Fruit Disease Detection using Color, Texture Analysis and ANN

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Abstract – Now-a-days as there is prohibitive demand for agricultural industry, effective growth and improved yield of fruit is necessary and important. For this purpose farmers need manual monitoring of fruits from harvest till its progress period. But manual monitoring will not give satisfactory result all the times and they always need satisfactory advice from expert. So it requires proposing an efficient smart farming technique which will help for better yield and growth with less human efforts. We introduce a technique which will diagnose and classify external disease within fruits. Traditional system uses thousands of words which lead to boundary of language. Whereas system that we have come up with, uses image processing techniques for implementation as image is easy way for conveying. In the proposed work, OpenCV library is applied for implementation. K-means clustering method is applied ***for image segmentation, the images are catalogue and mapped to their respective disease categories on basis of four feature vectors color, morphology, texture and structure of hole on the fruit. The system uses two image databases, one for implementation of query images and the other for training of already stored disease images. Artificial Neural Network (ANN) concept is used for pattern matching and classification of diseases.***

Keywords:-OpenCV, K-means clustering, SURF, Artificial Neural Network.

I. INTRODUCTION

The studies of fruit or plant can be determined by observable patterns of specific plant and it is critical to monitor health and detect disease within a plant. Through proper management strategies such as pesticides, fungicides and chemical applications one can facilitates control of diseases which interns improve quality. There are various techniques available such as spectroscopic and imaging technology, applied to achieve superior plant disease control and management. [1] With smart farming today's farmer can use decision tools and automation techniques which seamlessly integrate product, knowledge and services for better productivity, grading and surplus yield. The purpose of this paper is to monitor diseases on fruits and suggest better solution for healthy yield and productivity with the help of Artificial Neural Network concept. System uses two image databases, one for training of already stored infected area image and other for execution of query images. [1]

Three fruits namely grapes, apple and pomegranate have been used for research in this paper. Types of fruits and their respective diseases are as follows: [1]

1. Grapes:

a) Black Rot: For grapes, black rot is most widely occurring and severe disease. In this disease, fungus attacks canes, tendrils, leaves and fruit and it is most devastating in hot and moist areas. Now-a-days using combination of sound cultural practices, fungicides and resistant varieties it is possible to control black rot. First sign of black rot is visible on leaves as black border forms around the edge and small yellowish spot is formed, after that spots enlarges. Also center of lesions become reddish-brown. Spore furnish structure of the fungus appear as a minute black dots and inside margin of lesion they are organize in a ring pattern. Outline of lesion is oval having purple to black color. Mostly symptoms appear after half growth of grapes. [1]

Fig. 1 Black rot

b) Powdery Mildew: It is originated by fungus Uncinulanecator; it is also called as Oidium. Only grapes and other few related species are affected by this fungus. It is most frequently occurring disease on grapes. Primary symptom of powdery mildew is whitish or greenish powdery patches appearing on the underneath of basal leaves. It also causes leaf curling, withering along with blotched or deformation of badly infected leaves. Old infections appear on dormant canes as reddish brown. In case of premature powdery mildew inflammation can cause less sugar content and small berry size. Cracking and scarring of berries can make fruit unsuitable for any purpose. One should be aware that many wine makers have low tolerance for powdery mildew on the grapes. [1][14]

Fig. 2 Powdery mildew

c) Downy Mildew: It is deeply devastating infection on grapevine. During bloom, summer, rainfall and if the temperature goes to 10˚C (50˚F) in grape-growing areas across the world downy mildew occurs. First symptom of downy mildew can be seen on leaves after 6 to 7 days once the plant is infected. It is caused by Plasmoparaviticola. Almost all green portion of the grape are susplectible. Oil spots (yellow circular spots) along with an oily appearance occur on the leaves. Greater number of oil spots may be found under favourable weather condition. Young oil spots on young foliar are surrounded by brownish-yellow halo. Because of its downy growth it is named as Downy mildew. [14]

Fig. 3 Downy Mildew

2. Apple:

a) Apple Scab: It causes most devastating apple infection. It occurs throughout in the apple-growing areas. During the bloom in cool and wet weather apple scab is more severe but it is not reasonably significant in dry or warm climates. Signs of apple scab are visible on leaves, petals, flowers, husk, fruit, young shoots and bud scales of apple tree. Mostly infection on the fruit and leaves are common and obvious. [1]

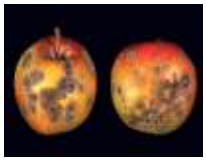

Fig. 4 Apple Scab

b) Apple Rot: It is a fungus caused due to Botryosphaeriaobtusa. It attacks on leaves, bark and fruits of apple tree. The first symptoms of apple rot appears on outer surfaces of leaves 1 to 3 weeks after petiole fall as small, purple blotch after which centre turn brown tan and yellowish brown. Second stage of apple rot occur after few weeks. In this stage secondary enlargement of leaf spots occurs. Leaf that are highly infected drop from the tree. [9]

