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Smart Farming: Pomegranate Disease Detection Using Image Processing

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Abstract

Crops are being affected by uneven climatic conditions leading to decreased agricultural yield. This affects global agricultural economy. Moreover, condition becomes even worst when the crops are infected by any disease. Also, increasing population burdens farmers to increase yield. This is where modern agricultural techniques and systems are needed to detect and prevent the crops from being effected by different diseases. In this paper, we propose a web based tool that helps farmers for identifying fruit disease by uploading fruit image to the system. The system has an already trained dataset of images for the pomegranate fruit. Input image given by the user undergoes several processing steps to detect the severity of disease by comparing with the trained dataset images. First the image is resized and then its features are extracted on parameters such as color, morphology, and CCV and clustering is done by using k-means algorithm. Next, SVM is used for classification to classify the image as infected or non-infected. An intent search technique is also provided which is very useful to find the user intension. Out of three features extracted we got best results using morphology. Experimental evaluation of the proposed approach is effective and 82% accurate to identify pomegranate disease.

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Keywords: color; morphology; color coherence vector; support vector machine; k-means algorithm; intent search

1. Introduction

Farmers normally observe visual symptoms of disease on fruit. Experts may easily diagnose the disease or may rely on lab diagnostic test. Most of the currently followed practices for fruit disease detection system in India are naked eye observation by domain expert. The consultation charges of professional experts are high and it is also not possible to get it on time at remote location. Hence, there is a need of automatic fruit disease detection system in the early stage of the disease.

We have selected pomegranate fruit for disease detection. This fruit is mainly affected now days by the attack of Bacterial blight (also called as "Telya") causes the major loss for the farmers. The fig. 1 shows the pomegranate fruit

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Fig. 1. Pomegranate fruit and leaf affected by bacterial blight disease

and leaf affected by Bacterial blight. Bacterial blight has wide occurrence in Maharashtra, Karnataka, Tamil Nadu, Rajasthan, Andhra Pradesh and Himachal Pradesh states of India. It is also globally reported in Pakistan and South Africa. The production of this fruit is taken in the low rain region and which gives more profit to the farmers. The severity of disease is mainly in rainy season. The range of temperature between 25 to 35^{o}c with humidity greater than 50%, rains and wind are favourable for rapid disease development. This disease affects steam, leaf and fruits, but major distractive part is on fruits. The leaf disease in the form of dark brown surrounded by dark yellow, infected leaves turn in yellow color. For fruit disease, with water soaked lesions on surface, this turns dark brown to black. Small cracks on spots and in severe cases entire fruit split. There is urgent need to identify this disease at the primary stage. But due to lack of domain knowledge, farmers are not able to do it.

The aim of this paper is to find out bacterial blight on pomegranate fruit. This system take input as image of fruit and identify it as infected or non-infected. The intent search technique which helps the farmers to identify disease properly by recommending relevant images to query image from database.

2. Related Work

The author Monica Jhuria[1] provided an approach for fruit disease detection based on image processing. The purpose of research work is to detect disease on fruit. Grapes, Apple and mangoes are selected for conducting experiments. Morphology, color and texture feature vectors are chosen for feature extraction. Morphology feature gives 90% accurate results than other feature vectors. For disease detection and weight calculation of fruit image processing techniques are used. Back propagation is used for weight adjustment of images that are stored in learning database. On the basis of disease spreading, the grading of fruit has been decided.

The author Shiv Ram Dubey[2] suggested an image processing based way for detection and identification of fruit disease. The fruit selected is apple and diseases considered are namely apple rot, apple blotch for conducting the experiments. For image segmentation, K-means clustering is used. Color coherence vector, Histogram, Local Binary patterns, complete local binary patterns are used for extracting the features. For fruit disease detection, multiclass support vector machine is used.

The author Ilaria Pertot[3] suggested multilingual web based tool. The web based tool provided for plant disease detection. Strawberry fruit is considered as case study. The farmer in the farm will observe symptoms and these symptoms will compare with images provided in the system. The outcome will be identification of fruit disease. The web based system consist user and super user. Super user has authority to add /modify / delete images and diseases. And user can use disease detection method /tool for disease detection.

