Identification of Mango Leaf Disease and Control Prediction using Image Processing and Neural Network

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Abstract— This proposed system has used the K-means clustering technique for the segmentation purpose and the Back Propagation Neural Network (BPNN) technique for the classification of the mango leaf disease. This system has been tested with the different numbers of test data set collected from different regions. The system is tested for different numbers of clusters to get the optimal number of cluster that can produce the best performance of the proposed mango leaf disease identification and control prediction system. This proposed system has overcome the problem of identification of mango leaf disease manually with the accuracy of about 94%.

Key words: K-Means Clustering, BPNN, Mango, Optimal, Leaf Disease

I. INTRODUCTION

Mango (Mangifera indica L.) having a place with Family Anacardiaceae is the most imperative monetarily developed natural product harvest of the nation. India has the wealthiest gathering of mango cultivars. It is called the king of fruits. The fruit is extremely prevalent with the masses because of its extensive variety of flexibility, high nutritive esteem, and lavishness in mixture, tasty taste and phenomenal flavor. It is a rich wellspring of vitamin A and C. The fruit is consumed raw or ripe. Great mango assortments contain 20% of aggregate solvent sugars. The corrosive substance of ready desert organic product fluctuates from 0.2 to 0.5% and protein substance is around 1%.

The proposed mango leaf disease identification and control prediction system is an automated system that can identify the two types of mango leaf disease such that Bacterial leaf spot and Red rust. The Bacterial leaf spot disease is apparent by the corroded red spots for the most part on leaves and in some cases on petioles and bark of youthful twigs. The spots are greenish dim in shading and smooth in composition. The Red rust disease is evident by the rusty red spots mainly on leaves and sometimes on petioles and bark of young twigs. The spots are greenish grey in color and velvety in texture. Later, they turn reddish brown. These diseases affect the production of mango and degraded the quality of mango. There is not an automated system that can detect the disease of the mango leaf so this proposed work will provide an automated system which will be able to identify mango leaf disease and predict the appropriate control for the mango leaf disease.

II. LITERATURE REVIEW

Earlier papers were describing the identification of various leaf diseases as illustrated and discussed below. [1] In this paper consists of two phases to identify the affected part of the cotton leaf spot disease. Initially Edge detection based Image segmentation is done, and finally image analysis and classification of diseases is performed using our proposed Homogeneous Pixel Counting Technique for Cotton Diseases Detection (HPCCDD) Algorithm. The goal of this research work is identify the disease affected part of cotton leaf spot by using the image analysis technique. This work finds out the computer systems which analyze the input images using the RGB pixel counting values features used and identify disease wise and next using homogenization techniques Sobel and Canny using edge detection to identify the affected parts of the leaf spot to recognize the diseases boundary is white lighting and then result is recognition of the diseases as output. [2] In the proposed system, grape leaf image with complex background is taken as input. Thresholding is deployed to mask green pixels and image is processed to remove noise using anisotropic diffusion. Then grape leaf disease segmentation is done using K-means clustering. The diseased portion from segmented images is identified. Best results were observed when Feed forward Back Propagation Neural Network was trained for classification. [3] This paper achieve automatic diagnosis of plant diseases and improve the image recognition accuracy of plant diseases, two kinds of grape diseases (grape downy mildew and grape powdery mildew) and two kinds of wheat diseases (wheat stripe rust and wheat leaf rust) were selected as research objects, and the image recognition of the diseases was conduced based on image processing and pattern recognition. After image preprocessing including image compression, image cropping and image de-noising, K-means clustering algorithm was used to segment the disease images, and then 21 color features, 4 shape features and 25 texture features were extracted from the images. Back propagation (BP) networks were used as the classifiers to identify grape diseases and wheat diseases, respectively. The results showed that identification of the diseases could be effectively achieved using BP networks. [4] This research developed a mobile application for paddy plant disease identification system using fuzzy entropy and classifier probabilistic neural network (PNN) that runs on Android mobile’s operating system. Paddy diseases are extracted from digital paddy leaf images using fuzzy entropy and then the diseases are classified using PNN. The experiment result shows that the accuracy of paddy diseases identification is 91.46%. [5] This paper presents a survey on methods that use digital image processing techniques to detect, quantify and classify plant diseases from digital images in the visible spectrum. Although disease symptoms can manifest in any part of the plant, only methods that explore visible symptoms in leaves and stems were considered. [6] This paper provides various methods used to study of leaf disease detection using image processing. The methods studies are for increasing throughput and reduction subjectiveness arising from human experts in detecting the leaf disease. [7] Cotton leaf spot disease spots were segmented efficiently
according to color and outline of disease spots. Initially, image segmentation is done, and finally image analysis and important features are extracted and classification of diseases is performed using SVM classifier. [8] In this work, the new feature extraction method has been proposed using Enhance PSO with Skew divergence technique. The obtained features have been classified using SVM, BPN and Fuzzy classifiers. The accuracy of 94% is obtained using proposed EPSO feature. [9] The available literatures on image processing in agriculture application under high performance computing (HPC) which provides basic understanding of parallel and distributed image processing for agriculture application. [10] There are so many classification techniques such as k-Nearest Neighbor Classifier, Probabilistic Neural Network, Genetic Algorithm, Support Vector Machine, and Principal Component Analysis, Artificial neural network, Fuzzy logic. This paper provides an overview of different classification techniques used for plant leaf disease classification. [11] This paper addresses how the disease analysis is possible for the cotton leaf diseases detection, the analysis of the various diseases present on the cotton leaves can be effectively detected in the early stage before it will damage the whole plant, initially we can be able to detect 3 diseases on the cotton leaves by the methodology of Eigen feature regularize and extraction technique. [12] another related work was Thai Herb leaf Image Recognition System used KNN and accuracy is 76%. [13] In this paper a noble methodology i.e. image processing of the paddy leaf by histogram is proposed, to avoid large scale effect of these diseases. [14] Alternaria Leaf Spot disease of cotton and deficiencies of major nutrients like Nitrogen, Potassium, Phosphorous, Manganese, Molybdenum, Chlorine and calcium has also been detected in this research. [15] This paper provides a survey to study in different image processing techniques used for studding leaf diseases.

