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Identification of Plant Disease Using Smart Phone Application

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Abstract: ***A steady plant monitoring is necessary to control the spread of disease but its cost may be high and as a result, the producers often miss critical preventive procedures to keep the production cost low. Though in the professional farming engineers are responsible for the recognition of plant diseases, intelligent systems can be used for their diagnosis in early stages. The recognition of infection can often be based on symptoms like lesions or spots in various parts of a plant. The color, area and the number of these spots can verify to a great extent the disease that has mortified a plant. A smartphone image processing application is described here which is capable of detecting the diseases through the pictures of leaves. The recognition of a disease can often be based on symptoms like lesions or spots in various parts of a plant. The color Area and the number of lesions or spots can often be used to determine the disease that has mortified plant. Hence image processing is used for the detection of plant leaf disease, an intelligent system can be used for their diagnosis in early stages. It includes several steps Image acquisition, the image resizes, RGB to GRAY, feature extraction on a convolution neural network. This paper also discussed the feature extraction algorithm used in plant disease.***

Keywords: plant disease, image processing, feature extraction, leaves, smartphone

I. INTRODUCTION

Agricultural production cost can be significantly increased if plant diseases are not found and cure in their early stages. The plants have to be monitored all the time for detecting the first symptoms of a disease before it is spread to the whole crop. In Professional farming, engineers may not be available to continuously monitor a crop if, for example, the crop residues in an isolated region. Remote vision can offer an alternative option. The symptom that appears, in this case, may differ from the cause of the symptom by the individual pathogens. The symptoms of a pathogen can be often expressed as bacterial leaf spots or fungal. Even though the color features are also important in the process of plant disease recognition we focus on three parameters of the lesions that can appear at the leaves, the stem, or the fruit of a plant:

A. The number of spots,
B. Their area
C. Their gray level.

The producer would use a smartphone with the application installed, in order to take pictures of mortified plant parts. The implemented image processing method extracts the following lesion features: number of spots, their grey level, and area and then extracts a histogram indicating the number of pixels that have an exact red, green or blue color level. The limits of the regions in this histogram with higher pixel concentration as well as their peaks are used to determine the disease that matches the leaf of the photo used. This can be guaranteed if e.g., the leaf is placed on a white sheet of paper serving as its background before it is captured by the camera server application of the smartphone. Machine learning-based detection and recognition of plant diseases can provide extensive clues to identify and treat the diseases in its very early stages. Automatic detection of plant diseases is very important to research topic as it may prove the benefits in monitoring large fields of crops, and thus automatically detect the symptoms of diseases as they appear on plant leaves. In the system design of smartphone image processing technique data set is acquired by the web camera. And it can be sent to the pre-processing unit; in prepossessing part image can go through several operations like image resize, RGB 2 GRAY conversion for simply reducing the complexity of the pixel followed by the object location which refers to identifying the location of an object in the image; ROI that is region of interest is used to create binary mask image. After that in the post-processing unit features are extracted by using the LBPH(Local Binary pattern Histogram), and GLCM (Gray-level co-occurrence matrix) algorithm. Convolution neural network is used for image classification, recognization, object detection, etc. In the train predict model, the large dataset is divided into the training set; the classification of the image is taking place, in which the training set is an important component.

II. LITERATURE REVIEW

In the literature plant disease detection techniques available are described as follows:

[N. Petrellis., 2016] The system isolates the spots (or lesions) that can appear at various parts of a plant like the leaves, or the fruit. The diagnosis is based on the number of spots, their color, and their area features. These features are compared with set limits in order to select the matching disease. A low-cost smartphone application has been developed in the framework of this paper, that is based on a simple image processing technique. The present version focuses on measuring the lesion features that appear at the leaves or the fruit of a plant or a tree. The lesion can consist of a number of spots. The developed application counts the number of these spots in a photo taken by the camera of the smartphone.

[S.K.Sarma et al., 2010] The expert system is one of the solutions for problem-solving in the agriculture field. One of them is used to diagnose plant disease. There were many types of research that have been done previously around the world. This can be done by observing the symptoms and characteristics of the physical condition of the rice plant. This process should be quick and accurate, due to the pests and disease of rice plant can spread very quickly and attack at agriculture land. The infected plant often shows the same symptoms and it's difficult to distinguish. Since the number of experts in the pests of agriculture plant is limited, this has caused the farmer and the agriculture extensionist is difficult to get information about the pests. because of that condition, this expert system can help farmers and agriculture extensionist to do the first identification to the pests or diseases attack to the farming land.

[N.W. Schaad et al.,2003] Detection of pathogens in plants showing symptoms can be relatively simple provided one has extensive experience with disease diagnosis and isolation of plant pathogens. On the other side, detection of pathogens in seeds or asymptomatic propagative materials, such as woody cuttings or potato tubers, can be extremely difficult since few propagules of the pathogen are present. Because of this, sensitive techniques capable of detection of very low numbers of pathogen propagules are needed.

