Leaf Disease Identification using Convolution Neural Network (CNN)

Reeja.SR, Pavithra.N, Pinky.B, Alfiya Anjum.M, Sheikh Hammaad

Abstract*: The tomato plant is the most broadly cultivated produce in India. As the Convolutional Neural Network (CNN) which comes under the field of image classification is performing the progressive work, thus using an approach of deep learning which mainly centers on achieving high accuracy of leaf disease of the tomato plant. Therefore, the main objective of this paper is to acquire more reliable performance in the identification of diseases. Amidst various plant diseases that affect leaf comprise of Late blight, bacterial and viral diseases have been chosen to differentiate infected leaves from that of the healthy leaves includes Late blight, bacterial and viral diseases. As we know, none of the other method has been proposed earlier which helps in detecting plant leaf diseases for the first time. Hence the proposed model is designed in such a way that it effectively identifies specific diseases that affect leaves of tomato plants through the use of a dataset containing about 4000 leaf images. CNN achieves an overall accuracy of 96% without implementing any pre-processing and feature extraction methods.

***Keywords*: CNN, Leaf, Classification, Leaf disease detection.**

I. INTRODUCTION

Plants have been faced with many harmful diseases that cause noteworthy reductions in the production of qualitative farming products. It's crucial to perform identification and prevention of plant diseases to overcome this issue. In general, plant diagnostics are performed with visual inspection by the experts and, if appropriate, measurement of the concentration or potency of a virus or bacteria by its effect on living cells or tissues of plant leaves are a second choice.

Many computer-based approaches have been used to identify plant diseases based on their leaf images. Many methodologies examine not only plant diseases, but also the localization of their impacted areas. In deep learning and image processing domain, object detection and location have recently gained a great deal of attention and many promising methods have been proposed. Most of the new methodologies have been evolved jointly with or applied on CNN and has shown excellent performance. Such CNN-based systems have been used as application testing on plant diagnostics.

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The diseases are distinctive to the different parts of the body of the plant. Leaves can be considered as the central part of the plant, but only with the aid of leaves can the process of photosynthesis be done. The life cycle of the plant is directly affected when the plant leaf is prone to disease.

To deal courageously with these diseases, it is important to set up a system that automatically classifies the diseases. Resolving it using deep learning is more effective. Several deep learning methodologies have been introduced for the classification of plant diseases with the help of plant photos. The greatest challenge with these automated methods is the consistency and robustness of the tests attained.

In this system, detection of plant diseases has been achieved with the help of imaging, and deep learning methods. The classification of leaf diseases is performed using CNN. The features including domestic connection, growth and pooling operations are proved to be effective in the reduction of the complexity of the application.

II. LITERATURE SURVEY

[1] Wang-Su-Jeon et.al 2017 stated "Plant leaf recognition using convolution neural network". The authors have demonstrated one of the techniques which use the CNN model to analyze leaves.

The measures suggested under this writing is constructed which results in-

1. Improving the performance of classification. CNN, that extracts and learns feature points.
2. Examines existing leaf recognition.
3. Describes CNN which imitates systems such as human visual systems and GooglNet.
4.Leaf identification system can be explained.
5. Explains the analysis and interprets the results.

In this paper, authors have introduced a method, CNN model to classify leaves and constructed two models through the use of GoogleNet which automatically adjusts the network depth using GoogleNet. Therefore, the proposed models are estimated according to damage that occurs to leaves and also decoloration of the leaves. Hence, the achieved rate of recognition was more elevated than 94%, despite while 30% damage that occurred to the leaf.

2] Davoud Ashourloo et.al, Demonstrated "An Investigation into Machine Learning Regression Techniques for the Leaf Rust Disease Detection Using Hyperspectral Measurement In this paper, the authors have explained a few regression techniques that can effectively examine leaf rust diseases through the use of hyper spectral measurement.

Those regression techniques included in this paper are partial least square regression (PLSR), support vector regression (SVR), and Gaussian process regression (GPR) for wheat rust disease detection. Firstly, this PSLR model showed a larger sample size which resulted in greater performance from this model at the canopy scale. Secondly, the SVM model showed an increase in sample size from 25-150. Finally, the GPR model showed higher accuracy when compared with PSLR and SVM models using the same sample size.