The Indian government following the e-pest surveillance approach to control pests and disease through meticulous field observations for major fruits like mango, banana, and pomegranate but still this process is time consuming[7].

The proposed systems[1,2,3] provide different approaches for fruit disease detection like mango, apple, strawberry. But proposed approaches may not give good results if input image quality is low. This problem motivates to implement intent search module which will help when input image quality is poor. This module will suggest relevant images to the input image.

3. System Architecture

The system architecture is shown in following fig. 2. A web-based system can be used by user from office/lab, farm (when in front of symptomatic fruit). The user gives the input to system in the form of infected fruit image. We provided access to the system as “User”and “Super User”. User is allowed to use the system for disease detection. “Super User”which performs the task of adding/deleting/updating i.e. there is needed to add new images of diseases, delete the some information that is not required and update the information (images). To use this system user need to register first and then access the system by using the username and password. The new disease information is added by using image.

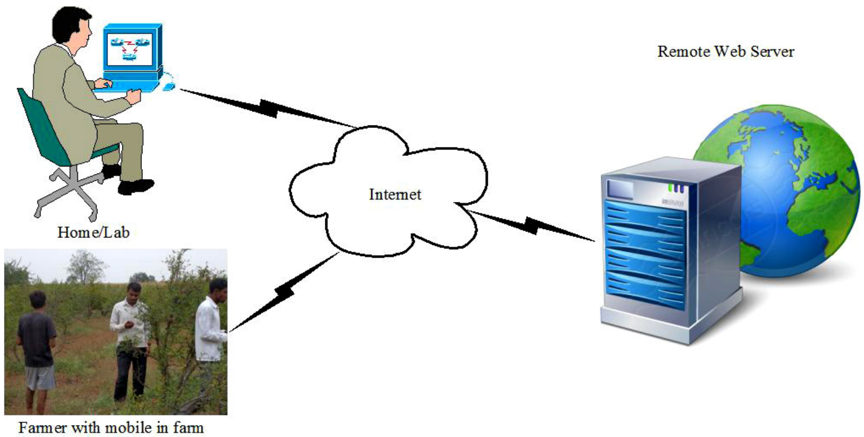

Fig. 2. System Architecture

4. Proposed Framework

Fig. 3 represents the framework of proposed system. Two image databases are required for detection of fruit disease, one for training purpose and other for testing. In the training phase, firstly input image is acquired then image pre-processing is done for resizing the images. Then feature extraction is carried out. Next, clustering is performed by applying K-means clustering algorithm and finally classification is performed using SVM. In the testing phase input image will be acquired from user, then pre-processing, feature extraction is carried out and finally the image will be classified as disease infected or non-infected.

4.1. Image Pre-processing:

The input image dataset is given and then image pre-processing is performed. The pre-processing of image includes image resizing. The images are captured by digital camera, so image size is very large. Due to large size of image, further processing may take more time so all images are resized to 300*300 PX.

4.2. Feature Extraction:

In the proposed approach, we have used color, morphology and CCV feature vectors are used for feature extraction. These extracted features have been used in classification process.

