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SVM Classifier Based Grape Leaf Disease Detection

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Abstract— **Grape constitutes one of the most widely grown fruit crops in the India. Productivity of grape decreases due to infections caused by various types of diseases on its fruit, stem and leaf. Leaf diseases are mainly caused by bacteria, fungi, virus etc. Diseases are a major factor limiting fruit production and diseases are often difficult to control. Without accurate disease diagnosis, proper control actions cannot be used at the appropriate time. Image Processing is one of the widely used technique is adopted for the plant leaf diseases detection and classification. This paper is intended to aid in the detection and classification leaf diseases of grape using SVM classification technique. First the diseased region is found using segmentation by K-means clustering, then both color and texture features are extracted. Finally classification technique is used to detect the type of leaf disease. The proposed system can successfully detect and classify the examined disease with accuracy of 88.89%.**

Keywords— Image Processing, Leaf diseases detection, K-means clustering, feature extraction, SVM Classification.

I. INTRODUCTION

In India grape productivity is highest in the world and there is scope to raise it further. Grape export from India is about 53,910 tonnes valued at 48,505 (1000US$) that makes a share of nearly 1.54% of total export of grapes in world. Near about 70% of population depends on agriculture. Grapes are an important fruit crop in India. Due to disease on grape plant there is loss of about 10-30 % of crop. Therefore there is a need to identify the diseases at the beginning and suggest solutions to the farmers so that maximum harms can be avoided so as to increase the yield.

Farmers generally use naked eye observation to judge the diseases. But sometimes this may be an inaccurate way. Many times farmer needs to call the experts for detecting the diseases which is also time consuming in large farms [3].

The grape suffers from enormous loss due to the leaf diseases like: Powdery mildew, Downy mildew and anthracnose etc [1]. The disease on plant is on their leaves, fruits and on stem of plant. In an agriculture field, an early detection of leaf diseases is the major challenge.

Using digital image processing techniques, number of applications has found in different fields such as industrial inspection, medical imaging, remote sensing, and agricultural processing etc.

For analysis in various agricultural applications, digital image processing techniques have been established as an effective way such as plant recognition, soil quality estimation, and crop yield estimation etc. in the field of agriculture. One of the applications of digital image processing techniques in agriculture is to detect plant disease.

The disease types are classified into bacterial, viral, fungal etc. on plant. In India the fungal diseases for grape leaf found are Downy Mildew, Powdery Mildew and Anthracnose. The proposed work focused on recognition and classification of fungal disease like Downy Mildew and Powdery Mildew using image processing. This work describes that how we can do the automatic detection of grape leaf diseases. The given system provides automatic, fast, accurate and less expensive method to detect and classify the grape leaf diseases.

II. LITERATURE SURVEY

Lots of researches have been done on the use of digital image processing for detection of plant leaf diseases in agricultural applications. Visual recognition of diseases on leaves is less accurate and it requires more experienced knowledge.

The automated plant disease detection provides advantages in an agricultural area hence it is an important research topic.

In [4] authors have proposed detection and classification of grape leaf diseases using Neural Networks (NN). In this system, grape leaf image is taken as input. Thresholding is deployed to mask green pixels. An anisotropic diffusion is used to remove noise. Then by using K-means clustering grape leaf disease segmentation is done. Using Neural Networks the diseased part is recognized.

In [5] authors provided color transform based approach to detect disease spot on plant leaf. In this paper a comparison of the effect different types of color space in the process of disease spot detection given. All color models (CIELAB, HSI and YCbCr) are compared and finally „A" component for CIELAB color model is used. Median filter is used for image smoothing. Finally by using Otsu method on color component, threshold can be calculated.

In [6] authors provided fast and accurate diagnosis and classification of plant diseases. In this method K-means clustering is used for segmentation and NN is used as a classification using some texture feature set.

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In [8] authors given the different types of diseases in rice leaf. In preprocessing techniques segmentation of leaf disease detection has been discussed. Using histogram plot the classification of normal and diseased leaf is done. Both shape and color features are extracted. Using PCA method shape features are extracted and using color based grid moments the color features are extracted.

