Detection and Classification of Pests Using Neural Networks

P. V. Rama Raju, P. M. P. Gayatri, G. Nagaraju

Abstract**: *Detection of pest is an essential factor to restrain serious outbreak in crops. Pest identification will not only add to the yield production but it is also a subsidiary for different types of agricultural practices or any sort of research. A common method for recognizing the pests is by naked eye observation. In this paper preprogrammed pest identification systems using various image processing techniques are presented. Initially, identifying and capturing the leaf with pest is done and in the subsequent steps techniques of image processing such as HSI conversion, segmentation, clustering, classifiers etc., are applied. Feature extraction is done on the area of interest of the segments. The results obtained are passed through neural network classifier. The neural network outperforms the task of classification of pest, disease or damage caused due to the presence of pest, medicine to cure the disease and the lifespan of pest.***

Index Terms**: *clustering, HSI conversion, neural networks, segmentation.***

I. INTRODUCTION

One of the factors that contribute to economy of the country is the agriculture sector. A rise in the agriculture productivity automatically increases the country's economy. Therefore, a country's economy is related to the agriculture field. The standard and volume of productivity is based on the environmental and biological factors. The environmental parameters comprise temperature, water salinity, humidity, soil erosion. All these environmental parameters cannot be controlled by humans. Biological parameters comprise various types of bacteria, fungus and pests which directly affect the productivity. Productivity can be raised by eradicating the diseases in the initial stages by identifying the pests which causes diseases. These pests can be identified by naked eye observation or automatic pest detection. The manual observation is a time taking and laborious work. For various pests' different kind of pesticides are sprayed on the fields. So, to identify and classify the pests a preprogrammed detection technique is required. One of the techniques which are capable and valid approach is image processing technique. A prevailing pre-processing step is noise reduction. There are various kinds of filters like Gaussian, mean, rank, median and many more.

A nonlinear filter which retains the shape, edge and other appropriate content without clarity loss is a rank filter [8]. Another nonlinear filter, used to eradicate salt and pepper noise generated because of the presence of sharp and swift disturbances in image is median filter [7]. A filter that reduces inequalities in intensities of neighboring pixels is the mean filter [6]. To enhance contrast histogram equalization is used [9]. A mathematical approach to define texture with the aid of statistical techniques which calculates various properties [1]. Segmentation helps to evaluate the picture in a smooth way. Segmentation can be accomplished either by the usage of boundary detection algorithm or spot detection algorithm [5]. Neural network and support vector machine are two prominent techniques for classification to alter the data SVM makes use of kernel approach [5]. Classification can also be achieved by using minimum distance criterion [4]. If a complex relation exists in between input and output then neural networks tackle the task in an efficient way [2].

In the projected method, the input color image is transformed to HSI image. FCM clustering technique is applied to the output of preprocessing step. Then the features like color, mean and covariance feature, texture features are calculated. Then FCM and NN techniques are carried out to obtain the required output. The block diagram of the projected method is displayed in figure1.

II. PROPOSED METHOD

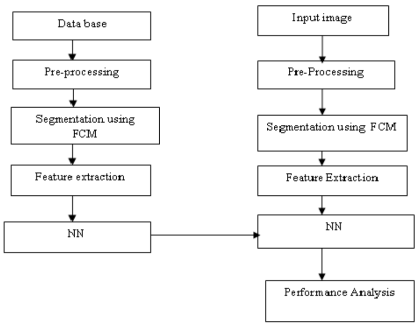

Fig. 1. Block diagram of proposed method

A. Image Acquisition

The action of restoring an image for processing from hardware based source is image acquisition. Without an image, processing is not possible so it is the initial stage in the workflow sequence. The processing starts with procuring the image of crops. The images in the database can be of any format. Here the leaf which is infected by pest is taken as an

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input image. The input image is shown in fig 2.

B. Image preprocessing

The goal of image preprocessing is to upgrade the quality of image and make the image suitable for the algorithm which is to be processed. One of the most common and apparent way to modify the image is either to resize or scale an image. To fit the primary image to desired size the contents of image are either shrunken or enlarged. In the section of resizing both the bicubic interpolation and antialiasing are performed on the input image. The range of the image when converted to the class function double will be in between [0,1]. In order to understand the role played by each and every bit of the image, plane separation is done on the digital image. The output of plane slicing is displayed in figure 3.In the course of image generation whether it can be either displaying or capturing of the image RGB color model is utilized. But the RGB color model cannot describe the images in a way human eye perceives it. In the HSI color model information about the color is obtained by separating the achromatic components from the chromatic components. Due to this aspect HSI is a classic tool for the algorithms of image processing.