III. PROBLEM IDENTIFICATION

By a detail study of literature we have identified the following problems:

The mango leaf disease is identified manually. In this technique a man who has the information of the plant leaf has been called for examination for the diseased plant then the leaf disease will be distinguished by the learning and experience of that individual and the control is advised by that individual.

This all procedure happens physically so the time it now, prolonged and has a great deal of shots of being misguided judgment of right leaf disease identification proof.

Till now the various automated systems have been developed for the cotton, grape, banana, bamboo, rice, herb leaf diseases but there is not any system that can automatically detect mango leaf diseases, so this proposed work will provide an automated system which will be able to identify mango leaf diseases and predict the appropriate control for the mango leaf disease.

IV. PROPOSED METHOD

The proposed method for the identification and control prediction of mango leaf disease is composed of image processing and neural network techniques. The block diagram of proposed mango leaf disease identification and control prediction algorithm is shown in figure 1.

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**Fig. 1: Block diagram of proposed mango leaf disease identification and control prediction algorithm**

This is the method which utilizes the techniques of image processing and neural network in a composite manner to obtain the desired goal. The proposed mango leaf disease identification and control prediction algorithm consist of the following steps:

A. **Step 1: Image Acquisition**

Mango leaf images are captured from different regions by using digital mobile camera, Xiaomi Redmi 1S, 8 Megapixel and are used for training and testing the system then the background data are removed and stored in standard jpg format.

B. **Step 2: Image Pre-Processing**

Image pre-processing includes the following three modules:

- Cropping leaf image.
- Resize.
- Median filter.

C. **Step 3: Image Conversion**

The image conversion includes the following types of conversion for different purposes:

- RGB to gray.
- Gray to binary.
- RGB to L*a*b* color shape.

D. **Step 4: Segmentation**

To extract the ROI in diseased mango leaf the K-means clustering algorithm is used. This algorithm clusters the point nearest to the centroid. The centroid is basically the average of all the points in that cluster and has coordinate as the arithmetic mean over all points in the cluster, separately for each dimension.

E. **Step 5: Feature Extraction**

The following features are extracted to classify the disease:

1) Area: The actual number of pixels in the region of interest.
2) Orientation: The angle θ (in degrees ranging from -90 to 90 degrees) between the x-axis and the major axis of the ellipse that has the same second-moments as the region.

\[
\theta = \arctan\left(\frac{c-a + \sqrt{(c-a)^2 + 4bc}}{2b}\right)
\]

3) EquivDiameter: It specifies the diameter of a circle with the same area as the region. Computed as:

\[
\text{EquivDia} = \sqrt{\frac{4\times \text{area}}{\pi}}
\]

4) Extent: It specifies the ratio of pixels in the region to pixels in the total bounding box. Computed as:

\[
\text{Extent} = \frac{\text{Area of ROI}}{\text{Area of bounding box}}
\]

5) Solidity: It specifies the proportion of the pixels in the convex hull that are also in the region and computed as:

\[
\text{Solidity} = \frac{\text{Area}}{\text{Convex Area}}
\]

6) ConvexArea: It specifies the number of pixels in ‘Convex Image’.

7) MajorAxisLength: It specifies the length (in pixels) of the major axis of the ellipse that has the same normalized second central moments as the region.

8) Number of Objects: It is the number of white pixels which are disconnected to each other in binary image.

F. Step 6: Classification

For the classification the feed forward Back Propagation Neural Network classifier technique is used which consists of three layers namely input layer, a hidden layer, and an output layer.

G. Step 7: Disease Identification and Control Prediction

The BPNN assigns an appropriate mango leaf disease class i.e., red rust or bacterial leaf spot. Then it appropriate control prediction for the bacterial leaf spot or red rust is also given by the system automatically.