All these mentioned methods uses either texture, shape or color features for feature extraction.

Also in NN classifier, it is hard to know how many neurons and can be done for small dataset only.

III. SYSTEM DESIGN

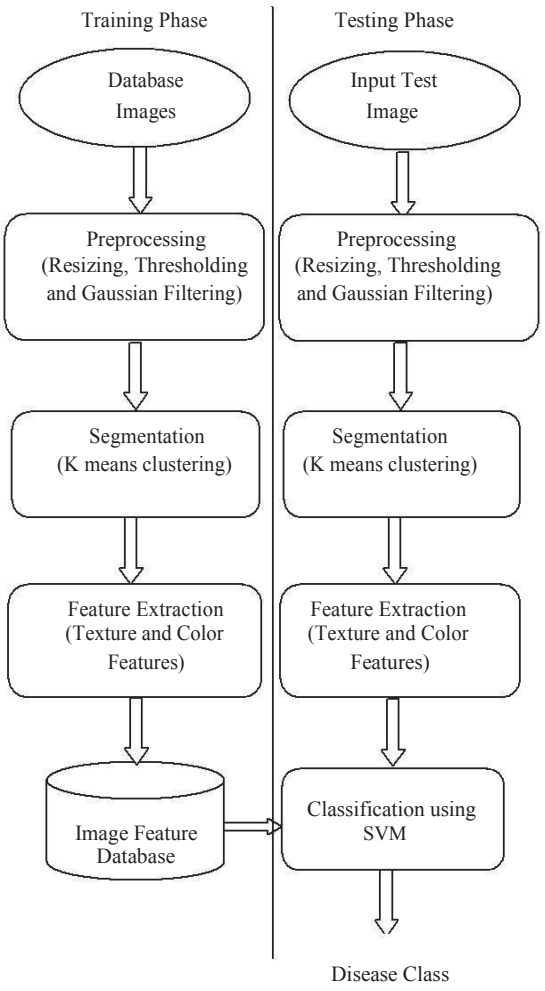


Fig. 1. System Block Diagram

A. Image Acquisition

In this step the sample images are collected, which are required to train the system. Grape leaf images are taken by using digital camera and are used for both training and testing the system. The standard jpg format is used to store these images. In this study, images are collected from different regions like Pune, Nasik. Few of the images have been taken from internet. Collected images include the leaves infected by Powdery Mildew and Downy Mildew.

B. Preprocessing

The image preprocessing is done on gathered images for improving the image quality. It removes the background noise as well as to suppress the undesired distortion. In this image is first resized to size 300x300 and then thresholding is done to get all green color component. Gaussian filtering is carried out to remove noise in the image.

C. Segmentation

In image segmentation the separation of the given image into homogenous regions with respect to certain features is done. Clustering is a method by which the large sets of data are grouped into clusters of smaller sets or segments of similar data.

In present work, K-means clustering is used to for segmenting an image into three groups as shown in Fig. 4. The clusters contain diseased part of leaf. Before clustering 'a' component is extracted from L*a*b space [5].

Properties of K-Means Algorithm and K-Means Algorithm Process [10] are given as below:

1) Properties of K-Means Algorithm

a) There is K number of clusters always.

b) There is minimum one item in each of the given cluster.

c) The clusters never overlap with each other.

d) Each member of single cluster is nearer to its cluster than any other cluster.

2) The Process of K-Means Algorithm

a) First divide the dataset into K number of clusters and assign the data points randomly to the clusters.

b) Then for each data point, calculate the Euclidean distance, from the data point to every cluster.

The Euclidean distance is the straight-line distance between two pixels and is given as follows:

$$\text{Euclidean Distance} = \sqrt{((x1 - x2)^2 + (y1 - y2)^2)} \quad (1)$$

Where (x1, y1) & (x2, y2) are nothing but two pixel points (or two data points).

c) If the data point is closest to its own cluster then leave it where it is.

d) Shift it into the nearby cluster, if the data point is not closest to its own cluster.

e) Repeat all steps until an entire pass through all the data points.

f) Now the clusters become stable and the process of clustering will stop.