C. Feature Extraction

Feature extraction is a vital approach in the field of object classification and pattern recognition. The main ambition or target of feature extraction is dimensionality reduction which can be accomplished with the help of some rules that extracts useful or meaningful data from the primary data. The new set of extracted information incorporates most of the related information from the initial data. One of the considerable problems that appear when analyzing complex data is the number of variables required. So, scrutiny for complex data with huge variables demand massive amount of computation power and memory.

Color Feature Extraction:

Color is one of the visual traits of object which is the result of light reflected or emitted or transmitted. The prolongation of scalar to vector signal is nothing but the color signal. These color features can be formulated from either the histogram or the hue and saturation components.

Mean and Covariance Features:

The mean vector comprise the mean of specific variable and covariance matrix holds the covariance amongst the every set of two variables in the alternative matrix positions. In the covariance matrix every row will be an observation and the corresponding column should be a variable. Basically, in the total image the contribution of intensity of the pixel is given by the mean value. To know the variation between a particular and its neighboring pixels covariance is used which aids to classify pixels into distinctive regions. The reason behind calculating these features is to understand the statistic behavior of particular image.

Texture Features:

A feature assists to segment images into interested regions and to classify the regions of interest is texture feature. The texture feature describes the attributes of regions which would be helpful in precise analysis of the image.

GLCM:

Gray level co-occurrence matrix has the information regarding pixel position possessing identical gray level values. GLCM takes into consideration the relation among the two pixels. The two pixels are the reference (first) and the respective neighboring (second) pixels. The GLCM matrix is an array of two dimensions, the rows and columns of the matrix serves as image values. So, in precise GLCM deals with relationship among pixels in the initial image. The GLCM is obtained from gray scale image and also a scaled version of the image. Once the GLCM is generated different statistics can be acquired with the suitable formulas. Finally, the statistics calculated provides the information regarding the image texture.

Energy: In GLCM, energy is called either uniformity or angular second moment. Energy measures the pairs of pixels which are repeating. In short, energy calculates the overall uniformity of texture. Finally, detects the texture disorder. The utmost value of energy is 1.

$$E=\sum\sum p(x, y)\ \hat{}\ 2\ P(x, y)$$

Entropy: Entropy like energy calculates the image disorders or the complexity of the image. Entropy will be lowest if the particular image is texturally non uniform and will be highest if image is texturally uniform.

$$S=\sum\sum p(x, y) \log p(x, y)$$

Contrast: Contrast measures the dissimilarity among the highest value and lowest value of the adjoining set of pixels. In precise, contrast calculates the number of disparities existed in the image.

$$I=\sum\sum (x-y)\hat{}2\ p(x,y)$$

Homogeneity: It is well known as inverse difference moment. Homogeneity will be large and the gray levels. Homogeneity is inversely proportional to contrast. If all the elements of image are alike then homogeneity is maximum else it will be minimum.

$$H = \sum\sum (p(x, y)/ (1 + [x-y])))$$

Correlation Coefficient: Correlation coefficient is used to calculate the relationship strength of pair of variables. It predicts the change in the one variable if the value of other variable changes. It lies in the range of -1 and 1. Correlation of value -1 indicates perfect negative correlation, +1 indicates the positive correlation and 0 indicates no correlation between the two variables.

$$C=\sum\sum((x- \mu x)(y-\mu y)p(x, y)/\sigma_x\sigma_y))$$

All the texture feature values are displayed in table I.

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TABLE I
Feature Values

Features	Value
Energy 1	0.4624
Contrast1	0.4667
Correlation 1	0.1583
Homogeneity 1	0.8389
Entropy 1	1.7323
Energy 2	0.3794
Contrast 2	1.3625
Correlation 2	-0.0643
Homogeneity 2	0.7735
Entropy 2	2.1325

D. Fuzzy Clustering:

Clustering is a statistical method in which objects possessing similar characteristics are combined. The word similar refers to color, magnitude, shape, dimension and many more. The steps in FCM are given below.
1. For every cluster allot a random centroid.
2. Calculate the distance in between the every point and center of the cluster.
3. Depending on the calculated distance again calculate the membership function
4. Again calculate the centroid of every cluster.
The output of clustering is displayed in figure 5.