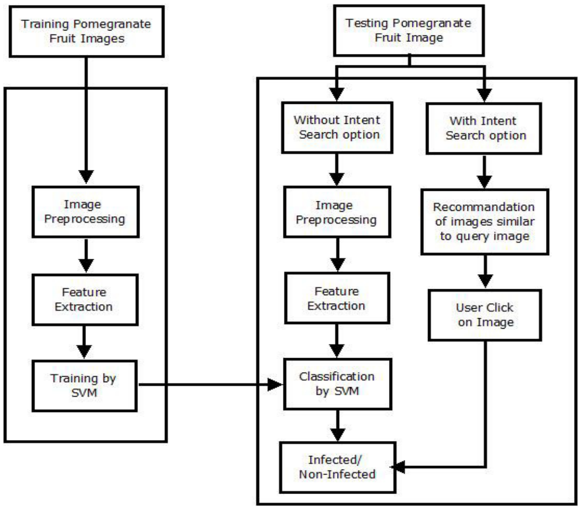

Fig. 3. Proposed System Framework

4.2.1. Color

A color is widely used visual feature and mostly used to compare images. A color histogram represents the distribution of color in image. While computing the pixels of different colors in an image, if the color space is large, then the color space is divided into certain number of small intervals. Each small interval is called bin. Then by counting number of pixels in each of the bins, we get color histogram of image. Here, we computed color histogram for all images in dataset and save in database which will be used for comparison of query image with dataset images. Usually, color histogram of two images is compared using sum of squared of differences. Here three bin histogram is built for RGB color space.

4.2.2. Morphology

Morphology is tool used for extracting image components. These extracted image components are useful in description and representation of region shape such as boundary extraction[6]. Here, the erosion concept is used which is fundamental operation of morphology for obtaining the boundaries of images. After applying erosion operation, we get image boundary by subtracting eroded images from original image. By using morphology, we will extract disease shape vector from healthy fruit.

4.2.3. Color Coherence Vector

CCV is a histogram-based method for comparing images that incorporates spatial information. In this technique, each pixel in a given color bucket is classified as either coherent pixel or incoherent pixel. Classification of each pixel is based on whether or not it is part of a large similarly-colored region. Coherent pixels are part of some sizable contiguous region, whereas incoherent pixels are not belongs to some sizable region. In order to compute CCV, first image is blurred. Then color space is discretized, ensuring that there are only n distinct colors in the image. Here, τ is considered as constant and τ's value is assumed as 1% of image. Any Connected Component has number of pixels more than or equal to τ then its pixels are considered coherent and the others are incoherent.

4.3. Clustering:

K-means clustering technique is used for partitioning the training dataset according to their features. When we deal with larger dataset, K-means clustering algorithm gives greater efficiency.

Algorithm for K-means Clustering:

Input: Dataset (Pomegranate fruit image), K number of desired clusters.
Output: K set of clusters.

1.Initialize the number of cluster k, and also pick initial centroid randomly.
2.The squared Euclidean distance will be calculated from each image to each cluster is computed, and each object is assigned to the closest cluster.
3.For each cluster, the new centroid is computed and each seed value is now replaced by the respective cluster centroid.
4.Euclidean distance from an object to each cluster is calculated, and the image is allotted to the cluster with the smallest Euclidean distance.

This process will be continue until image is in same cluster at every iteration.
The Fig.4 represents clusters generated by K-means clustering algorithm.

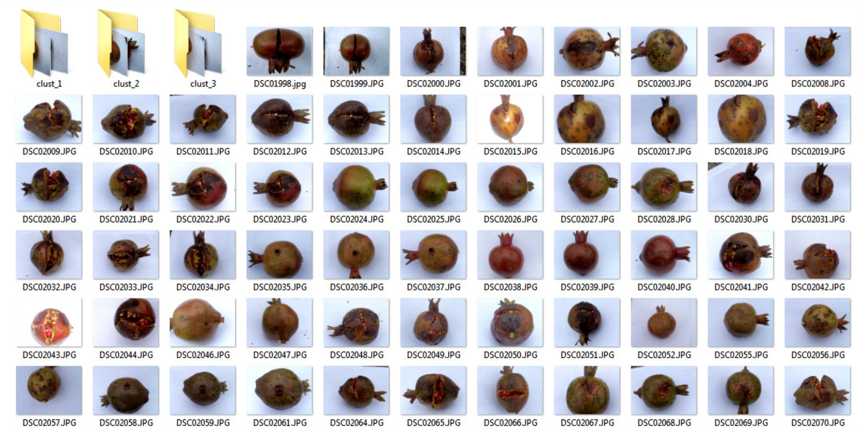

Fig. 4. Clusters

4.4. Training and Classification:

Support Vector Machine (SVM) algorithm is used for training and classification. Support vector machine find out the linear separating hyper plane which maximize margin and can be used for classification. SVM uses a nonlinear data into higher dimensions. Dimension boundary separate tuples from one class to another. The training time of Support vector machine is slow but they are highly accurate. After applying SVM, clusters will classify into two classes with labels disease infected images and non-infected images. Infected image class consist fruit images affected by bacterial blight and non-infected image class includes healthy fruit images.