Hyper spectral measurement: The use of hyper spectral measurements in which it measures continuous spectral bands, that is it analyzes a wide spectrum of light instead of just assigning primary RGB colors to each pixel

Disadvantage: The combination of various symptoms of disease towards a particular level of severity of disease appeared in extremely complicated spectra which doesn't satisfy the correctness of both NBNDVI and PRI.

[3] Yu Yang, Xiaofei He et.al Illustrated "Northern maize leaf blight detection under complex field environment based on deep learning". Within this writing, the authors state that. Northern maize leaf blight implies one such significant infection that affects the productivity of maize. Which involve disease symptoms such as, dark gray spores and decreased yield of the crop. Therefore, it is more complex to detect diseases due to the various light intensities and also the complexity of the background of the filed. Convolution neural network model signifies identification of maize leaf blight, this model combines Pre-processing, a module used for detection, and a fine-tuning network which are some major steps involved in the proposed model. Authors also practiced SSD (SINGLE STAGE TARGET DETECTION ALGORITHM) with some improvement alike Retinex (filter function) and GIoU is chosen to optimize the primary loss to enhance detection correctness.

Advantage: Compared to the original SSD model, the mean average precision of the latest model was raised from 71.80% to 91.83%.

Disadvantage: Frame per second had risen from 24 to 28.4%.

[4] Siddharth et.al Observed "Bacterial foraging optimization based Radial Basis Function Neural Network (BRBFNN): An automatic approach towards Plant pathology". As we know that plants perform a significant part in the durability of individuals and likewise for the environment. But due to the disorders that attack several parts of the plant where the actual growth of the plant is rigorously affected. Despite, if all these diseases are found in the earlier stages and detection of diseases precisely that recognizes and approaches the plant diseases automatically that delivers a vast impact on the overall health of the plants. This paper provides us with a method that effectively classifies and identifies the plant diseases automatically identified as Bacterial foraging optimization based Radial Basis Function Neural Network (BRBFNN). The suggested approach increases the network speed for identifying and classifying several diseases of plant leaves that affect different regions of the plant and precision.

Advantage:

The method introduced in this paper has reached higher performance in terms of the plant leaf disease classification and also the identification. while related to other segmentation algorithms like K-means clustering and Genetic algorithms where the result concerning segmentation noted had higher average sensitivity and specificity.

[5] Pranjali et.al Described "SVM classifier based grape leaf disease detection". In this paper, the authors have investigated the detection of disease in a grape leaf, as we know that grape crop constitutes more leading fruit crop produced in India. Infectivity detected in the grape crop can lower the overall productivity of the fruit and also makes it complicated to control the disease spread. The authors have adopted one of the techniques, Image processing which detects and classifies the plant leaf disease. This paper is also aimed at the detection and classification of diseases that affect the leaf of the grape using the SVM classifier.

Advantage: The suggested method can identify and classify the investigated diseases by accuracy of around 88.89%.

