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Detection and Identification of Potato Plant Leaf Diseases using Convolution Neural Networks

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Abstract— Crops suffering from various diseases can be a big turndown for crop yield. This can affect effective crop production, if left unnoticed. Hence, it is extremely important to examine the plant diseases in its initial stages so that felicitous actions can be taken by the farmers at the nick of time, to avoid further losses. It focuses on the method which is based on image processing way for identification of diseases of leaf in a plant .so let's introduce a system which uses convolutional neural networks that helps farmers to identify any possible plant disease by loading a leaf image in to the system. The system consists of a collection of algorithms which identifies the type of disease with which the leaf is affected by a disease. Input image given by the user goes through many pre-processing steps to identify the disease and results are returned back to the user on a user interface.

Keywords—Image processing, Leaf image, convolution neural network, Image resizing.

1. INTRODUCTION

Agronomist face huge problems in detecting and preventing plant diseases. Thus, identifying the plant diseases in its initial stages is important in order to avoid any further agricultural losses. Detection of diseases once they attack the plants is extremely important. In this paper, we focus, not only on detecting and identifying the type of disease with which the plant is affected, but also on suggesting remedies and preventing any such attacks in future. The concept that we are using here is Neural Networks. Neural Networks is a series of algorithms that recognizes relationships in data which is similar to the working of a human brain. In this system, mainly we have used Convolutional Neural Network as it provides high accuracy than other neural network algorithms and is highly suitable for image processing. Sherly Puspha Annabel et al.[20] explains various kinds of leaf diseases that a plant leaf can be prone to. These diseases can be bacterial, fungal or viral. Some of them are leaf fungus, Erysiphales, bacterial and potato late blight and so on.Ch. Usha Kumari describes the detection and classification of potato plant leaf diseases with four stages. Mr. Ketan D. Bodhe**,** Mr. Himanshu et al.[4]proposed the rule-based system for detecting leaf diseases in cotton leaves. They used an android application. Hence, it is important and crucial to diagnose the leaf diseases in potato plants at early stages in order to produce high crop yield.

2. LITERATURE SURVEY

This system is used to identify and classify grape leaf diseases using SVM classification methodology. It uses resizing, thresholding and Gaussian filtering for image pre-processing. In this way first have to separate the leaf surrounding by using K-means clustering technique. After that we have to apply feature extraction technique using both texture as well as colour features. In the final stage applied SVM classification technique is used to detect the kind of leaf disease. Through this approach, the accuracy level was 88.89%.**[2].**

In this paper goes to implement different kinds of analysis techniques and classification methods for detecting and identifying various leaf diseases. Here, separation of the leaf area was made by using K-Means clustering algorithm. Grey-Level Co-Occurrence Matrix (**GLCM**) is used in feature extraction method. Classification is done using SVM.**[6]**

In this system, finding the diseases in tomato leaves has been carried out using Convolutional Neural Network, along with Learning Vector Quantization algorithm. The main disadvantage in this method is that the leaves used here are similar to each other. Hence, similarities can bring ambiguity, leading to incorrect results. **[3]**

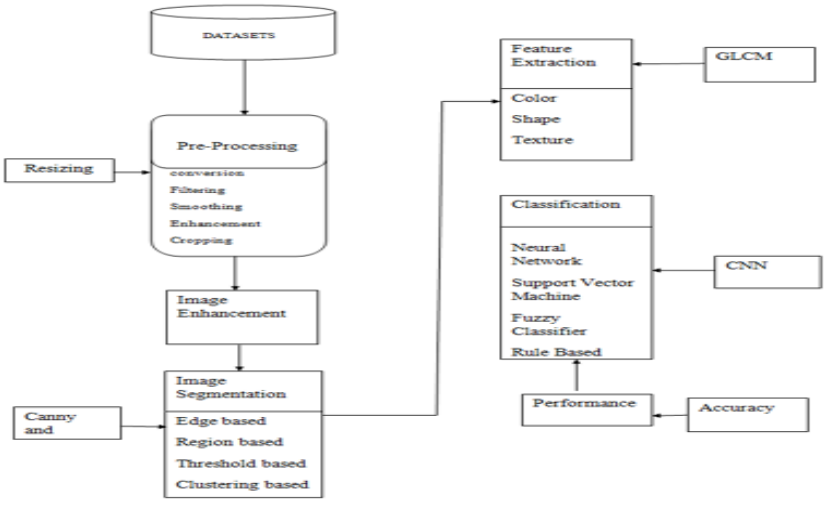
In this system, they were introduced an innovative model which was named as Multilayer Convolution Neural Network (MCNN) was used for classifying the Mango leaves that are affected by the fungus cells which is known as Anthracnose disease. It provides the highest performance with accuracy of 97.13%. **[26]**