[V. Pooja et al.,2017] The developed framework is based on the image processing; and consist of the following steps: firstly, K-means technique is used to segment the images, and secondly, the obtained segments are passed through a trained neural network. Final results show that the proposed approach correctly and automatically detects the leaf diseases. the classifier developed which base on statistical classification had performed well and can successfully classify and detect the diseases.

[S. Sankaran et al.,2010] Scouting is most of the time used mechanism for monitoring stress in trees, which is a labor-intensive, expensive, and time-consuming process. Molecular techniques such as polymerase chain reaction are used for the identification of plant diseases that require in-depth sampling and processing procedure. suitable information on collect health and disease detection can help to direct the diseases through proper management plan such as vector manage through insect killer application fungicide application, and disease-specific chemical application and can progress yield. Many such microbial diseases with time spread over a larger area in groves and plantations through the accidental introduction of vectors or through infected plant materials.

[Monica Jhuria et al.,2013] The purpose of this paper is to monitor the disease on the stem/leaf/fruits of the crop and suggest solutions to them for healthy yield and productivity. for this purpose neural network concept is used; for the training of this neural network a database of diseased images has been created. extracting the feature of each image color, morphology and texture features (measurement) into fewer, more effective features is termed feature extraction. this is used in the mapping of query image with training images. In the spectroscopic and imaging technology could be integrated with an autonomous Agricultural vehicle for reliable and real-time plant disease detection to achieve superior plant disease control and management.

[A. Kulkarni and A. Patil,2012] Agricultural practices such as irrigation, crop rotation, fertilizers, and insecticides were developed history, but have made great strides in the past century. By the early 19th century, agricultural techniques had so improved that yield per land unit was many times that seen in the middle ages. Without any adverse values, the enhancement of productivity can be done in a sustainable manner. Plants exist universally we live, as well as places without us. Many of them transmit significant information for the development of human society. As diseases of the plants are inevitable, detecting disease plays a major role in the field of Agriculture.

[Carmago, et al.,2009] Image processing and model classification to implement a machine vision system that identified and classified the visual symptoms of plant diseases. used for this purpose, multiple image-based features were extracted from test images. A classifier assessed each of them individually and in groups. A set of candidate features was then selected. In turn, candidate features were used to identify the best classification model; we used Support Vector Machine as a machine learning method. The results of this study demonstrated that this method could be used to automatically identify symptoms of plant diseases.

[Barbedo, G.C.A. 2013] There are several ways to detect plant pathologies. Some diseases do not have any evident symptoms related, or those appear only when it is too late to act. In those cases, normally some caring for cultured analysis, usually by means

of powerful microscopes, is necessary. In other cases, the signs can only be detected in parts of the electromagnetic spectrum that are not evident to humans. A common approach, in this case, is the use of remote detecting techniques that explore multi and hyperspectral image captures. The methods that accept this approach often employ digital image processing tools to achieve their goals. though due to their many peculiarities and to the amount of the literature on the subject, they will not be treated in this paper. [K. Georgakopoulou, et al.,2016] The readout system consists of three separate subsystems, namely, certain blocks from the prototype chip of a digital part implemented in a field programmable gate array (FPGA), and an external bank of capacitors. One of the outputs of a 6 × 64 NOR address decoder (six address bits select one of 64 lines) is activated by relating one of the 64 biosensors to the reference signal (Vref). The capacitance difference between the sensor and a properly selected reference capacitance (Cref) is measured and then digitized by the 12-bit ADC

[Di Cui et al,2010] The image processing techniques for multispectral images to detecting rust on a plant leaf and its growing amount of disease. The dataset contains the images collected from a greenhouse of a research institute. The explained method uses the concept of evaluating centroid for each image for further processing.

[Rittika Raichaudhuri et al,2016] This venture is to give a framework for identifying wheat leaf Diseases. In this robotized framework will be utilized to identify the wheat leaf infections however picture preparing. The k mean calculation and vigilant channel are utilization for the image preparing and segmentation handling. Design acknowledgment is accomplished through PCA or GLCM and arrangement through SVM or ANN. A portion of the calculation procedures that can be utilized for surface element extraction is Gabor channel, shading co-event techniques, wavelet change, and so forth.

III. ANALYSIS OF PROBLEM

Plant disease detection has become an important topic to ensure the health of the plants and taking necessary measures to prevent it from getting deteriorated and causing heavy losses to the farmers. In the early days, analysis of plant leaf diseases was done manually by the proficiency person in that field only. This requires a huge amount of work and also requires excessive processing time. A vast popular of the growing national population depends on agriculture yields. But the agriculture of these crops for optimum yield and quality produce is extremely technical & difficult. It can be better by the aid of technical support and mechanized agricultural.

Plant disease identification by the visual way is a more laborious task and at the same time less accurate and can be done only in limited areas. Whereas if automatic detection technique is used it will take fewer efforts, less time and more accurately. In plants, some general diseases are brown and yellow spots, or early and late scorch, and others are fungal, viral and bacterial diseases. Image processing is the technique which is used for measuring the affected area of disease, and to determine the difference in the color of the affected area. The system provides the facility to Capture image, process it and get the result through image processing.

