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A Review of Apple Diseases Detection and Classification

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***Abstract*- In current scenarios there are too many problems for agriculture sector like so much pollution, shortage of water, global warming etc. Because of them there are plenty of diseases which are spoiling the crop grown by farmers.**
Here, our idea is to provide a smart solution for save the crop from such diseases. Now-a-days mobile phones are easily available to anyone. So the idea is to make one mobile application which can easily detect the diseases in some specific crops and by this application farmer can also get the information about the solution or we can say pesticides for the diseased crop to save it from further destruction.

Some diseases can spoil the crop totally in just one or two days and applications like this can be very useful for farmers to save the crop in such critical conditions. By providing this solution we can possibly save the crop, money and efforts of the farmers. Also, we can overcome the problem of shortage of some crops to some extent.

Keywords- Disease detection, Image gray scaling, K-Means Clustering, Support Vector Machine, Color, Texture, Shape, Local Binary Pattern

1. INTRODUCTION

For India's Marketing Year 2017-18, apple production is forecast at 2.3 Million Metric Tons (MMT) [1]. Production also increases year by year as per the statistics. In short, India has a huge amount of production of apple. But Indian apple production is limited to the hill states of Jammu & Kashmir (J&K), Himachal Pradesh (HP), and Uttarakhand. And these are the states where people cannot get instant help if crop has any kind of disease because of the various reasons like bad weather, lack of fast transportation facility etc. which effects more to the producer in case fruits have any disease.

Apple commonly has three diseases in India- apple scab, apple rot, and apple blotch. Because of these diseases considerable amount of fruits are destroyed. Which affects economically also as India exports a small amount of apple fruit to the neighboring countries like Nepal and Bangladesh. So the diseases of the apples are the huge problems for the farmers of apple.

These diseases can be identified by the unique symptoms of each one. Apple scabs are gray or brown corky spots. Apple rot is having slightly sunken, circular brown or black spots which may be covered by a red halo. Apple blotch diseases are fungal diseases which appear on the surface of the apple fruit as dark, irregular or lobed edges.

Therefore, we can have some kind of computerized system which can identify these diseases by the symptoms visible in the fruit image. This way we can easily and early determinate the disease and we can get solution too.

Apple rot [2]

Apple scab [3]

Apple blotch [4]

Fig 1: Three common apple diseases

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2. LITERATURE SURVEY

"Quality evaluation of apple fruit: A Survey" by Komal sindhi, Jaymit pandya (2016)[5] in which they mainly focuses on the evaluation of quality of fruit. Most common four apple diseases have been taken under observation in this paper. Firstly author extracts various features like color, texture, and base on that classification of disease is done. Database is trained according to the classification of disease based on features, and disease detection will be done using this database.

Shivaram Dubey, Anand Singh Jalal (2012)[6].Three apple diseases have been concern in this paper apple scab, apple rot and apple blotch. In detection of the apple disease by image the first step is image segmentation by K-mean clustering. In second step features are extracted. These features are extracted from the segmented image and that features are global colour histogram (GCH), colour coherence vector (CCV), local binary pattern (LBP) and complete local binary pattern (CLBP). In which complete local binary pattern give 93% correct classification accuracy than other features because it calculates magnitude, sign and center value of pixel.

Monika Jhuria , Ashwani kumar , Rushikesh Borse (2013)[7]. Image processing is utilized as tool to monitor the execution on fruits during cultivating, right from plantation to reaping is shown in this paper. For achieving this artificial neural network is utilized. Three disease of grapes and two of apple have been taken for observation. According to the flow used in this paper, two database have to be created one for normal images and one for images with defects . Back propagation method is utilized for weight adjustment of training images database. The images are categorized and mapped to their respective diseases categories on reasons of three features vectors namely to be specific, colour, texture and morphology. From these feature vector morphology gives 90% right outcome and it is more than other two feature vectors.

Jagadeesh. D. Pujari , Rajesh Yakkundimath , Abdulmunaf S. Byadgi (2013)[8].This research paper gives the solution for apple disease detection base on color feature specially. In this paper, they have displayed a reduced feature set based methodology for recognition and classification image of apples into normal and defected. The RGB (Red Green Blue) colour features are reduced from 18 to 2 and GLCM (Gray-level Co-occurrence Matrix) texture features are reduced from 30 to 2. The reduced features set of comprises of 4 features namely, green mean, saturation mean, red GLCM sum mean and green GLCM sum mean. A feedback from classifier, performance is utilized in reducing the features. The average accuracy of 89.15% for normal type and 88.58% for affected type is obtained utilizing 2 colour features. The average accuracy of 93.15% for normal type and 89.50% for affected type is obtained utilizing 2 texture features. The average accuracy have expanded to 96.85% for normal type and 93.89% for defected type when the reduced color features and texture features are joined. A BPNN classifier is suitable for this work.

