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POTATO LEAF DISEASE DETECTION AND CLASSIFICATION USING CNN

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ABSTRACT

Potatoes are a well-known vegetable to all of us. Potato cultivation has been very popular in India form the last few decades. But potato production is being hampered due to diseases like early blight and late blight which are increasing the cost of production. The aim here is to build an automated and rapid disease detection process to increase potato production and digitize the system. Our main goal is to diagnose potato disease using leaf pictures that we are going to do through CNN algorithm. This paper offers a picture that is processing and machine learning based automated systems potato leaf diseases will be detected and classified. Image processing is the best option for detecting and analysing these diseases. In this analysis, picture division is done; more than 2000 pictures of healthy and unhealthy potato's leaf, which are collected from Kaggle and a few pre-prepared models are utilized for acknowledgment and characterization of healthy and diseased leaves. Among them, the program predicts with an accuracy of 91.41% in testing with 30% test data and 70% train data. Our output has shown that CNN exceeds all existing tasks in potato disease detection.

Keywords*: Potato disease, late blight, early blight, CNN, image processing*.

1. INTRODUCTION

Potatoes are well known all over the world and also an important basic food in many countries around the world. Potatoes are also called the root of all vegetables. As already known, that, India is an agricultural economy and grows different kinds of crops, potatoes occupy an important part in our country. India is the 2nd largest potato producing country in the world. India produced about 43,000,000 tonnes of potato in 2018. The demand is growing across the world day by day, and it is also required to export as much as our region can, so the main aspect is increasingly producing potatoes. But the fact is that, in the last few years the export and produce is decreasing because of some serious disease of potato leaf-like early blight, late blight, etc. The farmers also have to suffer due to this reason.

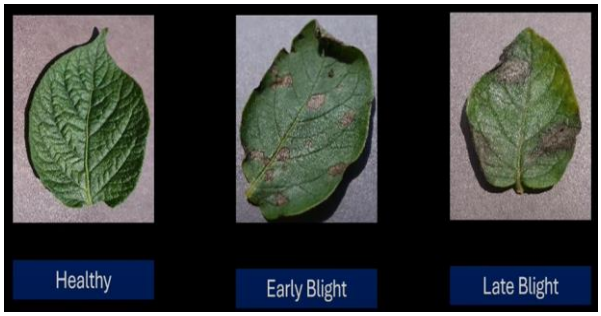


Fig. 1. Potato leaves

Sometimes the disease is visible on the affected potato leaf. Sometimes spots come out on the leaf of the plant as well. The common disease of potato is early and late blight. Early blight's symptoms can be seen as small, black lesions mostly & late blight symptoms can be seen blistered as if scalded by hot water and eventually rot and dry out. To distinguish these disorders from potato leaves, CNN algorithm will be used and this will be very beneficial for farmers. Three various types of processed images are accessible. They are early blight, healthy & late blight. The overall number of photos are isolated into two sections, one for training and the other for testing. Approximately 75% of the photographs are in the training portion and the remainder will be used in the testing section. The normal and diseased potato leaves would be classified by the proposed model. This will help farmers to detect these diseases easily and can use appropriate fertilizers to get rid of these blights in-order to easily enhance their growth and production momentum.

2. LITRATURE SURVEY

Some of the previous studies that have conducted trails in potato leaf disease detection include the following:

In a research paper titled "Krishi Mitra: Using Machine Learning to Identify Diseases in plants". Here they used TensorFlow Framework by CNN model methodology to implement their project. The advantage of this model was that only leaf area was calculated and fungi caused diseases in sugarcane can be recognized. The disadvantage of was that High Computational Complexity was required to implement it.

In a research paper titled "Severity Identification of Potato Late Blight Disease from Crop Images Captured under Uncontrolled Environment". Researchers used Fuzzy c-mean clustering, Neural Network in implementing the model. Does not need special training to farmers as dataset has images in different angles was the main advantage of the model. The only disadvantage was that the images captured by untrained farmers were not oriented and contain cluster of leaves with background visible in several segments.

In a research paper titled "Potato Disease Detection Using Machine Learning". Image processing was the used technology over here. Use of CNN Model gained 90% validation accuracy was the major pro in this project. Large Training Model Is Required was the major drawback of this model.

In a research paper titled "detecting the infectious area along with disease using deep learning in tomato plant leaves", the proposed methodology was mask R-CNN , Deep learning. Advantage of this was that using the R-CNN mask can improve and accelerate the pathogen detection process in plant leaves. The disadvantage was that it takes more processing time.

