discussion on this discontinuity based image segmentation approach.

d) K-MEANS CLUSTERING

K-means clustering classifies objects based on set of features into k number of classes. This is achieved by minimizing the sum of the square of the distance be- tween the object and the corresponding clusters.

The algorithm for k-means clustering is as follows.

1. Pickcenter of k cluster, either randomly or based on some set of rules.

2. Consider each pixel in the image in the cluster to minimize the distance between the pixel and the cen- ter of cluster.3.Compute the cluster center again by doing average of all the pixel in the cluster. Repeat the steps 2 and 3 until convergence is obtained [4].

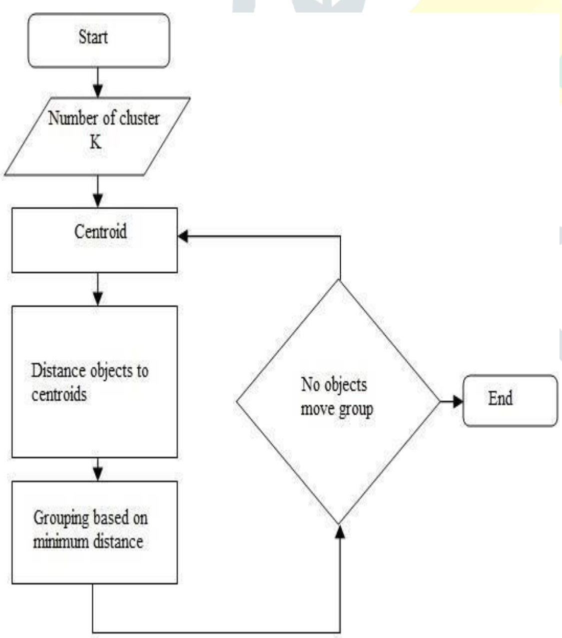


Fig 5. Flow chart of k-means clustering

e) MASK PROCESSING:

In discontinuity based image segmentation approach, our interest is mainly to identify the points isolated points or we want to identify the edges pre- sent in the image or we identify try to identify the lines present in the image and for detection of these kind of discontinuities that is either detection of points or detection of lines or detection of edges, the kind of approach that will take is use of a mask.

So, using the masks, we will try to detect isolated points or we will try to detect the lines present in the image or we will try to detect the edges in the image.

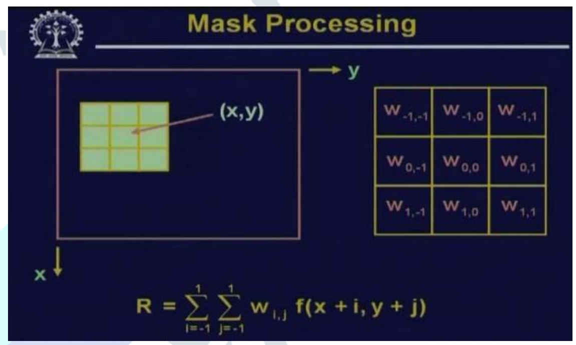


Fig 6. Masking process

Now, this masks, use of masks, we have discussed earlier in connection with our discussion of image processing like image smoothing, image sharpening, image enhancement and so on. So there, we have said that if we consider a 3 by 3 neighborhood like this, we take a mask of size 3 by 3. So here, on right hand side, this is a mask of size 3 by 3 having different

coefficient values given as $W_{\text{minus 1, minus 1}}$ $W_{\text{minus 1, 0}}$ $W_{\text{minus 1, minus 1}}$ and so on taking the center coefficient in the mask having a value $W_{0,0}$.

Now, in this mask processing operation, what is done is we shift this mask over the entire image to calcu- late some weighted sum of pixel at a particular loca- tion. Say for example, if we place this mask at a loca- tion (x, y) in our original image; then using all other different mask coefficients, we try to find out and weighted some like this - R equal to W into f X_{ij} Y (x plus i, Y i plus j) where i varies from minus 1 to 1 and j varies from minus 1 to 1 and this component, we call as a value R. Use of this mask as I have said that we have seen in connection with image sharpen- ing while we have taken different values of the coef- ficients.