D. Feature extraction

The feature extraction is used to extract the information that can be used to find out the significance of the given sample. The main types of features are shape, color and texture, which are mostly used in image processing technique.

For Downy Mildew color features and for Powdery Mildew texture features are need to be used. Hence in this system color and texture features both are extracted to get better accuracy.

Following steps are used to calculate the color features for a given image [8]

1) First conversion of RGB image into HSV color spaces is done.
2) An image is subdivided into 3X3 blocks uniformly.
3) The mean color (H/S/V) for each of the nine blocks is calculated by using following formula.

$$x' = \frac{1}{N} x_i \qquad (2)$$

Where x_i is the pixel intensity and N is the total number of pixels.

Here mean is considered as one of the feature.

4) For each block the variance is calculated by using below formula.

$$\text{Variance} = \frac{1}{N} \sum_{i=1}^{N} (x_i - x')^2 \qquad (3)$$

The computed variance has the ability of measuring the variability.

5) The skewness for each block of (H/S/V) is calculated.

$$\text{Skewness} = \frac{\frac{1}{N} \sum_{i=1}^{N} (x_i - x')^3}{\left(\frac{1}{N} \sum_{i=1}^{N} (x_i - x')^2 \right)^{\frac{3}{2}}} \qquad (4)$$

The skewness is used to judge the image surface. Each block will have 3+3+3=9 color features.

The 9 texture features-contrast, uniformity, maximum probability, homogeneity, diagonal variance, difference variance, entropy, inverse difference, and nine color features are used.

TABLE I. MATHEMATICAL FORMULAS FOR TEXTURE FEATURES [7]

We first need to combine the texture and color (9+9=18) features for classification, before we use SVM to train the classifier.

No.	Feature	Formula
1	Contrast	$\Sigma_i \Sigma_j \lvert i-j \rvert^2 p(i, j, d, \theta)$
2	Uniformity (Energy)	$\Sigma_i \Sigma_j p(i, j, d, \theta)^2$
3	Maximum probability	$\text{Max}_{ij}\, p(i, j, d, \theta)$
4	Homogeneity	$\Sigma_i \Sigma_j p(i, j, d, \theta)/(1 + \lvert i-j \rvert)$
5	Inverse difference moment of order 2	$\Sigma_i \Sigma_i 1/(1 + (i-j)^2)\, p(i, j, d, \theta)$
6	Difference variation	Variance of $\Sigma_i \Sigma_i \lvert i-j \rvert\, p(i, j, d, \theta)$
7	Diagonal variance	Variance of $p(i, j, d, \theta)$
8	Entropy	$\Sigma_i \Sigma_i p(i, j, d, \theta) \log (p(i, j, d, \theta))$
9	Correlation	$\sum_{i,j} \frac{(i-\mu_i)(j-\mu_j)p(i,j)}{\sigma_i \sigma_j}$

E. Classification

The classification technique is used to detect the type of leaf disease. Classification deals with associating a given input pattern with one of the distinct class. In the given system a Linear Support Vector Machine (LSVM) is used for classification of leaf disease.

SVM is a binary classifier which uses a hyper plane called the decision boundary between two classes. This hyper plane tries to divide, one class containing the target training vector which is labeled as +1, and the other class containing the training vectors which is labeled as −1.

Using this labeled training vectors, SVM optimizer finds an hyper plane that will then maximizes the margin of separation among the two classes as shown in Fig. 2.

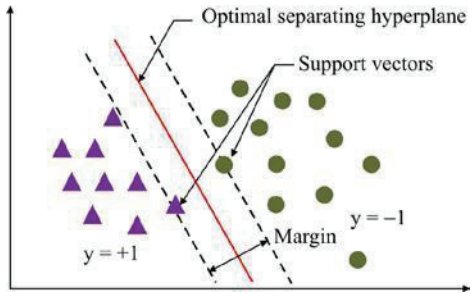


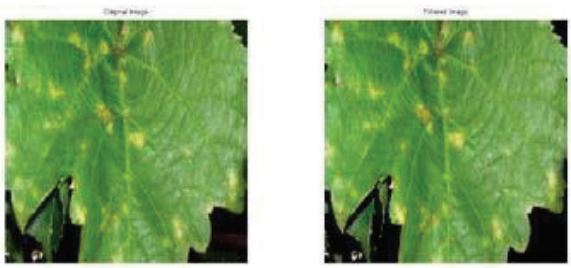
Fig. 2. SVM in Linearly Separable Condition [9]

IV. RESULTS AND DISCUSIONS

Classification involves two stages, training and testing using any classifier. In training phase, classifier is trained using feature values and its respective target values. This trained classifier is then used to classify test images.