In this system min thing is extracting the colour feature of potato leaf. It has been increasing the efficiency of differentiating the disease on the potato leaf. The important thing is differentiating the colours can be applied by calculate the different colour features by using the maximum and minimum colour difference between two opposite pixels on the boundaries. Then These features are further combined with statistical features to classify the potato leaf infection. It provides higher accuracy and better performance when compared to other identification schemes.**[21].**

It is actually to develop an algorithm that determines the heavy impact of Potato Blight disease that occurs in a potato leaf under uncontrolled environment. This paper uses FCM clustering algorithm and neural network classification to determine the heavy impact of this potato leaf disease. This approach achieves a high accuracy in computation and precision of the damage. **[14]**

3. OBRIDGEMENT

The rundown of our proposed system is illustrated as below:



In this system, we aim to detect and identify the diseases with which potato leaves are affected with. Initially, the image of a leaf is captured using a camera and is stored in a particular directory. This image undergoes pre-processing, starting with conversion of RGB image is converted to Grayscale image. The image is captured in RGB format, then the captured image is converted from RGB colour model into Grayscale. This image is stored in a destination path in the same directory. Next, comes the resizing of the image, which is done to feed the input data into the neural network to a specific pixel range. The pixel range defined here is 256*256. Next, we calculate the values of mean, variance and standard deviation. Next is the feature extraction technique. This may be defined as a kind of dimension reduction method that efficiently represents the enhanced parts of an image in the form of a feature vector. The image is initially blurred to an extent, such that it can be smoothened easily. Now, this smoothened image is stored in a directory. This is taken from the database directory for training. This image is used for training the neural network. The image could be read and resized for better accuracy. Further, this image is appended into the training directory.

4. PROPOSED SYSTEM

Our proposed system having four modules: Acquisition of Image, Pre-processing on images, Extracting features from images after pre-processing step and finally Classification. The stages in the system may be defined as follows:

A. Image Gathering Process: The plant leaf images are captured by using camera. The captured image obtained as a RGB format and this image is further processed in the preprocessing stage for refinement. An image in RGB format means nothing but it has the three primary colors namely: Red, Green and Blue, each color in their definite proportions.

B. Image Pre-processing: In the way to eliminate noise from the image, diverse pre-processing techniques can be considered. It will convert RGB colour model in to Gray scale model by using the Converter-Weighted method. The weighted method has a solution to that problem. normally Red colour has more wavelength when compared with the Yellow and Green colours, Hence, the resultant equation in that following form: New grayscale image = ((0.4 * R) + (0.69 * G) + (0.11 * B)). From the above equation, we can see that Red colour has 30% of its part, Green has 69%, which is greater in all three colours and Blue has 21%. Next comes an important phase called Image Resizing. Sometimes, the resolution of document images can be very high, typically higher than 2000 *2000, which is large to be set to a CNN with the current availability of resources. Large input dimensions are expensive, but can also lead to over-fitting conditions. To avoid such issues, we will be resizing the images. after the process of converting RGB image into Gray scale image, it resizes into a standard format.

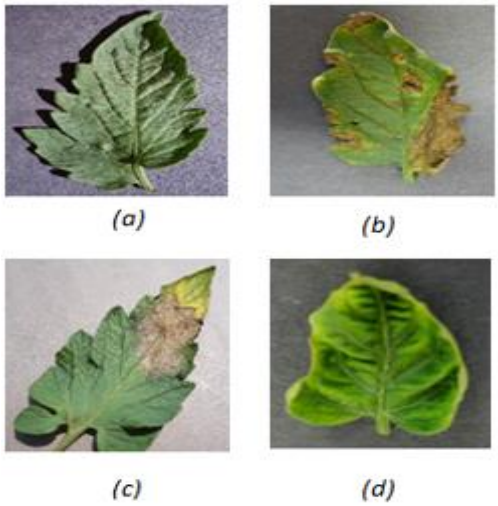


Fig 1.(a) healthy leaf Fig 1.(b) Leaf affected by bacteria Fig 1.(c) Leaf affected by Late blight Fig 1.(d) leaf affected by virus.

