RECOGNITION OF APPLE FRUIT DISEASE THROUGH IMAGE PROCESSING

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ABSTRACT

The quality and amount of the Nation's crop production heavily influence economic growth. Fruit diseases are a significant contributor to productivity and financial losses in the global agriculture sector. A faster output rate can be achieved through early disease detection. Over the past few years, numerous image processing-based methods for fruit disease diagnosis have been created. Plant diseases impose limitations on a plant's capacity for growth, quality, and quantity. This in turn lowers productivity and has an impact on the development of the farmers. With several research projects, image processing, a field that is always developing, has finally produced solutions for identifying plant illnesses. After locating the infected area, image pre-processing is carried out, including segmentation, feature extraction, and colour conversion. The classifiers are finally used to obtain the results. The discussion includes a variety of feature extraction and classification strategies. Here, a method of image processing is suggested for recognising fruit illnesses in apples. The suggested approach can be used to instantly and automatically detect diseases in apple fruit. The essential components of the suggested method are as follows: image pre-processing, image segmentation, feature extraction, feature combination, training, and classification.

Keywords: Wireless multimedia sensor networks, K-mean clustering, Random Forest classifier, Active Shape Model (ASP), Color Coherence Vector (CCV), and Gray Level Co-occurrence Matrix (GLCM).

1. INTRODUCTION

India is a rapidly developing nation, with agriculture serving as the foundation of its early development. India's economy is mostly reliant on agriculture about 70%. India has a reputation for being the biggest fruit advertiser. After China, India has been regarded as another important fruit producer. India is frequently referred to be the world's fruit basket. India is where the majority of the apple, banana, grape, mango, citrus, and guava are cultivated. However, as illnesses typically reduce crop output, India only makes up 1% of the global fruit market. Therefore, it is essential to employ cutting-edge technology to raise the production of agricultural goods and thereby raise farmers' incomes.

Pathogens, fungi, bacteria, and viruses are mostly responsible for plant-related disorders. Unfavorable environmental conditions are another factor that affects agriculture. As the environmental conditions are beyond human control, methods to identify diseases impacting the quality and quantity of crops have become increasingly popular. Traditionally, agricultural products are continuously observed on-site, either by farmers or by agricultural professionals. But because of the challenges posed by industrialization and globalization, this procedure requires a lot of money, time, and extra labor. Additionally, the younger generation needs to be made aware of the value of cultivation and its importance. In all areas nowadays, technology plays a vital role, yet in agriculture, we still rely on some antiquated practices. Inaccurate plant disease diagnosis results in significant yield, time, cost, and product quality losses. Successful cultivation depends heavily on determining a plant's health.

In order for computer vision to get results that are as similar to the human visual system as possible, disease detection imaging systems remain a significant issue. Due to the frequently changing fruit skin and the prevalence of many illnesses, fruit disease recognition via manual inspection is highly challenging. Therefore, in this case, image processing techniques can be used to identify fruit illness. The disease's symptoms can typically be seen on fruits, leaves, stems, flowers, etc. Exploiting image processing techniques, we are using apple fruit in this experiment to detect diseases in affected plants. Automatic fruit disease detection is essential to automatically identify disease symptoms as soon as they emerge on developing fruits Image processing makes it easier to identify fruit illnesses. By employing this approach, farmers can save time and minimise financial losses.

2. RELATED WORK

Wireless multimedia sensor networks (WMSNs) attract significant attention in the field of agriculture where disease detection plays an important role. Wireless Multimedia sensor networks (WMSNs) consist of camera-capable sensor nodes and regular sensor nodes deployed in the field of interest to gather information and communicate through wireless links. Reseachers propose [1] a novel Disease Detection System to detect the diseases in leaves and extract the features. The main contribution of the paper is a simple and efficient thresholding strategy that makes the segmented image effective for feature extraction. The extracted features are transmitted and at the receiver side, the SVM classifier is used to classify the disease.[2] developed a novel application of salad leaf disease detection using a combination of machine learning algorithms and Hyper Spectral sensing where reseachers conducted various field experiments to acquire different vegetation reflectance spectrum profiles using a portable high-resolution ASD FieldSpec4 Spectroradiometer. In their study, Principal Component Analysis (PCA), Multi-Statistics Feature ranking, and Linear Discriminant Analysis (LDA) Classifiers were used to classify disease-affected salad leaves. Their study concluded that a machine learning-based data-driven analytical approach along with a high-resolution Spectroradiometer could potentially be used on farms for rapid detection of salad leaf disease. According to [3], Remote sensing is the best approach to monitoring root-knot nematodes in coffee crops. For the spectral characterization, radiometric data of leaves measured from the same plants used to estimate agronomical parameters enabled the identification of the most sensitive spectral ranges for discrimination of the infected coffee plots. For the study of disease agronomic parameters like the Leaf Area Index (LAI) and chlorophyll relative content were considered and were measured by an AM300 Leaf Area Meter and SPAD-502 Chlorophyll Meter. radiometric data, Hemispherical Conical Reflectance Factors (HCRF) curves were used to show the spectral response of leaves collected from healthy and infected coffee plants.[4] uses Artificial Neural Network methods for the classification of disease in plants such as back propagation algorithm and SVMs. In [5] researchers adopt image processing and deep learning techniques to detect the pest attack and nutrient deficiency in coconut leaves and analyse the disease. Android application is buit to provide information about the nutrient deficiency pest attack and disease.