In case of image smoothing, we have taken the values of the mask coefficients to be all ones. So, that leads to an image averaging operation. So, depending upon what are the coefficient values of this mask that we choose, we can have different types of image pro- cessing operations.

Now here, you find that when I use this mask, then depending upon the nature of the image around point (x, y), I will have different values of R [3].

f) LINE DETECTION:

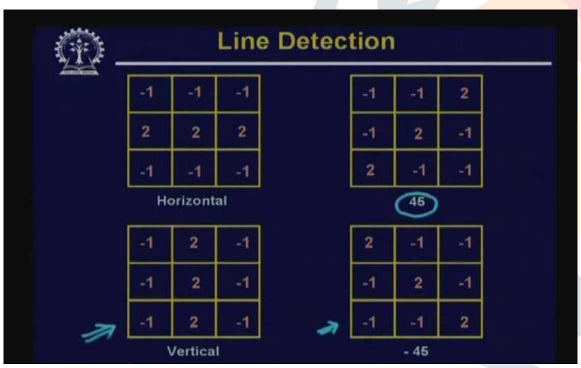


Fig 7. Line Detection

For detection of horizontal lines we have used a mask at the center row or the middle row hav- ing all values equal to 1 and the top row and the bot- tom row is having all values equal to minus 1, all the coefficient values equal to minus 1 and by moving this mask over the entire image, it detects all those points which lies on a horizontal line.

Similarly, the other mask which is marked here as 45, if you move this mask over the entire image, this mask will help to detect all the points in the image which are lying on a line which is inclined at an angle of 45 degree. Similarly, this mask will help to detect all the points which are lying on a line which is verti- cal and similarly this mask will detect all the points lying on a line which is inclined at an angle of minus 45 degree. Now, for line detection, what is done is we apply all these masks, all these 4 masks on the image. And, if we take a particular masks say, i'th mask and any other mask say j'th mask and if we find that the value computed are i with the i'th masks, the absolute value of this is greater than R_j where R_j is the value computed with the j'th mask for all j which is not equal to i. This says that the corresponding point is more likely to be associated with the line in the direc- tion of the mask i.

So, as we said what we are doing is we are taking all the 4 masks, apply all the 4 masks on the image, compute the value of R for all these masks; now if for an i'th mask if I find that R of i, the absolute value of R_i is greater than absolute value of R_j for all j which is not equal to i, in that case we can conclude that this particular point at which location this is true, this point is more likely to be content on a line which is in the direction of mask i.

So, these are the 2 approaches; the first one we have said, given a mask which is useful for identification of isolated points and the second set of masks is use- ful for detection of points which are lying on a straight line.

g) EDGE DETECTION:

Fig 8. Edge detection

Edge detection is one of the most common approach- es, most commonly used approach for detection of discontinuity of an image in an image. So, we say that an edge is nothing but a boundary between 2 regions having distinct intensity levels or having dis- tinct gray level. So, it is the boundary between 2 re- gions in the image, these two regions have distinct intensity levels. So, as is shown in the above figure particular slide.

So, here you find that on the top, we have taken 2 typical cases. In the first case, we have shown a typi- cal image region where we have a transition from a dark region to a brighter region and then again to a dark region. So, as you move from left to right, you find that you have transitions from dark to bright, then again to dark and in the next one, we have a transition as we move from left to right in the hori- zontal direction, there is a transition of intensity lev- els from bright to dark and again too bright.

So, these are the typical scenarios in any intensity image where we will have different regions having different intensity values and an edge is the boundary between such regions. Now here, in this particular case, if we try to draw the profile, intensity profile along a horizontal line; we find that here the intensity profile along a horizontal line will be something like this. So, we have a transition from dark region to bright region, then from bright region to dark region whereas in the second case, the transition will be in the other direction; so, bright to dark and again to bright.

So here, we find that we have modeled this transition as a gradual transition, not as an abrupt transition. The reason is because of quantization and because of sampling; all almost all the abrupt transitions in the intensity levels are converted to such gradual transi- tions [5].