Fig 2 image captured in RGB

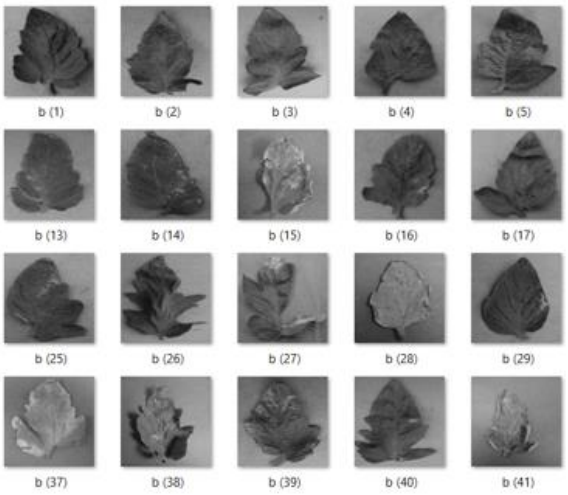
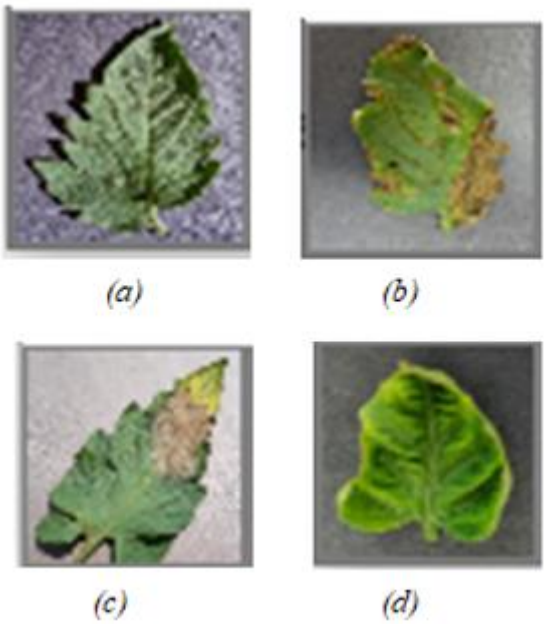


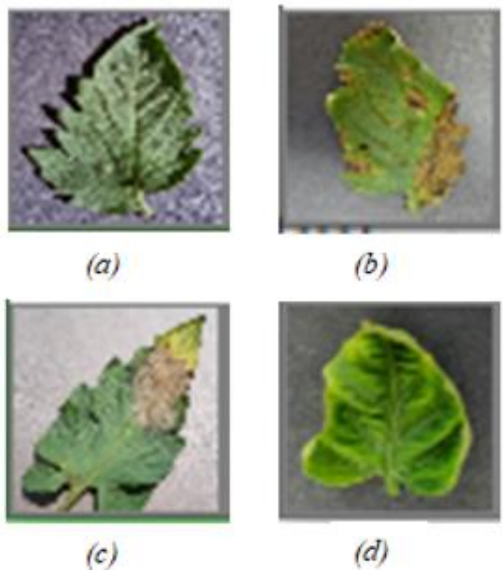
Fig 2 Captured image converted to grayscale

C. Image Enhancement: After removing noise from the image, what we need to do is feature extraction. It is a type of dimension reduction technique that represents the various parts of an image in the form of a feature vector. It has two main algorithms namely Contrast-Limited Adaptive Histogram Equalization (CLAHE) and Gaussian Blur which play a major role in performing feature extraction on the pre-processed image.

a. CLAHE – Adaptive Histogram Equalization (AHE) is an algorithm which is used to enhance the contrast of the image. There are two types of AHE- Ordinary AHE and CLAHE. Ordinary AHE may also be employed to enhance the contrast of the image. But this can bring many outliers. Hence, Contrast-Limited Adaptive Histogram Equalization(CLAHE) is employed to enhance the contrast and the same time, can reduce the number of outliers occurring.