III. SYSTEM DESIGN

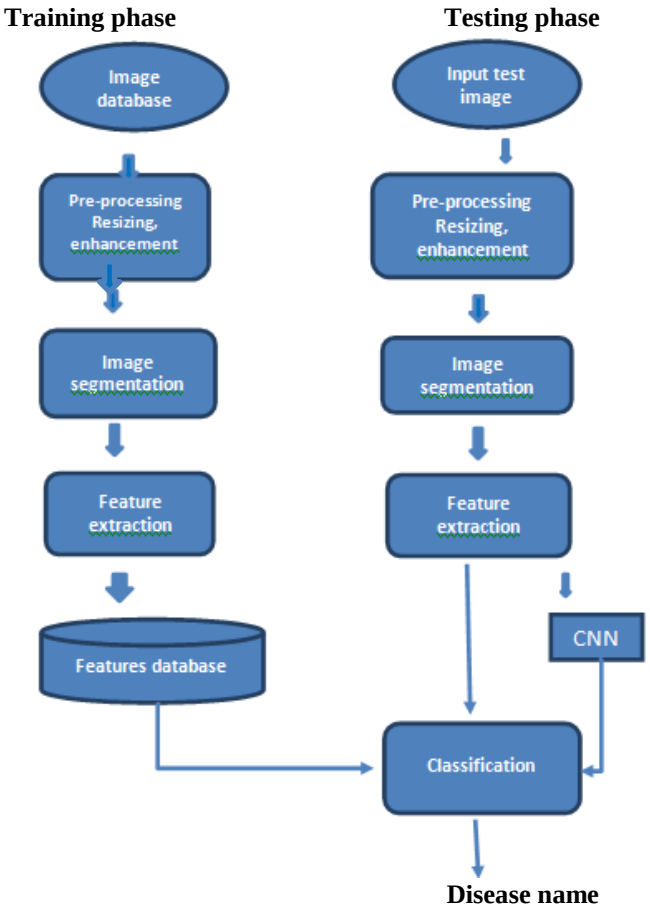


Figure 1: System Architecture

A. Image Acquisition and Pre-processing

Initially, there is a concentration of 3 types of plant leaf diseases that are specific to a large number of plant species. For which a set of trained 4000 images and a set of test images around 2000 are created. The preparation and research collection consist of a mixture of five pathogens and one insect.

The images captured may have different shapes and proportions, so the images are pre-processed and taken to the same size, removing noise, background and the unnecessary distortions. The output image obtained is given as input for the next module.

B. Segmentation

Segmentation is performed after doing some pre-processing which works on basis for classification and also verified object detection. In CNN image segmentation is performed by applying filters. These filters are also used in feature extraction. This also involves giving or feeding input to the CNN model, where labeling of pixels takes place. It scans the image based on the input stride given, and this process continues until it has covered the whole image.

C. Feature Extraction

After segmentation the features are extracted by applying the filters and also various features are extracted using various techniques of feature extraction. It specifically defines the diseased area on the basis of color, form and textural features. Various extraction techniques, such as color co- occurrence, skewness, comparison, similarity, etc., are used to obtain the desired set of features.

D. Classification

This is the last stage where "Convolutional neural network (CNN)" is used for classification. It provides us with better, more accurate results. The classifier is evaluated using a combination of different outputs which are features. Disease will be identified and the label will be displayed.

IV. ALGORITHM

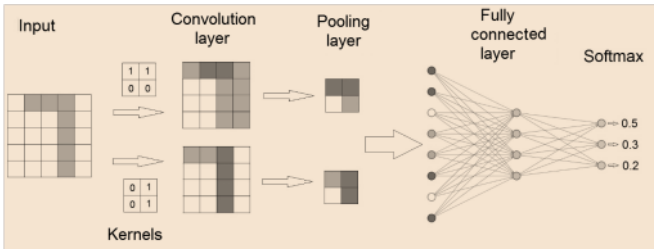
Convolution Neural Network

Neural Network is basically containing set of connections between several processors called artificial neurons. Each of these neurons will produce a series of real valued activation.

Convolutional Neural Network, which is known as CNN, consists of three layers which is the Reference layer, the Middle layers, and the Output layer. The first layer which is the input layer is the one that recognizes the features as input, in other words, the images are provided as input through this layer. The second layer which is the middle layer consists of the necessary number of nodes on the basis of the program. The output layer produces the data. Convolutional Layer performs a convolutionary operation over the elements of the image matrix which is the pixel values in it along with the kernel matrix. The kernel matrix will move over the image matrix which is the pixel matrix and the value will be calculated. This is used to find out the final size of the filter map provided as output. The basic functional unit of a neural network is “neurons or perceptrons”.

In the general, each neuron in a Neural Network consists of two things which is input and output. Here inputs are input values (y1, y2... yn) and weights represented as w1, w2, w3,..., wn. Each input yi is multiplied with Wi and the values are summed. Bias (b) is added which generates of activation signal (v) this is calculated with following formula v=∑_i▒〖yi.Wi+b〗 now the signal which is generated will be passed through activation function f (v) resulting in output signal z. There are basically four layers

(i) Convolution layer
(ii) Pooling Layer
(iii) Fully connected layer
(iv) Softmax Layer



CNN is basically used for image recognition which is the subset of ANN (Artificial Neural Network)

Convolution Layer:

In convolution Layer the input image is multiplied with a filter Where basic feature extraction takes place.

Pooling Layer:

It is used to reduce the spatial size representation and also it used for reduction in number of framework and calculation in the network.