So, this is your intensity profile along a horizontal scan line. Now, let us see that if I differentiate this, if I take the first derivative of this intensity profile; then the first derivative will appear like this. In the first case, the first derivative of this intensity profile will be something like this and the first derivative of the second profile will be something like this.

So, we find that the first derivative response whenev- er there is a discontinuity in intensity levels that is whenever there is a transition from a brighter intensi- ty to a darker intensity or wherever there is a transi- tion from the darker intensity to a brighter intensity. So, this is what we get by first derivative. Now, if we do the second derivative, the second derivative will appear something like this and in the second case, the second derivative will be just the opposite; it will be something of this form, it will be like this. So, we find that first derivative is positive at the leading edge whereas it is negative at the tailing edge; similarly here and we find that the second derivative if we take the second derivative, the second derivative is posi- tive on the darker side of the edge and it is negative on the brighter side of the edge and that can be veri- fied in both the situations that the second derivative is becoming positive on the darker side of the edge but it is becoming negative on the brighter side of the edge.

However, we will appreciate that this second deriva- tive is very sensitive to the noise present in the image and that is the reason that the second derivative oper- ators are not usually used for edge detection opera- tion. But as the nature says that we can use these sec- ond derivative operators for extraction of some sec- ondary information that is we can use the sign of the second derivative to determine whether a point is lying on the darker side of the edge or a point is lying on the brighter side of the edge and not only that, here we find that there are some zero crossings in the second derivative and this zero crossing information can be used to exactly identify the location of an edge whenever there is a gradual transition of the intensity from dark to bright or from bright to dark [5].

h) SOBEL EDGE OPERATOR:

The second mask which is also a first de- rivative mask is called a sobel operator. So, here again, you find that we have 2 different masks; one mask is responsible for computation of horizontal edges, the other mask is responsible for computation of the vertical edges. Now, if you try to compare this pewit operator, pewit edge operator and sobel edge operator; you find that this sobel edge operator gives an averaging effect over the image. So, because this sobel edge operator gives an averaging effect, the effect due to the presence of spurious noise in the image is taken care of to some extend by the sobel but it does not taken but it is not taken care of by the pewit operator. Now, let us see that what kind of re- sult we can use, we can have by using these edge detection operators.

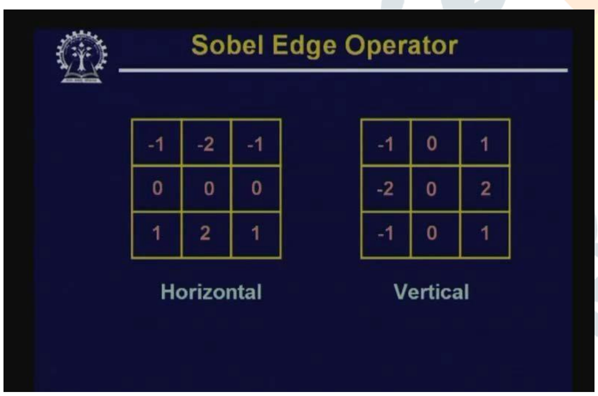


Fig 9. Sobel Edge Operator

We find that here we have shown result on a particular image. So, this one is our original image on the top left, this is our original image; on the top right, it is the edge information which obtained using the sobel operator and the edge components in this particular case are the horizontal components. The third image is again by using the sobel operator but here the edge components are the vertical edge com- ponents and the fourth one is the result which is ob- tained by combining this vertical component and the horizontal component.

So here, we find that if we compare this image with our original image, you find that different edges pre- sent in the original image, they have been extracted by using this sobel edge operator and by combining the outputs of the vertical mask and the output of the horizontal mask, we can have the edge components, we mean we can identify the edges which are there in various directions. So, that is what we have got in the fourth slide in the fourth image.