Mr. Abhijeet, prof. A.P. patil (2017)[9] .In this research paper apple disease detection solution is given base on the kmeans clustering and Learning vector Quantization neural network techniques . According to the approach of the paper , first step is the preparation of data set and pre-processing. Second step is image segmentation after that feature extraction and based on that training and testing by a neural network is the final step. result showed that apple fruit disease recognition rate of this algorithm can reach more than 95% accuracy.

Miss.Kambale , Anuradha Manik ,Dr.Mrs.Chougule (2015)[10] In this paper author gives the solution based on Image processing for classification and grading of apple fruit images. According to this paper , first step is to creates two database one with normal images and one with defected images. Second step is image pre-processing and image segmentation. Third step is feature extraction and after that classification and grading. experimental result of this algorithm indicate that the proposed solution and can be significantly support automatic classification and grading of apple fruit diseases.

O. Kleynen, v. leemans, m.f. Destain (2005)[11] In this paper The global methodology consisting in selecting a reduced number of spectral bands and implementing the corresponding filters in a multi-spectral image acquisition device was found appropriate for defect detection on apples. The most efficient wavelength bands were centred at 450, 750 and 800nm. The 450nm spectral band brought significant information to identify slight surface defects like russet while the 750 and 800nm bands offered a good contrast between the defect andthe sound tissue and were well suited to detect internal tissue damage like hail damage, bruises, etc. A Bayesian classification procedure was successfully used to segment these defects. The proposed methodology has the potential for being used in apple sorting machines. Indeed, the selection of the most efficient wavelength bands can be done once _off-line_ and consequently, the _on-line_ process consisting in image acquisition and analyses may occur at acceptable speeds. The efficiency of the method was demonstrated on a bicolour apple variety presenting a high colour variability. The procedure has therefore the potential for being extended to other varieties.

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By analysis of all such papers related to this work, it is concluded that following are the steps to be observed:

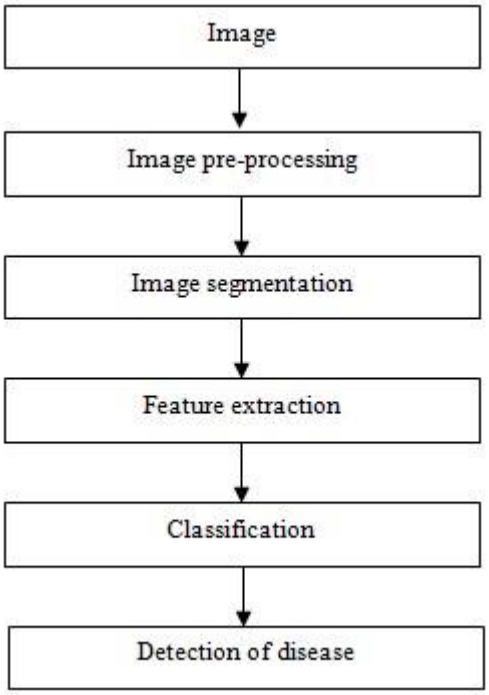

Fig 2: Approach for the disease detection process

3. IMAGE SEGMENTATION

In computer vision, image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super-pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. [12]
Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. Image segmentation methods are generally based on one of two fundamental properties of the intensity values of image pixels which are similarity and discontinuity. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image. Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture.

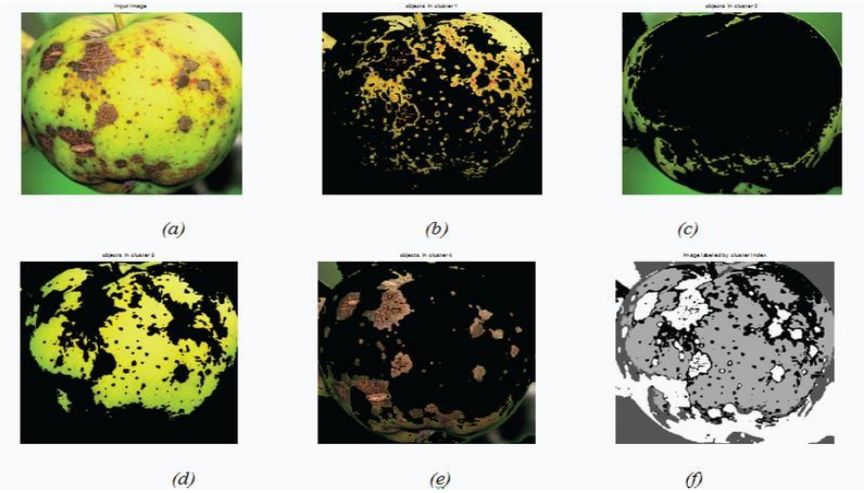

Fig 3: image segmentation using k-means clustering [13]

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Table 1: COMPARISON OF DIFFERENT SEGMENTATION TECHNIQUES