E. Neural Networks:

Neural networks are enormous computational prototype operates in parallel replicating the function of human brain. Artificial neural networks comprises of huge number of processors associated by weights. The processing unit receives input from previous unit and the strength of the network depends on the entire structure of neural network but not only on single processing unit. Feed forward network comprises of concatenation of layers. The network input is fed into the first layer and it is made to forward to the consecutive layers. The output is produced by the final layer of the network. The feed 8forward network takes into account the arguments of sizes and training function. The training function used here is Bayesian regulation back propagation updates the weights based on Levenberg-Marquardt optimization. This Bayesian regulation back propagation generates a good working network by reducing squared errors. The classifier output that is name of the pest is shown in figure 6 and details of the pest are displayed in figure 7.

F. Performance Metrics

The performance metrics contains the synopsis of prediction outcomes regarding the classification problem. Performance metrics is calculated with the help of four parameters. True positive is a conclusion in which the system accurately anticipates the positive class, likewise true negative correctly anticipates the negative class. A false positive is a result in which the system inaccurately anticipates the positive class, similarly false negative incorrectly anticipates the negative class.

Sensitivity: Sensitivity calculates the proportion of real positive values that are accurately recognized.

$$\text{Sensitivity} = TP/\ (TP+FN)$$

Specificity: Specificity calculates the ratio of real negative values which are perfectly recognized.

$$\text{Specificity} = TN/\ (TN+FP)$$

Accuracy: Accuracy deals with standard of the data and also the amount of errors present in the data.

$$\text{Accuracy} = (TP+TN)/\ (TP+FP+TN+FN)$$

The performance metrics values are displayed in table II.

TABLE II
Performance Metric Values

Performance Metrics	Values
Sensitivity	85.7143
Specificity	100
Accuracy	90.9091

III. RESULTS

Fig. 2. Input image

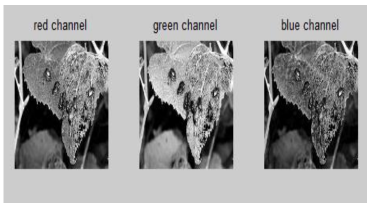

Fig. 3. Pre-processing output

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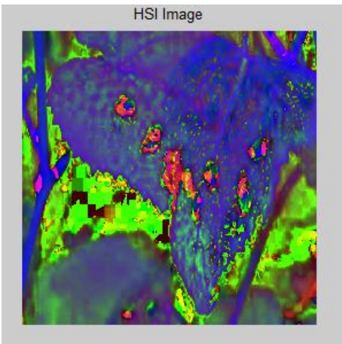

Fig. 4. HSI Image

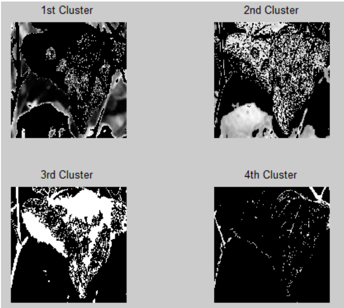

Fig. 5. Clustering Output

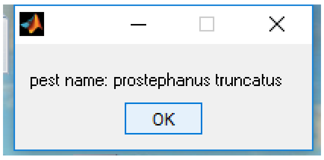

Fig.6. Pest name

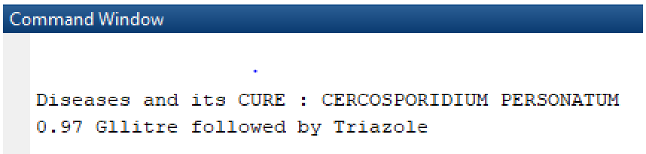

Fig. 7. Details of pest

IV. CONCLUSION

In the current work texture statistics are employed for the detection of pests on the leaves. The input color image is transformed to HSI image because it is best color descriptor. Useful segments are obtained by performing segmentation with the help of FCM. For the segments selected texture analysis is carried out by GLCM. In the final stage to classify the pests neural networks are used.

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