There should be solutions for detecting and classifying the diseases to get some knowledge which will later help in improving the quality of plants. So, patterns on the plant's leaves will help in identifying what problem it has Various techniques of image processing and pattern recognition have been developed for detection of diseases occurring on plant leaves, stems, lesion, etc. by the researchers. The earlier a disease appears on the leaf, the earlier it should be detected, identified and corresponding measures should be taken to avoid loss. Hence a fast, accurate and less expensive system should be developed. So according to some causes, we can motivate to develop this application which can help the farmers.

IV. PROPOSED SYSTEM

In this proposed system the mobile web camera application is used to obtain the image of plant leaves then image is going to be read in image acquisition and from here it can send to pre-processing unit; in the pre-processing unit image resizing, RGB to GRAY conversion is done which is used as a color metric which converts the colored 2D image into 1D array; after that object localization is made for finding the leaf in the picture and the region of interest (ROI) is a portion of an image that wants to filter or perform operation on it.

In the post-processing section features are extracted such as Color, texture edges, and morphology which is the features of leaves and these can be extracted by using the two algorithms named as gray level co-occurrence matrix(GLCM) which is used for extracting the texture intensity while local binary pattern histogram algorithm(LBPH) is used for color intensity. Convolution neural network(CNN) and machine learning used for to classify image under a certain category by after training and testing and gives the result of captured plant leaves with there disease name, its causes, and remedies for it.

In the proposed system we show the only prototype of smartphone application for plant diseases identification for that we create a dataset of mainly 4 types of different plant leaves with there diseases name, causes, and remedies; for that we need to start the

server and capture an image of leaf from the given dataset and after that it will send to the image processing module on server side after performing image processing result will be shown on the mobile which includes the disease name, causes, and its remedies.
Here we created a dataset of 4 types of plant leaves diseases are as follows:

1) Bacterial Disease
2) Black spots Diseases
3) Mildew
4) Healthy

V. SYSTEM DESIGN

The system design mainly contains the server side and mobile side as shown in Figure1:

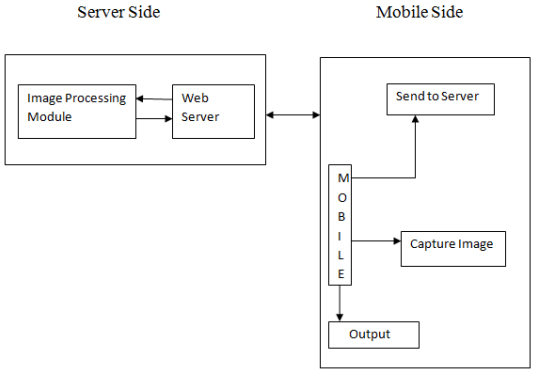

Figure 1: Block diagram of the server-side and mobile side

In the mobile side, image is captured by using the camera server application of the smartphone which is input to the server side; the captured image is sent to the web server for image processing to the image processing module by using the socket programming for the communication of mobile side and server side. At the server side, the image processing module performs the image processing and again the generated result is sent to the mobile side for seeing the output which includes the diseases name, its cause and the remedies for it.

A. *Technologies used*

In the system of identification of plant diseases using smartphone application we use the various techniques in the system design these are as follows:

1) *Python:* Python is a powerful modern computer programming language. It bears some similarities to Fortran, one of the earliest programming languages, although it is much greater than Fortran. Python allows you to use variables without declaring them (i.e., it determine types implicitly), and it relies on indentation as a control structure. You are not forced to define classes in Python (unlike Java) but you are free to do so when suitable Python was developed by Guido van Rossum, and it is free software. free of charge as in "free beer," in that you can obtain Python without spending any money. But Python is also free in other important ways, for the pattern you are free to copy it as many times as you like and open to study the source code and make changes to it.
2) *Open CV:* (Open-source Computer Vision) is the Swiss Army knife of computer vision. It has a wide range of modules that can help us with a lot of computer vision problems. But maybe the most useful part of OpenCV is its architecture and recollection management. OpenCV's highly optimized image processing function is used for real-time image processing of live video feed from web camera. OpenCV is an open source library of python ties intended to take care of PC vision issues. It makes the use of Numpy, which is a deeply improved library for arithmetical tasks. All the OpenCV cluster structure are changed over forward and backward pumps exhibits. Which makes I simpler to include with different libraries that use Numpy, for example, Matplotlib.
3) *Web Sockets:* Web sockets are defined as two-way communication between the servers and the clients, which mean both the parties converse and substitute data at the same time. The key points of Web Sockets are true concurrency and optimization of performance, resulting in more responsive and rich web application