In this work total 137 grape leaf images (containing both initial stage as well as final stage images) are used out of which 75 images are Downy leaf images and 62 are Powderly leaf images. For training phase 60 Downy and 50 Powderly images are used and 15 Downy and 12 Powderly are used for testing.

First step is thresholding and filtering. Fig. 3 shows original image and filtered image.



(a) (b)

Fig. 3. (a) Original Image (b) Filtered Image.

Then filtered image is segmented into 3 clusters using K-means clustering. Fig. 4 shows 3 clusters formed using K-means clustering.

Fig. 4. Segmentation using K-means Clustering.

The texture and color features of all three segmented images are extracted.

In this work nine texture features and nine color features are calculated for all three segmented parts of single leaf image. Hence total number of feature values for single leaf image becomes (9+9)*3=54. These feature values, collectively called as feature vector, is given to trained SVM classifier which classifies the input leaf image into two classes Downy and Powderly, depending upon its feature values.

Image shown in Fig. 3 is Downy leaf image so SVM classifies it into Downy class and this result is presented into a message box as shown in Fig. 5.

Fig. 5. Classification Result Presented by a Message Box.

The overall performance of SVM classifier is summarized into Table II. It can be seen from the Table II that SVM perform extremely good with Downy class of grape leaves but gives considerably poor performance with Powderly class.

TABLE II. CLASSIFICATION RESULTS OF SVM

Dataset	Total test samples	Correctly Classified	% Accuracy
Downy	15	14	93.33%
Powderly	12	10	83.33%
Combined	27	24	**88.89%**

$$\text{Accuracy (\%)} = \frac{\text{Correctly Recognized Images}}{\text{Total Number of Test Images}} * 100 \quad (5)$$

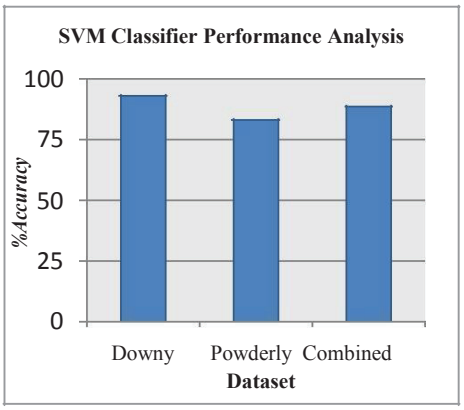


Fig. 6. SVM Performance Analysis.

Table III shows comparative study of this system with previous system.

TABLE III. COMPARATIVE ANALYSIS

Parameters	Previous System, S. S. Sannakki et al. [4]	This System
Classifier Used	NN	SVM
Total Samples	33	137
Features Used	9 (Texture)	18 (9 Texture & 9 Color)
% Accuracy	100%	88.89%

V. CONCLUSIONS AND FUTURE WORK

The given system uses resizing, thresholding and Gaussian filtering for image preprocessing. To segment the leaf area, the K-means clustering technique is used for segmentation of image then feature extraction is done using both texture as well as color features. Then finally SVM classification technique is used to detect the type of leaf disease. In the experiment two classes of grape leaves were considered namely, Downy Mildew and Powdery Mildew. The given system gives **88.89%** average accuracy for both Downey and Powderly grape leaf disease.

Future expansion of this work will be focused on following points:

1) To develop combinations of more algorithms by using fusion classification technique, so as to improve the detection rate of the classification process.
2) On the basis of detection of disease the proper mixture of fungicides will be provided to the grape farmer for further use in their farms.
3) To design an automated system with the help of embedded system so that this fungicide mixture will be automatically sprayed using spraying mechanism.

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