Apple rot disease occur in three forms: 1) leaf blotch on apple trees 2) fruit rot on apple trees 3) limb canker on apple tree. [1]

Fig. 5 Apple Rot

c) Apple Blotch: It is most common “summer disease ” of apples in the northwest. Apple blotch is caused due to two different organisms. Economical loss and commercial quality damage are some of the harsh outcomes of this disease. Signs of disease appear as dark greenish-blue spots on the surface of contaminated fruit. One to many nearly circular colonies are develop individually. These symptoms occur 3-4 weeks later once leaflet falls. Large and unshaped colonies widens over the fruit. [3]

Fig. 6 Apple Blotch

3. Pomegranate:

a) Bacterial Blight: This disease was first recorded in Delhi(India) in the year 1952. Until 1998 Bacterial Blight was considered a lower economic threat. However now-a-days this disease occurs widely and has been recorded in all states.This disease occurs in all pomegranate-growing states like Maharashtra, Karnataka, and Andhra Pradesh. Sepals, twigs and pomegranate are affected by Bacterial blight. Preliminary symptoms for the disease can be black colored spots surrounded by bacterial slime. 90% yield of pomegranate depletes due to bacterial blight. Fruits crack due to this disease. [4] [13]

Fig. 7 Bacterial Blight

b) Aspergillus Fruit Rot: Alias of alternaria fruit rot. It appear when flower begins to open after the rainfall and it infect the internal portion of pomegranate. Tiny off-color in the skin and less weight due to internal decay are some of the exterior signs of disease. But this problem usually is not apparent until harvesting or during fruit sorting. Without any external symptoms fungus may grow within the fruit. Mostly, infected fruit show some yellowish to brownish-red discoloration and are slightly off-color such as a pale red. [13]

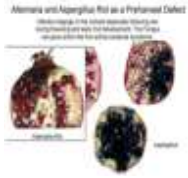

Fig. 8 Aspergillus Fruit Rot

c) Gray Mold: Gray mold is also called as Botrytis cinetea. This disease is more active and commonly occured during post-harvest wash and spread when kept at room temperature. Gray Mold damage flower part of pomegranate and affects the fruit until its ripening. Once the fruit is washed or stored at high humidity, condensation or water on the blossom tissues activates the fungal mycelium to begin

growing. The typical grayish coating of spores and pathogen sporulats on the flower parts are developed. Eventually the fungus will outspread inside fruit tissue the crown tissue will be colonized. Infected fruit stored at high moisture.

Fig. 9 Gray Mold

II. LITERATURE SURVEY

Image Processing for Smart Farming: Detection of Disease and Fruit Grading, Authors (Monica Jhuria, Ashwani Kumar, Rushikesh Borse), 2013: [1]

As there is a need of high yield in agricultural industries improved yield of fruit is important, for this there is a need of automated technique which will find disease on fruits. For this artificial neural network methodology is suggested which can be helpful to categories fruit infection. K-Means clustering is applied to find diseased area on the fruit but it has disadvantage of sizable estimation load. It will encourage agronomist to build better production and make correct time to time judgment.

A Review of Image Processing For Pomegranate Disease Detection, Authors (Manisha A. Bhange, Prof. H. A. Hingoliwala), 2015: [4]

The process suggests a solution for the recognition of pomegranate fruit disease. In this process, web based technique is applied to help non experts in identifying fruit diseases which depends on the picture representing the symptoms of the fruit. Farmers can take image of fruit disease and upload it on the system. After this farmers would be able to see if the fruit is affected by bacterial blight or not.

A Cost Effective Tomato Maturity Grading System using Image Processing for Farmers, Authors (Sudhir Rao Rupangadi, Ranjani B.S., Prathik Nagaraj, Varsha G Bhat), 2014: [2]

This system classifies ripeness of fruit based on its color or texture. It involves current techniques mainly manual inspection which leads to errorious classification; it results in economic losses due to inferior produce in the market chain. The short comings are several methodologies which require highly expensive setups and complicated procedures; overall accuracy is achieved up to 98%.

Adapted Approach for Fruit Disease Identification using Images, Authors (Shiv Ram Dubey, Anand Singh Jalal): [3]

This adaptive approach is validated on the basis of experiments. The approach consist of steps and that are stated as; first step is k-means clustering technique which is applied for defect segmentation and second step involves some state of art features that are extracted from segmented image and then segmented image are classified into one of classes with the help of multi-class support vector machine. It achieves precision up to 93%.