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4) *WebSocket Protocol:* This protocol defines a full-duplex communication from the position up. Web sockets take a step forward in bring desktop rich functionalities to the web browsers. It represents an evolution, which was accepted for a long time in client/server web technology. Websockets is a library for building WebSocket servers and clients in Python with a focus on correctness and ease Web Sockets is a next-generation bidirectional communication knowledge for a web application which operate over a single socket and is showing using a JavaScript interface in HTML 5 obedient browsers.
5) *Python web framework:* There are many web frameworks for Python; some provide more services than others, some offer a better degree of flexibility or more extensibility. various try to provide everything you need for a web application and require the use of very specific mechanism whereas others focus on to give you the bare least so that you can choose only the works your application wants.
6) *Tornado:* It is a combination of an asynchronous networking library and a web framework. It is intended for use in applications that require long-lived associates to their users. Tornado has its own HTTP server base on its asynchronous library. While it's possible to use the web framework part of Tornado with WSGI, to take advantage of its asynchronous nature it's compulsory to use it as one by the web server. In addition to typical web framework features, Tornado has libraries and utilities to make writing asynchronous code easier. Instead of depending on callbacks, Tornado's coroutines library allows a programming style more similar to synchronous code. Tornado includes a simple templating language. Unlike other templating languages discussed here, in Tornado templates, there are no limitations on the kind of expressions that you can use.
7) *Convolution Neural Network(CNN):* Convolutional neural networks aim to use spatial information between the pixels of an image. Convolutional Neural Network was designed to map image data to an output variable. They have confirmed so effectively that they are the go-to method for any type of prediction problem involving image data as an input.The benefit of using CNN's is its capacity to develop an internal symbol of a two-dimensional image. This allows the model to learn position and scale invariant structures in the data, which is important when working with images.

B. Use CNN's For

1) Image data
2) Classification prediction problems
3) Regression prediction problems

More generally, CNN's vocation well with data that has a spatial relationship.
The CNN input is often two-dimensional, a field or medium but can also be distorted to be one-dimensional, allow it to develop an inside representation of a one-dimensional sequence.

a) *Machine Learning:* The process of machine learning is like to that of data mining. equally system search through data to look for a pattern. though instead of extracting data for machine learning uses that data to detect patterns in data and adjust program actions, therefore. Machine learning algorithms are often considered as being supervised or unsupervised. Supervised algorithms can transmit what has been learned in the past to new data. Machine learning sends to program.
b) *Algorithms Used:* We have used two algorithms in this project for feature extraction they are as follows:

C. Local Binary Pattern Histogram(LBPH)

There are several methods for extracting unique and useful features from leaf images local binary pattern (LBP) is among the most popular ones, and it is also the most efficient and newest algorithm in that research field. The LBP operator is a signified robust method of texture description; it is described as an ordered set of binary comparisons of pixel intensities between the center pixel and its surrounding pixels. LBP was originally defined for 3_ 3 neighborhoods, giving 8-bit codes based on the 8 pixels around the central one and representing the outcome as a binary number.
This project uses LBPH (Local Binary Patterns Histograms) Algorithm to detect leaf It labels the pixels of an image by thresholding the neighborhood of each pixel and considers the result as a binary number.
LBPH uses 4 parameters

1) Radius: the radius is used to build the circular local binary pattern and represent the radius around the central pixel.
2) Neighbors: the number of sample points to build the circular local binary pattern.
3) Grid X: the number of cells in the horizontal direction.
4) Grid Y: the number of cells in the vertical direction.

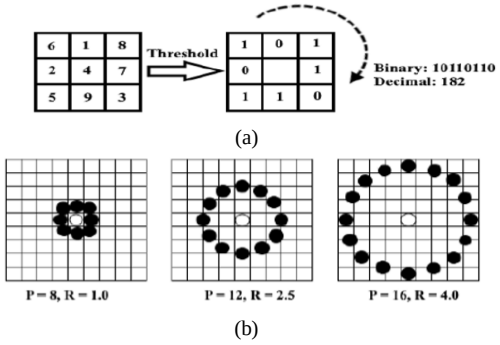

Figure 2: (a) The original local binary pattern (LBP) operator
(b) Circular neighbor-set for three different values of P, R

D. Gray Level Co-occurrence Matrix (GLCM)

A GLCM is used to extract texture feature from the images. The size of GLCM is equal to a number of gray level in the image This method is used to estimation image properties by considering the relation between two neighboring pixels where the first pixel is called the mention and the second is called the neighbor pixel. The GLCM contains information about how frequently a pixel with a value I occur either horizontally, Where i & j are the gray level values (tone) in an image.GLCM directions of analysis are Horizontal (0˚or 180˚), Vertical (90˚or 270˚), Right Diagonal (45˚or 225˚), and Left diagonal (135˚or 315˚).