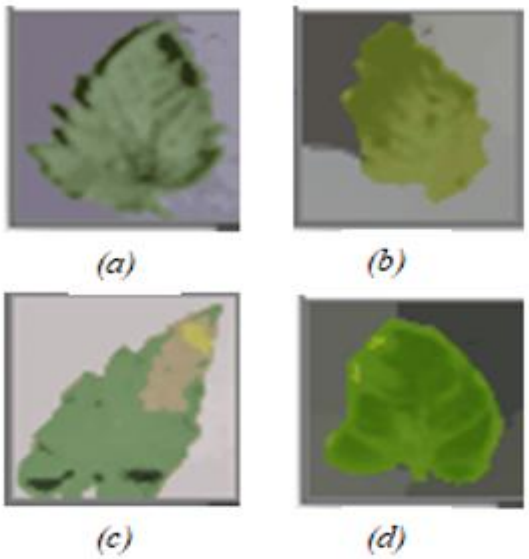


Original images of leaves Fig 4.(a) healthy leaf Fig 4.(b) Leaf affected by bacteria Fig 4.(c) Leaf affected by Late blight Fig 4.(d) leaf affected by virus.



Colour contrast Image of leaves Fig 5.(a) healthy leaf Fig 5.(b) Leaf affected by bacteria Fig 5.(c) Leaf affected by Late blight Fig 5.(d) leaf affected by virus.

b. Gaussian blur– Gaussian blur is an algorithm which is used to blur the image after resizing. This blur algorithm takes a single pixel as an average of all the pixel points around. The center point calculates the average of all the surrounding pixel points. If the average is 1, then it is data smoothing. As the blur radius increases, the blur increases. The result obtained through this technique is a smooth blur, similar to the image that is seen through a butter paper or a thin plastic sheet i.e. it looks translucent.



Mean Shift Image of leaves Fig 6.(a) healthy leaf Fig 6.(b) Leaf affected by bacteria Fig 6.(c) Leaf affected by Late blight Fig 6.(d) leaf affected by virus.

D. Feature Extraction: Feature extraction may be defined as a process of dimensionality reduction in which, a set of unprocessed data is reduced to more convenient number of groups for processing. Feature extraction is useful as it reduces the number of resources needed for processing without any loss of important or relevant features of data. It also eliminates redundant data for a given analysis. This helps in facilitating the speed of learning and generalization in the machine learning process.

E. Classification– In this phase, we use Convolutional Neural Networks (CNN) for document image classification. It is one of the type of neural networks in deep learning technology, it is hugely used in the fields of processing of images and natural language processing. In our system, we have used five hidden layers and eight iterations (epoch). The convolutional neural network consists of four layers namely: Convolutional layers, ReLU layers, pooling layers and fully connected layers. Convolution layer is used to extract features from an input image. It performs a mathematical computation by taking an image matrix and a filter matrix as input. The image matrix would contain pixel values of 0, 1. The filter matrix may contain any square matrix value, say 4*4. A matrix produced by multiplying the image matrix and filter matrix at the end. Strides are the pixels that will be used to shift over the input matrix. Padding may also be used to adjust the matrix to perfection. ReLU layer is used to introduce non-linearity i.e. it will be used to remove any negative values, as negative values do not play any role in the real world. Pooling layer have three layers namely: Maximum pooling, Average range of pooling and Sum of pooling. Maximum pooling which selects the largest number in a stride matrix. Average range pooling which selects the average of the large elements. Sum pooling will sum up the elements in the stride matrix. Complete connected layer is used to flatten a matrix to a vector. Finally, a function which is used for activation that classifies the outputs according to the given inputs.

```
11cf 7d3f 0000 0000 8284 123d 1581 fb3d
3f6c 5dbe ca66 88be 2c68 833e 23bc 743e
eabc 18be 7c5c 8f3d 7bc3 6fbe a8b6 7b3e
e489 7f3d 20c4 81be a229 a33e 089b 12bc
74b3 84be 0149 9dbe e717 553d 8dfe f83d
15fb 7fbe ee06 903d 260f a6be 7834 9d3d
a02f 58be c18a 95be 1a8a 353e 2c1b 33be
1dde 923e 3809 913e fae0 e53d 414a ccbd
493f e3bd 0a77 c53d 75d0 a7be d7bb f9bb
bfcf 84bd 5016 5a3e ce84 633d 0097 febd
b23a dd3d 9b63 b03d 8efd 8f3e b65b 273e
954e 143c f16f b83d 489e 9cbe 0bc5 873e
4b28 643e ce35 86be fc6d 933e d8a4 a0bd
b960 b03d ae68 223d 28ed 193d 0a96 573e
d1ad babe 4a34 32be 72b5 e63c 1228 a83d
99a0 dcbc 0c06 8a3d 187e 3bbe 4ebe f43d
0ac9 68be 0e61 c1bd ab1b f8bc e12d 13be
5277 6dbe febe aa3e de4b 43be 89c9 31bd
2a91 bb3d 054d 863e 39fa 90be 01c5 b53e
6655 333e 30cf 88be 3d8b 6c3e 1500 43be
```