Fully Connected Layer:

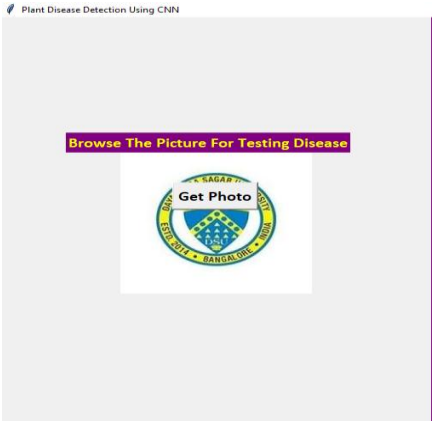
Fully Connected layer works as multi-layer in forward direction where the output of one neuron is traversed over another as input to another neuron.

Softmax Layer:

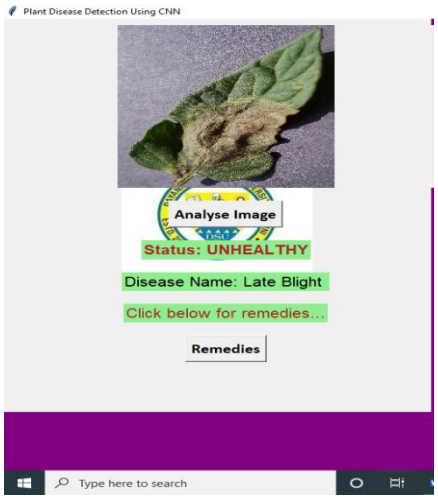
This layer consists of N x 1 matrix where the output data is interpreted by probability distribution function.

V. RESULT AND ANALYSIS

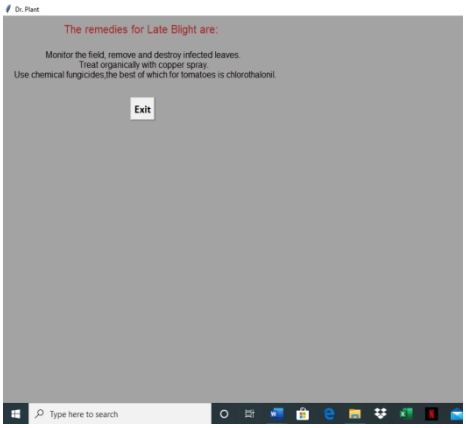
In the proposed system, we had interacted the end user with graphical interface to provide flexibility for the usage of application. It is designed to test three plant diseases with the usage of 4000 images in the dataset. The diseases identified are bacterial disease, viral disease, and late blight disease. This application could successfully identify and classify the specified diseases with an average precision of 93% and minimum precision of 80%. It displays the remedies for the diseases after successful prediction.



1. The output window



2. Late Blight Leaf Disease



3. Remedies for Late Blight Disease

The proposed approach is based on deep learning. In the first step, the images captured may have different shapes and proportions, so the images are preprocessed and taken to the same size, removing noise, background and the unnecessary distortions. The output image obtained is given as input for the next module. Next, in the second step, Segmentation is performed to identify the infected area.

In the third step, the features of the segmented infected leaves are extracted. In the final step, CNN is used for classification. It gives us better, more accurate results. It gives us better, more accurate results.

VI. CONCLUSION

A method is introduced in this paper, which is simple and reliable compare to other methods for detecting particular disease in a given leaf image. The convolution neural network, is the deep feed-forward artificial neural network which is applied for detecting the leaf disease. we are considering one leaf per image because the surrounding leaves may have the same or different disease and it will be difficult to detect accurately. In the proposed method, we are performing series of steps like data pre-processing for improving detection accuracy and other image processing methods to improve our result accuracy where our accuracy is 96 percent and above. If this method is fully implemented then the disease can be detected at early stage and this will reduce the cost and the time consumed manually.

FUTURE SCOPE

The model which was developed in this paper using CNN, considers only the leaf part of the plant to detect the disease of that crop. It will be more effective and convenient if the other parts of the part such as stem and roots are also used for detecting the disease. Future work will involve considering more image which contains more than one leaf. Using this model in more complex environment and wider land areas. This will help the crop production quantity and quality by treating the plant in early stage.

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