Glcm = graycomatrix (I) creates a GrayLevel Co-occurrence Matrix (GLCM) as of image I. The graycomatrix purpose create a Gray-Level Co-occurrence Matrix (GLCM) by calculating how frequently a pixel with the intensity (gray-level) value I occurs in a specific spatial association to a pixel with the value j. graycomatrix uses scaling to reduce the number of intensity values in the gray-scale image from 256 to eight. The number of gray levels determines the size of the GLCM. To control the number of gray levels in the GLCM and the scaling of intensity values, using the NumLevels and the Gray Limits parameters of the gray matrix function. The gray-level co-occurrence matrix can expose certain properties about the spatial division of the gray levels in the texture image.

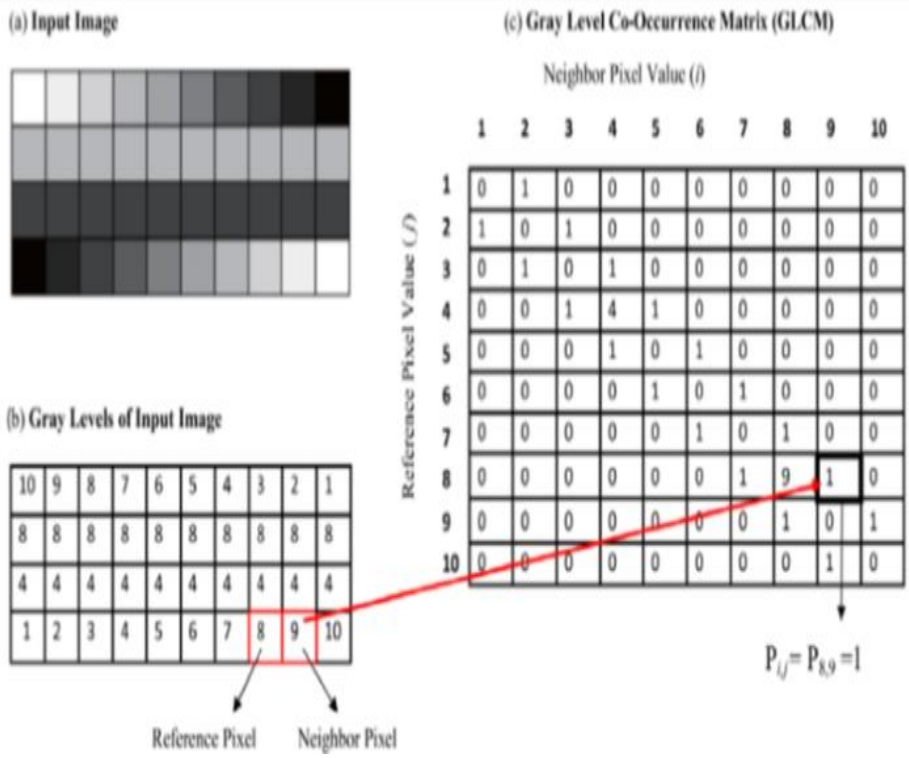

Figure 3: Construction of Gray Level Co-occurrence Matrix (GLCM) from an image

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VI. IMPLEMENTATION

The detection of plant leaf diseases includes various stages for implementation of the project is as shown in the following figure:

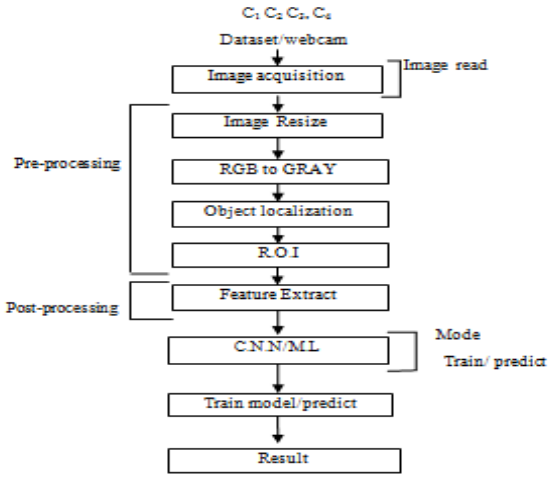

Figure 4: Flowchart of system implementation

A. Collection of Database

The sample images are collected from the datasets of the leaf using different web cameras with different resolutions. Which are used to train the system sample images are stored in the form of the PNG format. All the sample images are in RGB (Red, Green, Blue) form. The obtained images include healthy images and also diseased images like bacterial spot, mildew, etc. Various methods of pre-processing can be applied to the image to get a better result.

B. Image Acquisition

The images of various leaves captured by a web camera with the required resolution for better quality. The construction of an image depends on the application. Initially, the digital images are acquired from the circumstances using a web camera or digital camera and given as input to the identification system. The initial process is to collect the data from the public ordnance supposed plant leaves are used to carry out this project. The images were stored in PNG format. This was to eliminate any sign and get light evenly distributed everywhere in order to get a better view and brightness of the image to be processed. The object (leaf) was properly zoomed using the web camera to ensure that the picture taken contained only the leaf and white background with the rightful image size.