Fruit Detection using Improved Multiple Features based Algorithm, Authors (Hetal N. Patel, Dr. R. K. Jain, and Dr. M. V. Joshi), 2011: [5]

This gives improved solution for locating the fruits on the plant based on multiple features. Multiple feature extortion technique can include steps like extraction of color and intensity feature, extraction of orientation feature, extraction of edge feature, extraction of area from feature maps. The process is entirely automatic and it can work without user involvement. To improve output it considers numerous features.

Tomato quality evaluation with image processing: A review, Authors(Abraham Gastélum-Barrios, Rafael A. Bórquez-López, Enrique Rico-García, Manuel Toledano-Ayala and Genaro M. Soto-Zarazúa), 2011: [6]

All over the world there is excessive requirement for tomato. Therefore grade assessment of tomato is prime task using image processing it can be acquire. Worldwide study of tomato production is done to accomplish the target. It is useful to obtain tomato quality, good color, pattern, size and composition. Instead of manual testing we can achieve fast and accurate testing in laboratories for tomato grading.

Fast and Accurate Detection and Classification of Plant Diseases, Authors (H. Al-Hiary, S. Bani-Ahmad, M. Reyalat, M. Braik, and Z. ALRahamneh), 2011: [7]

Improved solution for automated diagnosis and grading of plant leaves disorder can be diagnose with help of K-Means Clustering procedure. It uses SGDM Matrix for Hue Saturation. Also Otsu method is applied for masking pixels based on certain threshold values. It uses color concur technique for extracting features of leaf but it is unable support huge complicated network structure.

III. PROPOSED SYSTEM

A. Introduction

The purpose of proposed system is to supervised the diseases on fruit and suggest alternate solution for healthy yield and good productivity. Labeling of border pixel can be achieved by image segmentation this can be done by K-Means clustering technique. Trained database of infected image has been generated using Neural Network. Feature vectors such as image color, morphology, texture and structure of hole are applied for extracting features of each image and for diagnosis of disease morphology gives accurate result. SURF algorithm used as locator and descriptor for extracting the features. Using extracted features Scope of Interest can be calculated and extraction can be followed as its first step after which refinement and analysis is done.

Family of Artificial Neural Network is inspired by biological Neural Networks which is used to evaluate or

appraisal functions that depends upon huge number of inputs and they are generally unknown. They are systems of interdependent "neurons" and utilities from inputs for computing and are having a potential of machine learning along with pattern recognition in adaptive nature. This is convenient technique which reduces human effort and gives 90% accurate result.

For starting this process, initially non-uniform weights are fixed and then training begins. Supervised and unsupervised are two methodologies used for training. Supervised training mechanism provides the network with the specific output either by manually "grading" the network's performance or by providing the desired outputs accomplished by the inputs while Individual training can be achieved by network that takes inputs without external help. Supervised training approach is used by bulk of networks whereas unsupervised training is applied to execute some initial characteristics on inputs. Basically database server is used for comparison of extracted image with trained database which in turns diagnose and classify disease of fruits.

IV. METHODOLOGY

Image Acquisition - Image acquisition can be widely described as the activity of restoring an image from some origin, usually a hardware-based source which can be proceed along with processes that need to appear afterward. Image acquisition is consistently the initial condition for the work flow series of image processing because as processing is possible only with the help of an image. The image obtained is entirely natural and is the consequence of any hardware which was handled to produce it.

Image Segmentation - It is the method for segregation of digital image into several segments. The primary aim of segmentation is to clarify and/or convert the rendering of an image into something that is further relevant and easier for analyses. Objects and bounding line of images are located by using image segmentation.
Pixels with similar label portion share distinguishing features for allocating a label to each pixel in an image. For this we are using K-Means Clustering methodology.

Feature Extraction - Four feature vectors are considered namely color, texture, morphology and structure of hole of the fruits. For describing huge data set sometime enormous resources are required.
Algorithm used for extracting the features is as follow:
SURF (Speed up Robust Feature) algorithm is applied for extracting the features. SURF algorithm used as local descriptor and blob detector.

$$S(x,y) = \sum_{i=0}^{x}\sum_{j=0}^{y} I(i,j) \quad (1)$$

Sum of the primitive image inwards a rectangle which can be calculated quickly using the integral image, requiring four calculations at the junction of the rectangle.
Algorithm is mainly divided as -

1. Scope point Detector
2. Local surrounding descriptor
3. Matching.

Blob Analysis - Blob detection methods are intended at detecting scope of interest surrounded by digital image that varies in properties, such as color or brightness comparison with its vicinity regions. Region of an image in which some properties are approximately constant can be called as Blob.
The basic scenario of the Blob Analysis solution consists of the successive stages:
1. Extraction: It is primary step of image thresholding technique which inspects a region corresponding to single object or objects.
2. Refinement: Extracted region contain various kind of loud sound due to degraded quality of image. Region transformation techniques are used in refinement step.
3. Analysis: It is ultimate stage for refined region to evaluate & compute the outcome. If the region shows multiple objects then divide it into separate blobs for inspection.