4.5. Intent Search:

The intent search technique helps to find the user intension when finding the disease of the fruit. The selection of this technique is optional to the user. When user uploads the image for disease detection, user will get this option. This option will be very useful when text based query or visual identification is ambiguous. When user selects this option, the recommendation of images matching closely to query image will be shown from database to the user[4,5]. By looking the number of images visually user will click on image which is similar to his fruit disease image. Then the clicked image will be considered as query image for further processing. So this technique helps to improve the detection results even more precisely.

Algorithm for Intent Search

```
Input:  Src img
Output:Set of most relevant images
1.histr = computehistogram(src img , r);
  histg = computehistogram(src img , g);
  histb = computehistogram(src img , b);
2.Set dist_vect = ← ϕ
3.for each di from dataset image
  compute r, g ,b histogram
  histr_d = computeHist(di,r);
  histg_d = computeHist(di,g);
  histb_d = computeHist(di,b);
  dist_vector[di] = compute Euclidian distance(histr,histr_d)
  + compute Euclidian distance(histg,histg_d)
  + compute Euclidian distance(histb,histb_d)
  end for
4.Order(sort) dist_vector from lowest to highest (i=1...........n).
5.Select the k-nearest instances to src_img.
6.Return k-nearest instances.
7.End
```

5. Experimental Analysis and Result

5.1. Data set Preparation:

To demonstrate the proposed system we have created the dataset of pomegranate images with the help of domain expert (professor from agricultural college). Images are captured by digital camera of 10 mega pixel. The fig.5 shows the different classes of data set. Data set contains total 610 images of disease infected (440) and normal (170) pomegranate fruits. Under infected category three subcategories such as infected stage-I(180), infected stage-II(150) and infected stage-III(110). In infected stage-I of the fruit, the disease is at the preliminary level and it is still at surface of the fruit i.e. it affects by having small dot like structures on the fruit surface. In infected stage-II, the spots on the fruit surface are darken, grow in size and a small crack is developed within. In infected stage-III, the fruit surface darkens furthermore, and the cracks widen at such a scale that, the fruit splits almost entirely into two parts.

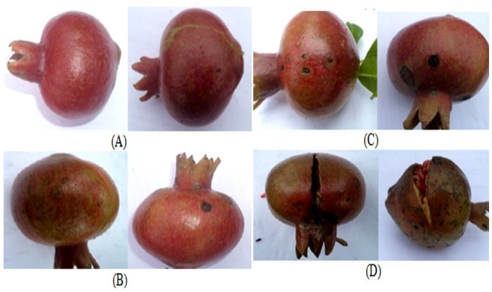

Fig. 5. Sample images of Data set (A) Non-infected (B) Infected Stage-I (C) Infected Stage-II (D) Infected Stage-III

5.2. Result Discussion:

Following table 1 shows disease detection accuracy for different stages of disease, we got less accuracy for infected Stage-I because at this stage very small spot/s appears on fruit and detection by image processing techniques becomes difficult. The disease detection accuracy shown in table 1 and table 2 are obtained by applying color, morphology and CCV feature vectors.

Table 1. Disease Detection accuracy for different stages of disease

Input image category	No. of images	Disease Detection Percentage
Non-infected	60	88%
Infected Stage-I	40	66%
Infected Stage-II	45	82%
Infected Stage-III	50	87%

For training purpose, all images are captured by digital camera. But for testing purpose, we have considered images those are captured by digital camera as well as mobile device camera. We considered here mobile device camera because farmers also use mobile camera to capture fruit images. Table 2 shows the disease detection accuracy for images captured by different cameras.