C. Image Pre-processing

The image is pre-processing to progress the image data that suppress undesired distortion & enhancing some image features important for further processing and analysis task. It includes color space conversion, image enhancement, and segmentation. Affected leaf disease area is cropped and then converted to the gray level. In this process, the noise is eliminated from the captured image to improve the image quality. The image preprocessing unit consists of

D. Resizing of image

Images are resized according to the need. For resizing of images nearest neighbor interpolation is used. Resizing image is necessary when you need to increase or decrease the total number of pixels, whereas remapping can occur when you are correcting for lens distortion or rotating an image. Zooming refers to an increase in the number of pixels, so that when you zoom an image.

E. RGB to GRAY

In RGB each pixel is complete up of 3 components i.e., red, green, blue. So more space and time is required for RGB. That's why RGB is converted to a gray image. In the RGB to GRAY conversion, the 2D colored image can be converted into a 1D gray image. Gray is simply reducing complexity from a 2D pixel value (R, G, B) to a 1D value.

F. Object Localization

Object localization is made in the image pre-processing unit for leaf localization. The process of finding a leaf in a picture is generally divided into two steps: leaf Localization detects the location and size of the leaf. leaf Recognition extracts leaf characteristics and compares them with a dataset.

G. Region Of Interest (ROI)

ROI is a chosen subset of tests inside a data set identified for a specific purpose. The idea of an ROI is usually utilized as a part of numerous application ranges.

H. Image Post-processing

1) *Feature extraction:* Feature extraction is the process done after that segmentation. According to the segmented image and dataset some features, images can be extracted. Feature extraction can depend on statically, structure, shape .size, color. There is various method are used for detection of leaf disease are GLCM method, LBPH method, for feature extraction. After segmentation, the GLCM features are extracted from the image. Feature extraction acting a central role in the identification of an object. here many application of image processing, feature extraction is used Colour, texture, morphology, ends are the features which can be used in plant disease detection.

I. Convolution neural network and Machine Learning

Image classification is done using Convolutional Neural Networks (CNN). CNN is a kind of neural networks that shares weights among neurons in the same layer. CNN is good at discovering spatially local correlation by enforcing a local connectivity pattern between neurons of adjacent layers. With multiple layers and pooling between layers, CNN by design learns the hierarchical layout features with tolerance to spatial translation, and by sharing weights it captures repeating patterns efficiently.

The process of machine learning is related to that of data mining. Both systems search through data to appear for patterns. However, instead of extracting data for human comprehension as is the case in data mining applications machine learning uses that data to detect patterns in data and adjust program actions accordingly. Machine learning algorithms are often categorized as

Being supervised or unsupervised. Supervised algorithms can relate to what has been learned in the past to new data. Unsupervised algorithms can draw inference from datasets.

J. Train Model/Predict

The process of training models involves providing an ML algorithm with training the data to learn from. The term ML model refers to the model that is created by the training process we basically try to create a model to predict on the model and testing data to test it; after that send to the model file is calculate you want to use the model to predict the predictable output.

K. Classification Of Diseases

Classification technique is used for training and testing to identify the type of leaf disease. Classification deals with associating a given input with one of the distinct class. The classification process is useful for early detection of disease, identifying the remedies, cause.

For implementing the project we have first create a dataset of diseases of plant leaves. For starting to detect the disease of plant leaves take one image of the dataset. for that first, connect the server to the hotspot of the internet and to the same hotspot we need to connect the mobile side also as we implement the project on the localhost. And start the camera server application for capturing the image from the given dataset when a connection is open at the localhost but before that save the IP address of the server. Then from the mobile side, the image is sent to the server side for image processing module by using the python web framework tornado and then the result is sent back to the mobile side which shows the leaf diseases name, its causes and the remedies for it.

VII. RESULTS

The result on the mobile side is shown as follows after the image processing on the server side:

As we implement the project in the localhost server we need to take an image from the given dataset and also there is a requirement of same internet hotspot is required on both sides. When the connection is opened on the server side with the given IP address that we save on mobile camera server application then the image is captured otherwise not.

As we have 4 types of the dataset so that we take the result of every dataset by capturing the image by using the smartphone application named camera server application and the result is shown on the mobile side as:

1) Bacterial: when we choose any random image from the bacterial dataset we will get the result as follows:

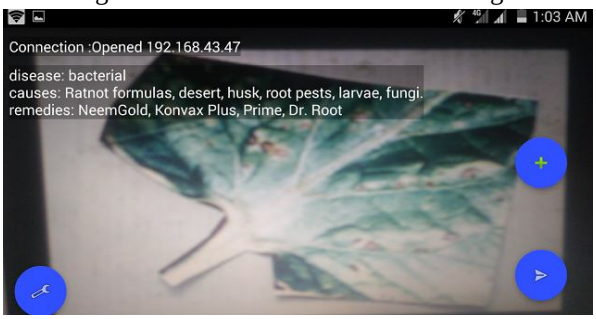

Figure 5: Bacterial disease causes and Remedies

From the result, we observe that the disease found is bacterial disease and its cause is Retinol formulas, desert, husk, root pests, larva, and fungi. And the remedies to avoid such disease is NeemGold, Konvax Plus, Prime, and Dr. Root.