Pattern Matching - It is the procedure of examining stated successions of tokens for the existence of the elements of some pattern. In proposed system ANN that is artificial neural network concept is applied for pattern matching which interns classifies disease.

Comparison between patterns can be accepted using artificial neural network. ANNs can be evaluated as Artificial intelligence (AI) neural network structure.

A. Architecture

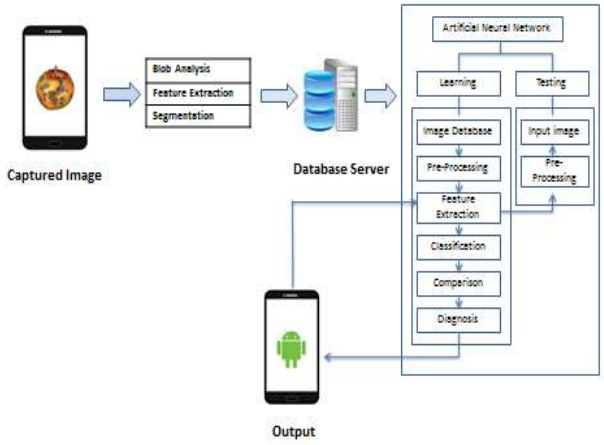

Fig. 10 Architecture of Proposed System

B. Algorithm of Proposed System

Input – Images of Various Fruits
Output – Detection of Fruit Disease

Step 1: Accept image using android phone from user:
(Color, Morphology, Texture, Structure of Hole)
Step 2: Extraction of Feature Vectors
E (n) = [C (n) + M (n) + T (n) +H (n)]
Here,
C = Color
M = Morphology
T = Texture
H = Structure of Hole
E = Extraction of features
n = No. of images
Step 3: Calculating ROI:
Let E (n) be set of Extracted Images and
If<Fruit Detected>
Then
E (n)
Else
Reject

Step 4: Pattern Matching
Let T be set Trained Database
If<E (n) = = T>
Then
Classification
Detection
Else
Go To Step (2)
Step 5: Stop.

C. Mathematical Model
Feature Extraction of Image Classification: Four feature vectors such as color, morphology, texture and structure of hole are used as learning database images for extracting the features.
a) Color: It is the most valuable properties used by human for object discrimination. As RGB color space is affected by light and angle of image which has been captured so there is need for conversion into HSI color space.

$$Hue = \begin{cases} thita & if\ B < G \\ 360 - thita & if\ B > G \end{cases} \quad (2)$$

Here,

$$thita = \cos^{-1} \frac{½(R-G)+(R-B)}{[(R-G)^2+(R-B)(G-B)]^{½}} \quad (3)$$

$$Saturation = 1 - \frac{3}{(R+G+B)}[min\,(R,G,B)] \quad (4)$$

$$Intensity = \frac{1}{3}(R+G+B) \quad (5)$$

b) Morphology: Erosion concept is applied for acquiring boundaries of all database images.

Erosion= {Z/ (Y) z ⊆ X} (6)

Image Boundary= Original image - Eroded image (7)
Where,
X is erosion which indicates database images and Y as input image which is set of each points Z such that Y converted by Z and contained in X in morphology. Entire knowledge about structure is symbolized with the help discrete cosine conversion considering few co-efficient.

c) Texture: Visual patterns describe texture property, each having similarity. Texture identification is done by modeling textures as two-dimensional deviation of gray level.

$\psi^{ab}(x) = |a|^{(-½)} \psi(x - b/a)$ (8)
Then,

$$W\psi = \frac{1}{\sqrt{a}} \int_{-\infty}^{\infty} f(t)\psi \quad (9)$$

Where,
Ψ(x) = mother wavelet
$\psi^{ab}(x)$ = daughter wavelet

V. CONCLUSION

The innovative outcome suggests that the advanced approach is a worth, which can distinctly support an accurate diagnosis of fruit diseases in a minor computational effort. It also dedicates future study on automatically estimating the severity of the disease.

An image processing derived solution is proposed for detection of grape, apple and pomegranate fruit disease. For Grape -Black Rot, Powdery Mildew, Downy Mildew; For Apple -Apple Scab, Apple Rot, Apple Blotch; For Pomegranate -Bacterial Blight, Aspergillus Fruit Rot, Gray Mold diseases are detected and classified. Once diseases are detected proper treatments are suggested accordingly.

It would also promote Indian Farmers to do smart farming which helps to take time to time decisions which also save time and reduce loss of fruit due to diseases. The leading objective of our paper is to enhance the value of automatic fruit disease detection.

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