So, this prewitt operator and the sobel operator, as we have said that these 2 operators are basically first derivative operators and as we have already men- tioned that for edge detection operation, the kind of operators derivative operators which are used are mainly the first derivative operators and out of these 2 - the prewitt and sobel operator; it is the sobel oper- ator which is generally preferred because the sobel operator also gives an smoothing effect and by which we can reduce the spurious edges which can be gen- erated because of the noise present in the image and we have also mentioned that we can also use the sec- ond derivative operator for edge detection operation but the disadvantage of the second derivative opera- tor is it is very very sensitive to noise.

And secondly, as we have seen that second derivative operator gives us double edges. Once for every tran- sition, we have double edges which are generated by the second derivative operators. So, that is these are the reasons why second derivative operators is not normally preferred for edge detection operation. But the second derivative operators can be used to extract the secondary information.

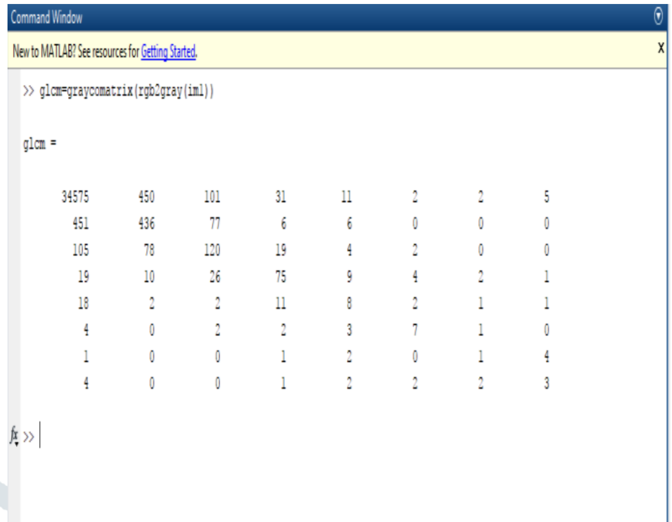
So, as we have said that by looking at the polarity of second derivative operator output, we can determine whether a point lies on the darker side of the edge or the point or a point lies on the brighter side of the edge and the other information that we can obtain from the second derivative operator is from the zero crossing, we have seen that second derivative opera- tor always gives a zero crossing between the positive side and the negative side and the zero crossing points accurately determine the location of an edge whenever an edge is a smooth edge.

i) FEATURE EXTRACTION

In every classification problem, same set contains some similar properties. For different set it will have different properties. We can call it as features. In our problem each disease contains different textures. Hence we used GLCM (gray level co-occurrence matrix) [6].

GRAY LEVEL CO-OCCURRENCE MATRIX:

Image analysis techniques consists of gray level co-occurrence matrix and associated texture feature cal- culations. If a certain image composed of pixel each with a specific gray level is given, the GLCM is a tabulation of how many times combinations of gray level co-occur in an image or image section. The fea- ture calculation of the texture is done by using the GLCM and gives a measure of the variation in inten- sity at the pixel of interest [7].


Command Window

New to MATLAB? See resources for Getting Started.

```
>> glcm=graycomatrix(rgb2gray(im1))

glcm =

       34575         450         101          31          11           2           2           5
         451         436          77           6           6           0           0           0
         105          78         120          19           4           2           0           0
          19          10          26          75           9           4           2           1
          18           2           2          11           8           2           1           1
           4           0           2           2           3           7           1           0
           1           0           0           1           2           0           1           4
           4           0           0           1           2           2           2           3

fx >>
```

Fig 10. GLCM matrix

We have calculated various features of leaf. Those are as follows:

Texture equations

Energy feature

$$Energy = \sum_{i,j=0}^{N-1} \left(P_{ij}\right)^2$$

Entropy feature

$$Entropy = \sum_{i,j=0}^{N-1} -\ln\left(P_{ij}\right) P_{ij}$$

Contrast feature

$$Contrast = \sum_{i,j=0}^{N-1} P_{ij}\left(i-j\right)^2$$

Homogeneity feature

$$Homogeneity = \sum_{i,j=0}^{N-1} \frac{P_{ij}}{1+\left(i-j\right)^2}$$

Correlation feature

$$Correlation = \sum_{i,j=0}^{N-1} P_{ij} \frac{\left(i-\mu\right)\left(j-\mu\right)}{\sigma^2}$$

Shade feature

$$Shade = \mathrm{sgn}\left(A\right)\left|A\right|^{1/3}$$

Fig 11. GLCM features

j) CLASSIFIER

Classification is the process of identifying the catego- ry of set by some rule which is made by training samples [7].