2) Blackspots: when we choose any image from the black spotted dataset we will get the result as follows:

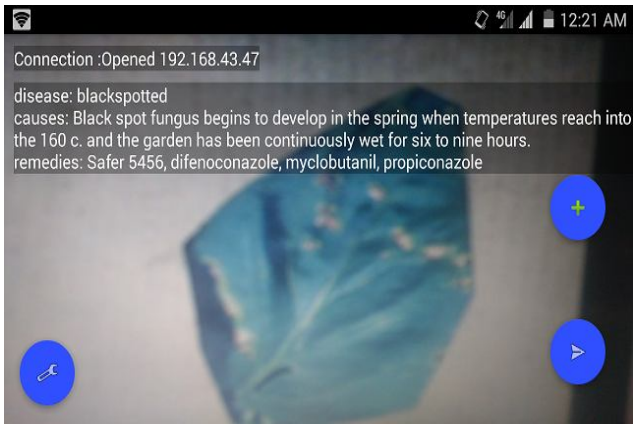

Figure 6: Blackspotted disease causes and remedies

From the result, we observe that the disease name is black spotted on the leaf, which can be caused by the black spot fungus begins to develop in the spring when the temperature reaches into 160 c. and the garden has been continuously wet for six to nine hours. And the remedies for this kind of disease is Safer 5456, difenoconazole, myclobutanil, propiconazole.

3) Mildew: when we choose any image from mildew dataset we will get the result as follows:

Figure 7: Mildew disease causes and Remedies

From the result we can say that the disease found is mildew with causes such as powdery mildew from when plant foliage is dry, lighting is low, temperature is moderate and there is high humidity; and the remedies for such powdery mildew is use of Abtec Bio Neem, Trifecta Crop control, plant Magic Plus, Growsafe, and Vanproz.

4) *Healthy:* when we capture the image of a healthy plant it will give the result as follow:

Figure 8: Healthy leaf

From the above result, we observe that the leaf is healthy with causes and remedies none.

VIII. GRAPHICAL ANALYSIS

1) *False_Positive:* in this graph we have taken 10 sample test cases, where every test case taken on 10 individul data samples, in this graph red bar represents no. of false positive sample in respective test case, and blue bar represent no. of true positive samples in respective test cases.

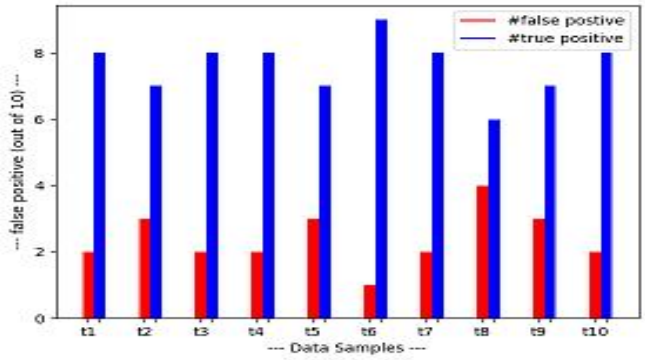

Figure 9: false positive

2) *Precision:* This graph shows the average accuracy of the system which is being taken on 10 sample test cases,where every test case taken on 10 individual data samples, the red bars here shows the average accuracy for given test case, which is measured by calculating no. of true positive data samples in respective test case.

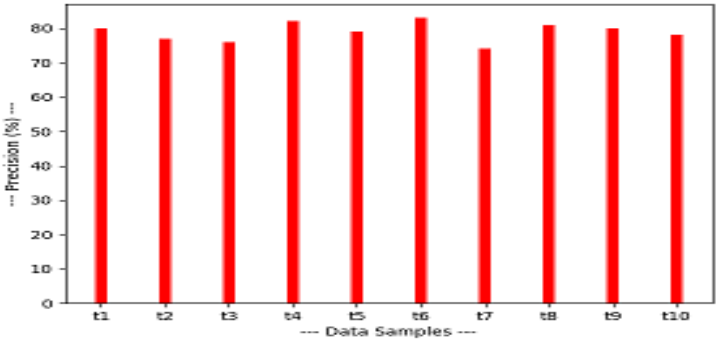

Figure 10: Precision

3) Time: This graph represents time computed in microseconds required by every data sample to classify input sample image, this time represents all image proccessing steps, needed to classify the input sample image, and show respective output.