As described above, models based on deep neural networks along with image processing outperforms compare to traditional image processing methodology. So here an expirement is conducted to investigated the detection of Apple disease and performance analysis between SVM and RFC.

3. METHODOLOGY

There are five key phases in the detection of fruit diseases. The processing system consists of image pre-processing, image segmentation, feature extraction, training, and classification. Finally, the presence of diseases on the fruit will be identified. Below is a step-by-step breakdown of the process:

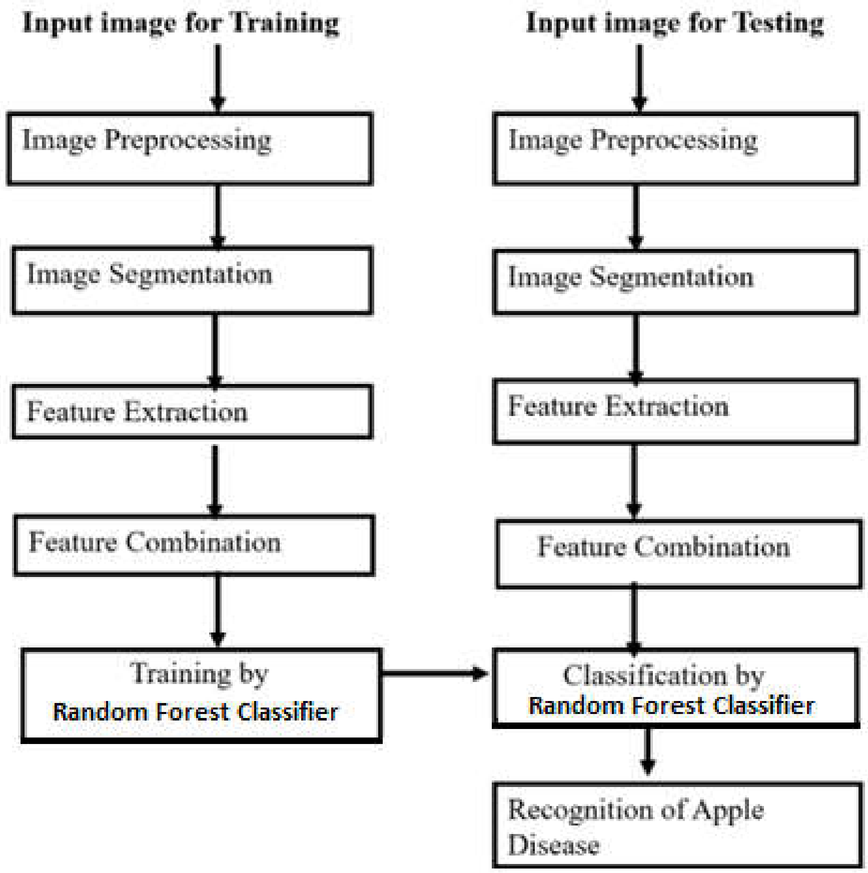

Fig 2.1: Frame work of proposed approach

A. Image Preprocessing

After the acquisition of the image, image preprocessing was carried out to enhance the image quality. Each of the original Apple fruit photos are kept in a separate folder. Only horizontal images are rotated by 90 degrees and resized by 256*256 pixels. Vertical images were resized by 256*256 pixels and when the width and height of the image are the same, those images were resized to 256*256 pixels. The processing operation requires additional time when the image size is too huge. To reduce noise in images and make them sharper, a noise reduction technique is applied. All previously processed images are then saved in a different folder.

B. Image Segmentation

The segmentation of apple fruit is required for disease classification; otherwise, the traits of the unaffected portion will dominate over those of the affected portion. For of an apple fruit image, defects are found using K-means. Unsupervised clustering method K-mean clustering divides input datasets into K clusters according to how far off they naturally are from one another. The following are the steps for defect segmentation of the apple fruit image:

Step1: Read the infected apple fruit image

Step 2: Transform an input image into L*a*b* color space.

L*, a*, and b*stand for:

- L*: Lightness
- a*: Red/Green Value
- b*: Blue/Yellow Value

Step 3: Use K-means clustering to group similar colors together.

Step4: Do the labeling of each pixel.

Step5: Segmented Image is generated.

C. Feature Extraction

The features provide the pertinent information in image processing and computer vision for solving various computational problems of various applications. Features could result from the functioning of neighboring pixels. Features serve as a representation of the image's particular structure. In the proposed method texture, color, and shape aspects are used to provide a solution to validate it.