Fig 7 Machine readable format of the images

5. EXPERIMENTAL RESULTS

The results are displayed in a User Interface. The interface prompts for an input image. User provides the image that he wishes to predict. The algorithm takes this input and processes it to tell if the leaf is healthy or unhealthy. If the leaf is predicted unhealthy, it displays the unhealthy leaf along with the name of the disease with which it is affected (be it bacterial, fungal or viral). It also suggests remedies to cure the disease and provide solutions in order to prevent the disease to recur in future.

Fig 8 Prompts to give input image

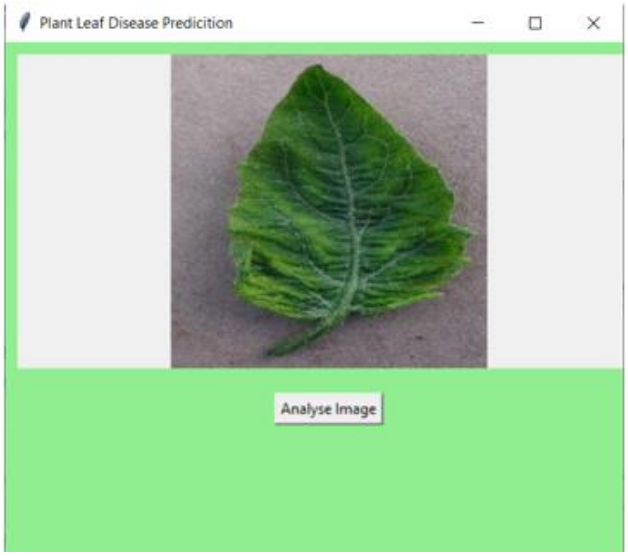


Fig 9 System prompts to analyse image

Fig 10.(a) Display the status of the leaf

Fig 10.(b) Display the status of the leaf

Fig 11 Display the remedies for the unhealthy

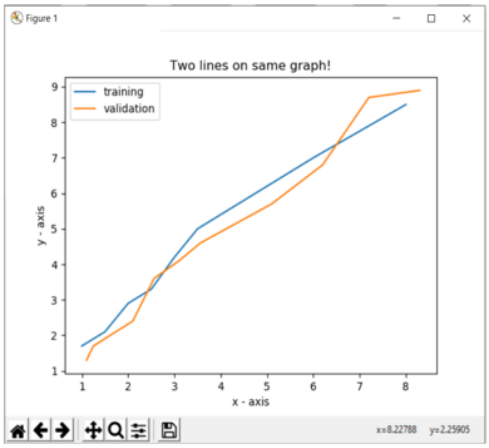


Fig 12 Training versus Validation Graph

Table-1: Performance table

S.NO.	NAME OF THE PROJECT	PLANT	YEAR	METHOD USED	PERFORMANCE (%)
1.	Identification of Potato Late Blight Disease from Crop Images Captured under Uncontrolled Environment	POTATO	2014	BPNN	93
2.	Automated Identification of Late Blight Disease from Leaf Image of Potato Crops	POTATO	2017	Adaptive Thresholding	96
3.	Identification of Potato Diseases Using Image Segmentation and Multiclass	POTAT	2017	SVM	95

	Support Vector Machine	O			
4.	Identification and Prediction of Potato Disease from Leaves using Deep Convolution Neural Network towards a Digital Agricultural System	POTATO	2019	DEEP CNN	98.33
6.	**Detection and Identification of Potato Plant Leaf Diseases using Convolution Neural Networks**	**POTATO**	**2020**	**CNN**	**99.4**

6. CONCLUSION

This paper describes about the plant diseases that a leaf of a potato plant can be exposed to. Further, not only does it detect and identify the type of disease it is prone to, but also it suggests remedies for the farmers so that they are aware of it and can take preventive measures towards effective crop yield. The accuracy of the CNN method for our work is found to be 98.54%.

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