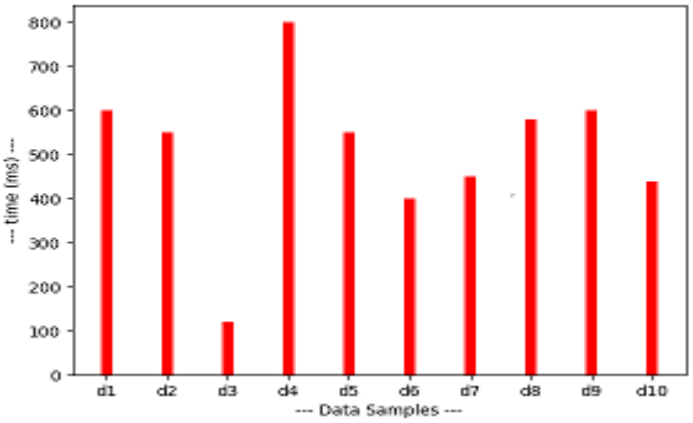

Figure 11: Time

IX. CONCLUSION

A smartphone application for plant disease identification was presented. It is based on image processing which can analyze the color features of the spots in the plant parts. This automatic recognition using image processing techniques help farmers to know about the disease in the early stage and to take necessary preventive action. reducing cluster time and the area of the tainted region. Feature extraction technique helps to extract the infected leaf and also to categorize the plant diseases. In this project, the detection as wells the disease name, remedy for causes it is achieved. By the use of Local Binary Patterns Histogram(LBPH) and Gray level Co-Occurrence Matrix(GLCM) algorithm, the infected region of the leaf is segmented and analyzed. The images are feed to our application for the detection of diseases.

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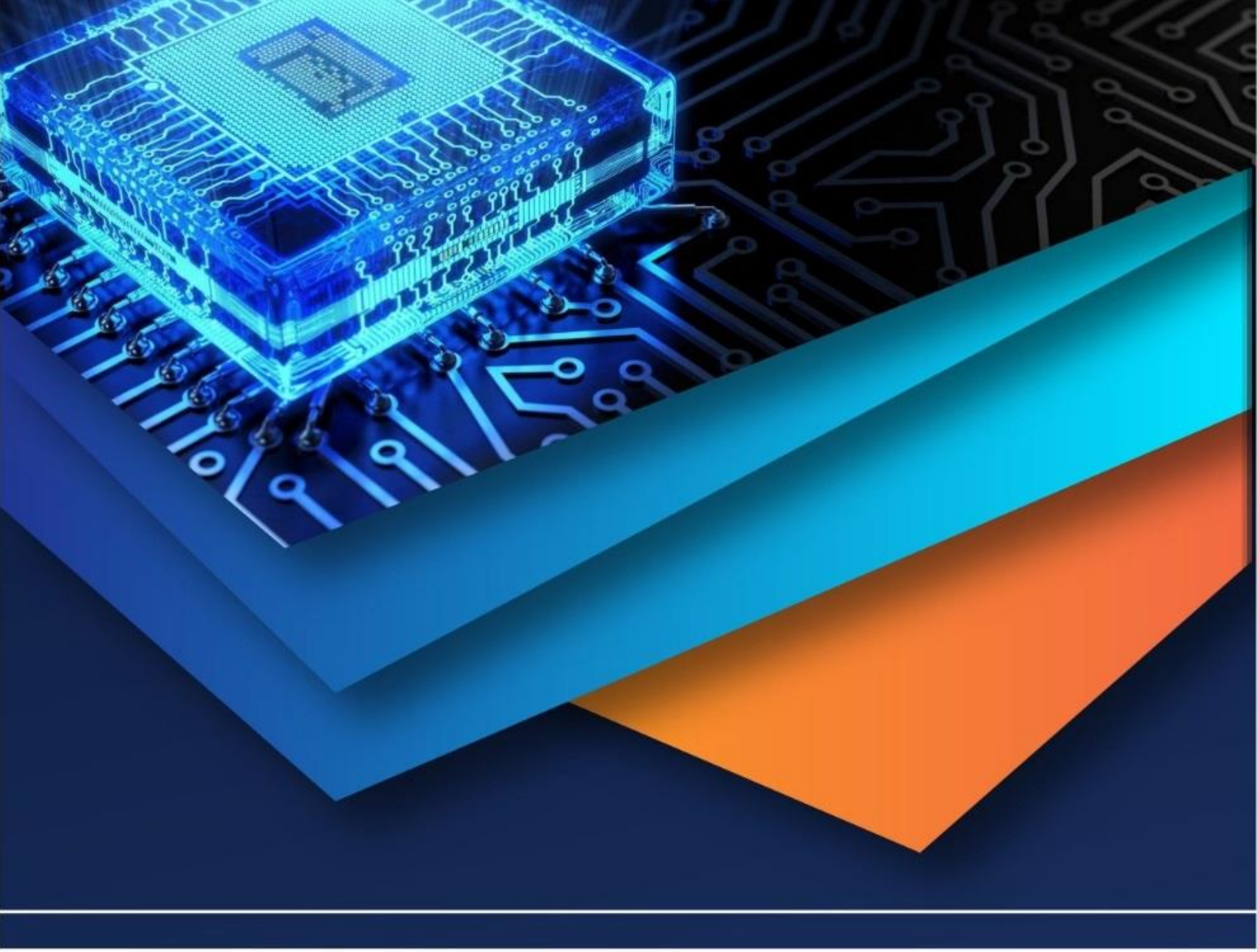

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