To distinguish between healthy and unhealthy fruits, features of the Active Shape Model (ASP), Color Coherence Vector (CCV), and Gray Level Co-occurrence Matrix (GLCM) is used.

- **GLCM**

The GLCM functions determine how frequently pairs of pixels with particular values and in a particular spatial relationship occur in an image, building a GLCM, and then extracting statistical measures from this matrix to define the texture of an image.

- **ASP**

The Active Shape Model (ASM) is a model-based technique that uses a previous model of the predicted contents of the image and normally seeks to locate the optimal spot for matching the model and the data in a new image. It has been effectively used to solve a variety of issues, and we use ASM for face recognition.

- **Homogeneity**

The fluctuations in intensity that appear in a particular area of an image are connected to the homogeneity of that area. If every pixel (dot) in an image has the same color, the image is homogenous. An image is inhomogeneous if it has sharp contrasts. In terms of statistics, it is possible to determine the standard deviation of each pixel from the mean gray value.

- **Dissimilarity**: Numerical measures of how different two data objects are.
- **Correlation:** It is the measure of association that tests whether a relationship exists between two variables.
- **Contrast**: The difference in brightness between light and dark areas of an image.
- **Energy:** It is the rate of change in the color/ brightness of the pixel over local areas.
- **Coherent:** Provides a quantitative method of estimating the similarity of the data.
- **Incoherent:** Provides a quantitative method of estimating the dissimilarity of the data.

Other feature includes no of colors, color, maximum coherent, maximum noncoherent.

D. Feature combination

In this phase, we have integrated the color, texture, and shape features to create a single feature descriptor that can be used for further training and classification.

E. Training and Classification

Here, we have utilized the Random forest classifier for the training and classification of apple fruit disease. Image classification defines a set of target classes (objects to identify), and trains a model to recognize them using labeled example photos.

4. RESULTS AND DISCUSSION

A. Dataset

The image of the fruits, which are used for giving input for detecting the diseases were taken from the image repository named Kaggle.com.This dataset consists of diseased and normal fruit images. Here we have used two apple fruit diseases, blotch and rot. We have used 300 images of diseasesed and normal apple each class has 100 images.

Step 1: Input Image
At the first step of the proposed method, the image of the fruit is given as input (either fresh or diseased). The image which is given as the input will be displayed first.

(a) (b) (c)

Fig.3.1: Input Images (a) Normal fruit image, (b) Rot Apple, (c) Blotch Apple

Step 2: Image Segmentation
After displaying the input image, the disease affected areas will be highlighted . disease affected areas will be segmented and highlighted by using K means clustering algorithm.

Fig3.2: Blotch Apple

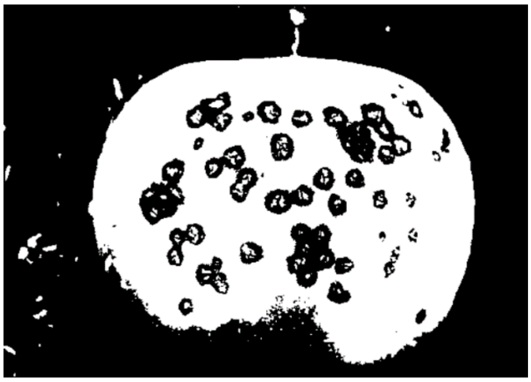

Fig3.3: disease affected areas are highlighted

Step 3: Feature extraction and feature combination

Dissimilarity, correlation, homogeneity, energy, contrast, ASM, coherent, no of colors and max noncoherent color are the features of apple fruit which are extracted using CCV and are stored in CSV file.

Step 4: Training and classification
After highlighting the disease affected areas of the fruit, then the name of the disease, accuracy of the model, pesticide and description of the diseased fruit and normal will be shown in the python shell.

If we have given a apple rot image as an input the output will be displayed as below showing the disease name and some information related to the disease along with the pesticide.

Comparison of accuracy between SVM and RFC Classifier

	Normal Apple	Rot Apple	Blotch Apple
SVM Accuracy	**35%**	**37%**	**33%**
RFC Accuracy	**73.2**	**74.6**	**71.8%**

In the proposed approach we have combined CCV and GLCM features which gives us greater accuracy as compared to SVM. Training and classification done by RFC. The accuracy is calculated using fallowing formula.
Accuracy (%) = (Correctly classified images / Total number of images used for training) *100

5. CONCLUSION AND FUTURE WORK

An image processing-based solution is proposed and evaluated in this project for the detection and classification of fruit diseases. The proposed approach is composed of mainly five steps which includes image preprocessing, image segmentation performed by using the K-Means clustering technique, features are extracted using CCV, training and classification are performed by random forest classifier. It would also promote Indian Farmers to do smart farming which helps to take time decisions which also saves time and reduce the loss of fruit due to diseases.

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