Neural network – The multi-layer perceptron (a non-parametric classifier) is the standard network to use for supervised learning. Other types of neural networks are useful for unsupervised learning. Train- ing can be very slow, but classification is fast. The number of hidden nodes must be set using validation (see below). Can have excellent performance. Impos- sible for a human to “understand” the classifier. Per- formance is vulnerable to unforeseen input data [7].

Parzen window – Robust non-parametric. Must se- lect form of kernel and size parameter h. Complexity and performance is similar to k-NN method.

K-Nearest neighbor – A robust non-parametric clas- sifier. Classification has high computational com- plexity when. Must select metric and value of k. k must be set using validation. Can have excellent per- formance for arbitrary class conditional pdfs [7].

Neural network-The subject of artificial neural net- works has matured to a great extent over the past few years. And especially with the advent of very high performance computing, the subject has assumed a tremendous significance and has got very big applica- tion potential in very recent years. As the name im- plies, actually the term neural networks derives it is origin from the human brain, or the human nervous system, which consist of a massively large parallel interconnection of a large number of neurons. And that achieves different tasks, different perceptual tasks, recognition tasks etcetera, in an amazingly small amount of time. Even as compare to today’s very high performance computers [7].

So, this is what inspired the researches to think that is there anyway, whereby a computer can be made to mimic the large amount of interconnections and the networking. That exists between all the nerves cells, can it be utilized to do some complex processing tasks where today’s high performance computers also cannot do. We know that our brain, the human brain is having a highly complex and nonlinear parallel competitor. A human brain has a highly complex non-linear and parallel computer; and this can organ- ize it is constituent structural elements. So, it is struc- tural constituents of human brain, they are known as neurons. And the neurons are interconnected not in a very simple way, but in a rather complex way, so complex that many of the things we do not know yet. Say, if we have got a large number of such neurons or nerve cells, which carry out the processing. They will be interconnected typically in a highly complex manner between each other. And there will be con- nections which exist from one neuron to the other, and that is how a network is realized. And this net- work is as told it is highly complex, as well as non- linear and is massively parallel. Because, our human brain has got, typically billions of nerve cells with trillions of such interconnections existingBasically, if there is a system where we give a set of inputs and we expect some output out of it. In that case, we call the system to be linear, if the relation between the output and the input can be best described in terms of a simple linear equation. If there are let say 4 inputs and 1 output, then if the output is a linear combina- tion of all the 4 inputs, then naturally the system is linear. Whereas, if we can write the output only in terms of, not only the linear terms, but also it is high- er order terms, in that case the system is no longer linear, the system becomes non-linear [7]..

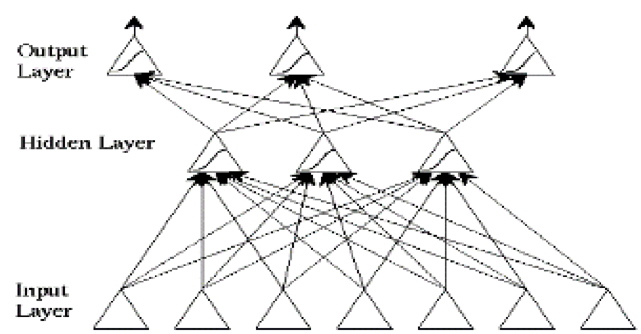


Fig 12. Block diagram of neural network

III. EXPERIMENTAL RESULT

Fig 13 Original image

By doing edge detection of the diseased plant leaves, we derive out the maximum edges part and then cropped the same.

(a)

(b)

Fig 14. Regenerated image (a) with and (b) without background.

After cropping the image that we get from edge de- tection result, we regenerate the image and removes it background by using line scanning.