Table 2. Disease Detection Accuracy for images captured by different cameras

Input image captured by device	No. of images	Disease Detection Percentage
Digital Camera (10 mega pixel)	34	85%
Mobile (5 megapixel)	54	82%
Mobile (3 megapixel)	48	79%

The image from database closely matches to query image is shown first in the result. Images are shown according to descending order of rank we got from the algorithm which is shown in fig. 6. We got almost similar results in case of combining all features together and morphology. The results of histogram features are poor as compare to other features.

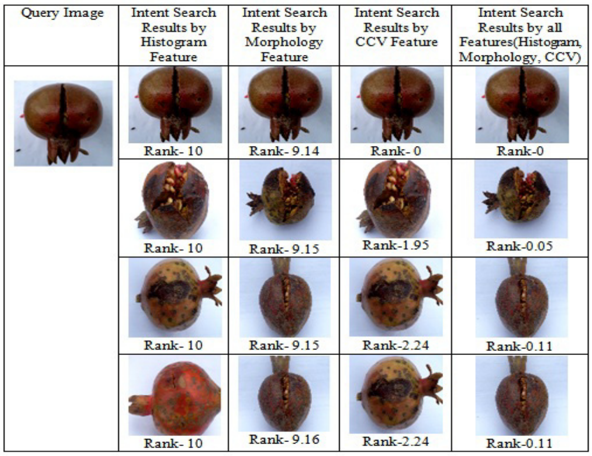

Fig. 6. Intent Search ranking

The accuracy of intent search is calculated by the correct result shown for query image. Fig. 7 shows the graphical representation for intent search accuracy by applying different features. When we apply features individually then morphology gives better results.

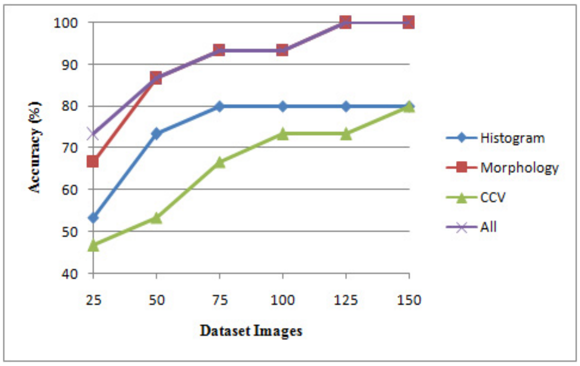

Fig. 7. Graphical representation for accuracy of Intent Search

Fig. 8 shows graphical representation for the time taken by the intent search technique for different features. The histogram technique takes less time and all features together takes more time.

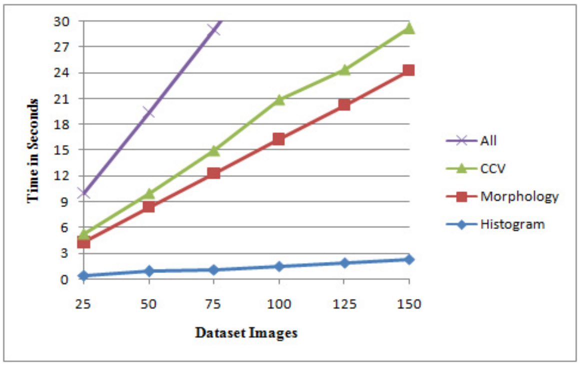

Fig. 8. Graphical representation for time taken by features extraction techniques

6. Conclusion

In this paper, a Web based Image Processing dependent approach for the Bacterial Blight (“Telya”) disease for Pomegranate fruit is proposed. The input image is first pre-processed, then its features are extracted on three parameters namely- color, morphology, and CCV then, training and classification of the same are done. The proposed system provides two methods for the user to check the disease infection for the input pomegranate image as- with intent search and without intent search.

Experimental results display different accuracy levels of disease detection based on the input image quality and the stages of the disease. The overall system accuracy is measured to be 82%. Thus, this system takes one step towards promoting the farmers to do the smart farming and allowing them to take decisions for a better yield by making them capable to take the necessary preventive, corrective action on their pomegranate crop. In future, the system can be improved with the new features incorporated as- training the system to detect diseases for other fruits, increase dataset size to improve the overall system performance to detect diseases more accurately.

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