V. EXPERIMENTAL RESULTS

The experimental environment is worked on a 2.13 GHz Intel(R) Core(TM) i3 CPU m330 with 3 GB of RAM PC. By using computer simulation “MATLAB R2014a” version 8.3, we analyzed the performance of the leaf disease identification and control prediction algorithm in standard digital color images taken from test data set.

Fig. 2: The original diseased mango leaf images used for testing (a) Bacterial leaf spot (b) Red rust.

These test images are pre-processed by using median filter and the output pre-processed images are shown in figure 3.

Fig. 3: Pre-processed test images of (a) Bacterial leaf spot (b) Red rust.

Now these pre-processed images are converted into the binary images based on the threshold value 0.17 which output is shown in figure 4.

Fig. 4: Binary images of (a) Bacterial leaf spot (b) Red rust.

These binary images are now used for the segmentation in which the K-means clustering method is used; here the number of cluster taken is 5 and the clusters formed by K-means clustering method is shown in figure 5.

Fig. 5: Five clusters formed by K-means clustering method in segmentation (a) Bacterial leaf spot (b) Red rust.

By using these clusters the different features are extracted.

Now these testing data features are compared with the training data features by using BPNN and the following experimental results are obtained:
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In figure 6 the proposed system is tested in which all the steps of proposed algorithm is performed step by step and the features of diseased region in testing data is compared with the training data and then the appropriate disease is identified by the system as follow:

Figure 7 shows the final result of the system where the mango leaf disease is identified as well as the control for the identified disease is also predicted by the system, which is useful for the farmers.

<table>
<thead>
<tr>
<th>Test Image</th>
<th>Testing time (in seconds) needed for different number of clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Image 1</td>
<td>0.046452 0.075943 0.106 0.154597</td>
</tr>
<tr>
<td>Test Image 2</td>
<td>0.045826 0.075146 0.105354 0.152318</td>
</tr>
<tr>
<td>Test Image 3</td>
<td>0.045531 0.078333 0.109949 0.149549</td>
</tr>
</tbody>
</table>

Table 1: Total Testing Time Required For Different Number of Clusters for Test Data Sets

Table 1 shows the time required by the proposed mango leaf disease identification and control prediction algorithm for detecting the disease and control prediction for diseased mango leaf with the different numbers of clusters that has been given at the time of segmentation step.

<table>
<thead>
<tr>
<th>Test Image</th>
<th>System output (True/False) for different number of clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Image 1</td>
<td>True True False False</td>
</tr>
<tr>
<td>Test Image 2</td>
<td>True True True True</td>
</tr>
<tr>
<td>Test Image 3</td>
<td>True True True True</td>
</tr>
<tr>
<td>Test Image 4</td>
<td>True True True True</td>
</tr>
<tr>
<td>Test Image 5</td>
<td>True True True True</td>
</tr>
<tr>
<td>Test Image 6</td>
<td>True True False True</td>
</tr>
<tr>
<td>Test Image 7</td>
<td>False True False True</td>
</tr>
<tr>
<td>Test Image 8</td>
<td>False True True True</td>
</tr>
<tr>
<td>Test Image 9</td>
<td>True True True True</td>
</tr>
<tr>
<td>Test Image 10</td>
<td>False True True True</td>
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</tbody>
</table>

Table 2: Accuracy of the System For Different Number Of Clusters To Identify The Mango Leaf Disease

Table 2 shows the experimental results that have been obtained to detect the correct mango leaf disease with the different numbers of clusters.

<table>
<thead>
<tr>
<th>Test Image</th>
<th>System output (True/False) for different number of clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Image 1</td>
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</tr>
<tr>
<td>Test Image 2</td>
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</tr>
<tr>
<td>Test Image 3</td>
<td>True True True True</td>
</tr>
</tbody>
</table>

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mango leaf disease is also increase with the rate of approximate 65% to 50% with respect to its previous cluster segment with our proposed algorithm. From table II we observed that the 3 clusters segment produces 70% accuracy, 5 clusters segment produces about 100% accuracy, 7 clusters segment produces the mango leaf disease with our proposed algorithm. From table III it is observed that the bacterial leaf spot can be identified with the 90% accuracy 70% accuracy and the 10 clusters segment produces 90% accuracy to identify with the 3, 5, 7 clusters segments and 80% with the 10 clusters segment with our proposed algorithm. From table IV it is observed that the red rust can be identified with the accuracy 40% in 3 clusters segment, 90% in 5 clusters segment, 80% in 7 clusters segment and about 100% in 10 clusters segment with our algorithm.

Hence we can conclude that the optimal number of segment is the 5 clusters which give optimal performance about 94% of the proposed system.

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REFERENCES


VI. CONCLUSION

This work proposed a mango leaf disease identification and control prediction algorithm. Based on the experimental results we can conclude the following results:

From table I it is observed that when the number of clusters increases then the total testing time to identify the mango leaf disease.