Segmentation technique	Description	Merits	Demerits
Thresholding Method	to find particular threshold values based on the histogram peaks of the image	a) No need of previous information, simplest method b) Low computation complexity.	a) Spatial details are not considered b) Cannot promise the segmented regions to be adjacent.
Edge Based Method	based on discontinuity detection.	a) good for images having better contrast between objects	a) Less immune to noise and doesn't work well if the image have many edges.
Region Based Method	based on partitioning image into homogeneous regions	a) Noise immune in edge detection approach.	a) expensive method in terms of time and memory
Clustering Method	Classify or cluster an image into several parts (regions) according to the feature of image.	a) fuzzy uses partial membership therefore more useful for real problems	a) Its worst case behavior is poor. b) The clusters are expected to be of similar size, so that the assignment to the nearest cluster center is the correct assignment.
Watershed Method	based on topological interpretation	a) results are more stable, detected boundaries are continuous	a)complex calculation of gradients
PDE Based Method	based on the working of differential equations	a) fastest method, best for time critical applications	a)computational complexity is higher
ANN Based Method	based on the simulation of learning process for decision making	a) no need to write complex programs	a)wastage of time in training

4. FEATURE EXTRACTION

The features which are extracted from the fruit are color, texture and shape of fruit. Based on these features classification of the apple disease will be done. Color and texture play a vital role in correct classification of diseases of apple.

Like if some apples have the symptoms like gray or brown corky spots on fruit so by image segmentation we can identify those spots and detect the disease that it is an apple scab.

In the same way if some apples have a slightly sunken, circular brown or black spots which may be covered by a red halo on fruit then we can say that this is an apple rot. Likewise using color, shape and texture kind of features, a particular disease can be identified.

Table 2: COMPARISON OF DIFFERENT COLOR FEATURE AND TECHNIQUES

Color feature extraction method	Description	Merits	Demerits
HSV Histogram	Hue, saturation and value. It describes colors in terms of their shades and brightness.	a) High Accuracy. b) Suitable for real time application.	a) Less sensitive to lighting variations.
Color coherence vector	A way to deal with images based on color coherence vectors they characterize color coherence as the degree to which image pixels of that color are individuals of a large region with homogeneous color. These regions are called as coherent regions.	a) Spatial info	**a)** High dimension, high computation cost
L*a*b	Color information in L*a*b color space is stored only in two channels. Space with dimension L for lightness and a and b for the color-opponent dimensions.	a) Color and intensity are managed independently. b) Ability to measure small color difference.	a) Singularity problem as other. b) nonlinear transformation.
RGB	An RGB color space is any additive color space based on the RGB color model.	a) Convenient for display.	a) Due to its high correlation not good for color image processing.
Mean of Three Color Array	Color is calculated based on mean of three color value for red, green and blue.	a) Very easy for implementation.	a) Not accurate as other methods.

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4.2 Different texture feature extraction:-

Table 3: COMPARISON OF DIFFERENT TEXTURE FEATURE TECHNIQUES

Texture method	Description	merits	Demerits
Local Binary Pattern	In which center pixel and its corresponding neighbor pixels, calculate thresholding value for neighbor based on centre pixel.	a) It's robustness to monotonic gray-scale changes caused such as illumination variations. b) Its computational simplicity.	a) Binary data is sensitive to noise.
Complete Local Binary Pattern	LBP features consider only signs of local differences. Whereas CLBP considers both signs (S) and magnitude (D) of local differences as well as original centre level (C) value.	a) It achieves much better rotation invariant texture classification results than conventional LBP-based schemes.	a) CLBP_S preserves more information of the local structure than CLBP_M, which shows why simple LBP operator can extracts texture features well.
Spatial texture	The texture extraction algorithms analyze spatial distribution of pixel in gray scale images.	a) Meaningful, easy to understand, can be extracted from any shape without losing info.	a) Sensitive to noise and distortions
Gray Level Co-occurrence Matrices	It is in tabular form. In which how different combinations of pixel gray levels occur in an image.	a) Smaller length of feature vector. b) Applied it with different color space for color cooccurrence matrix.	a) They require a lot of computation (many matrices to be computed). b) It's not invariant with rotation and scaling
Gabor filter	It is a signal processing method used for defining a set of radial centre frequencies and orientations.	a) It's a multi-scale, multi resolution filter. b) It has selectively for orientation, spectral bandwidth and spatial extent.	a) Large bank of filters used in application so computational cost is very high.

5. CLASSIFICATION

Based on the features extracted, a suitable classification technique can be used. A classification algorithm will work in two phases, training and testing. During training, the machine is trained for every disease based on the features particular for that specific disease. The system will learn from all the examples given to identify the name of a disease given.

In the testing phase, we give an image of a diseased apple to trained machine and it will label the image with name of the most suitable disease. For this, it will first find the feature values from the image and will compare with already known values extracted during training phase.

Researchers have used classification techniques like support vector machine, local binary patter, neural network etc. for similar work.

6. CONCLUSION

In this paper, various research papers are studied with the purpose of finding the efficient solution of disease detection in apple. From the review, a generalized work flow is derived to follow a similar work. According to this flow, features are extracted from the image of diseased apple to test. A classification algorithm is used to train the machine for identification of disease. Such a trained machine is used to find the name of disease in a new image uploaded by the farmer. This kind of system will help farmers to improve the quality and quantity of crop.

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