By using the color feature extraction technique we separate out the diseased leaf part from the healthy leaf part.

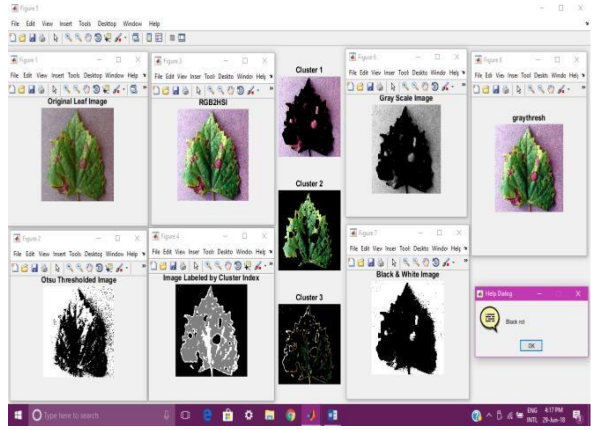


Fig 15. Final result

After training the data set in neural network which acts as a classifier, we get the final result.

Algorithm/Classifier	**Algorithm/Classifier**	**Accuracy Value (range in %)**
Decision Tree	Complex Tree	89.50%
	Medium Tree	83.50%
	Simple Tree	79.80%
SVM	Linear SVM	89.70%
	Quadratic SVM	90.70%
KNN	Medium KNN	89.10%
	Cubic KNN	89.30%
	Weighted KNN	96.90%
Neural Network	NN classifier	91.70%

IV. CONCLUSION

In this work a combination based feature extraction is proposed and classification is done through Decision Tree, Multiclass SVM and K-NN classifiers to classi- fy the leaf images from datasets. The texture, shape and pixel co-efficient features are combined. This combination gives better results for classification of leaf diseases with high accuracy, sensitivity and specificity The accuracy of each one of the four classes using GLCM features. The accuracy can be calculat- ed by K-fold methods. The final performance is measure using the average of 1-fold, 2-fold and 3- fold by the K-NN, Multiclass-SVM and Decision Tree classifiers. The classification accuracy for the folding method shows 97.50% for WG, 97.50% for WM, 94.45% for GM, 97.50% for WGM are accom- plished by the K - NN classifier with Global Thresh- olding. The K-NN classifier with Global Threshold- ing can be reduced time and also gives better results as compare to other methods and classifiers. In the future, we can be extended the work by increasing the number of images and type of lung diseases. Al- so, we can apply the various segmentation, feature extraction techniques for detection and classification of leaf images of diseases.

V. REFERENCES

1] Singh, Vijai, and Ak K. Misra. "Detection of plant leaf diseases using image segmentation and soft computing techniques." *Information Processing in Agriculture* 4.1 (2017): 41-49.

2] Barbedo, Jayme Garcia Arnal. "Digital im- age processing techniques for detecting, quantifying and classifying plant diseas- es." *SpringerPlus* 2.1 (2013): 660.

3] Patil, Jayamala K., and Raj Kumar. "Ad- vances in image processing for detection of plant diseases." *Journal of Advanced Bioin- formatics Applications and Research* 2.2 (2011): 135-141..

4] Pappas, Thrasyvoulos N. "An adaptive clus- tering algorithm for image segmenta- tion." *IEEE Transactions on signal pro- cessing*40.4 (1992): 901-914.

5] Maini, Raman, and Himanshu Aggarwal. "Study and comparison of various image edge detection techniques." *International journal of image processing (IJIP)* 3.1 (2009): 1-11.

6] Mohanaiah, P., P. Sathyanarayana, and L. GuruKumar. "Image texture feature extrac- tion using GLCM approach." *International Journal of Scientific and Research Publica- tions*3.5 (2013): 1.

7] Kurale, Neha G., and Madhav V. Vaidya. "Classification of Leaf Disease Using Tex- ture Feature and Neural Network Classifi- er." *2018 International Conference on In- ventive Research in Computing Applications (ICIRCA)*. IEEE, 2018.