3. METHODOLOGY

In this project, there are multiple stages of research as can be seen from Fig. 1. In the form of research framework. In the proposed research framework, there are four stages which are as follows:

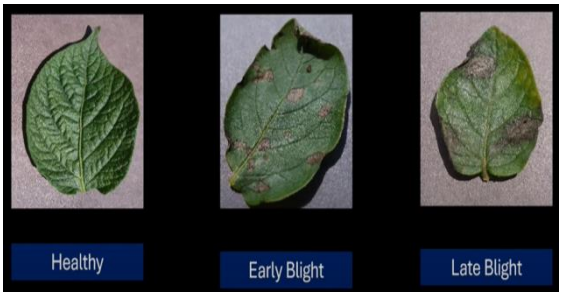


Fig. 2. Image data

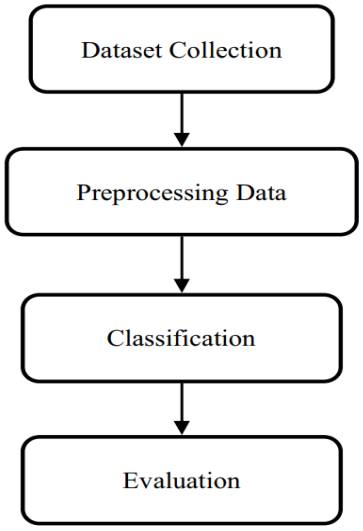


Fig. 3. Proposed research framework

A) Dataset Collection

The dataset used in this project are the pictures of potato leaf divided into three categories:- The healthy leaves, the early blight and the late blight. The dataset was taken from Kaggle website under the name "PlantVillage Dataset". The amount of data used is:

Samples	**Number**
Healthy leaf	150
Early blight	500
Late blight	500
Total	1150

Table 1. Dataset details

B) Pre-processing Data

At this stage, 1150 potato leaf images are used divided into three classes: healthy, early blight and late blight. The table below gives details about the distribution of each data from each class used are divided into training dataset and testing dataset with 80:20 and 70:30 as the data division. The result of each of these data sharing will be compared to the results of its accuracy to determine which is better in dividing in the proportion of data.

Dataset	**80:20**		**70:30**	
	Train	**Val**	**Train**	**Val**
Late Blight	400	100	350	150
Early Blight	400	100	350	150
Leaf Healthy	122	30	105	45
Total	922	230	805	345

Table 2. test-train dataset details

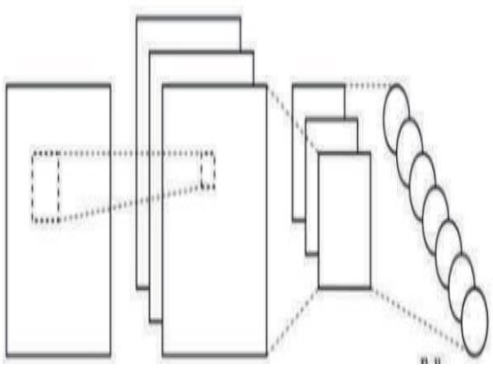
C) Classification

After the above processes, further we need to classify images using Convolutional Neural Network(CNN) architecture. CNN is a supervised learning method where identification of image by training existing dataset and targeting image variables. The convolutional layer in CNN helps neural network to recognize potato leaves based on the attributes that they have. Neural network uses pixels in the picture to recognize images of potato leaves.

In this project we will be using image with size 150X150X3; where it will have three channels, that are red, green and blue. The leaf image will be convoluted with a filter firstly. Then pooling will be applied to reduce the resolution of the image with keeping its quality intact. MaxPooling will be used on output image.

In the next step, this layer us being flattened. This will change the feature map resulting from pooling into vector form.

This project has the proposed model for CNN architecture in identifying diseases in potato leaves using 4 convolutional layers and 4 MaxPooling.



Input image **Convolution** **MaxPooling**

(Feature maps)

Fig. 4. CNN architecture

CNN is used to compute potential maps by using the activation functions. The function is:

$$y_j^l = f(z_j^l)$$

here, y_j^l is the forthcoming graph, & $f(z_j^l)$ is the activation function.

Documents are treated in CNN in 2-D convolution operations.

$$O = \frac{(W-F+2P)}{(S+1)}$$

Here, height, input height, filter size, padding & stride are given by O, W, K, P, S.

D) Model building

Using CNN, the sequential model is formed. For this, we have used rectified linear units. SoftMax is also used like an activation for forecasting

$$P(x) = \frac{e^{x^T w^l}}{\sum_{k=1}^{k} e^{x^T w^l}}$$

which depends on the maximum likelihoods. The equation for the SoftMax function is given below:

Here, X^T W signifies X and W's internal product.

4. RESULTS AND OUTCOMES

Deep learning techniques perform significantly in plant leaf disease detection to improve crop productivity and quality by controlling the biotic variables that cause severe crop yield losses. In our project, a fast and straightforward multi-level deep learning model for potato leaf disease recognition is proposed to classify the potato leaves diseases. It took the potato leaves from the potato leaf image at the first level, then developed the potato leaf disease detection convolutional neural network at the secondary level to classify early blight and late blight potato diseases from potato leaf images. At the same time, it also considers the effects of the environmental factors on potato leaf diseases.

The performance of the proposed PDDCNN techniques was also evaluated in another dataset, where the approach outperformed other methods. This technique's performance was compared with other techniques, and existing studies were used for potato leaf disease detection. The proposed method

was trained on the PLD dataset with and without data augmentation techniques, thus achieving 91.41% accuracy, high precision, recall, F1-score and roc curve on the PLD dataset. It had a minimal number of parameters and was simpler than the state-of-the-art methods, saving a substantial computational cost and speed.

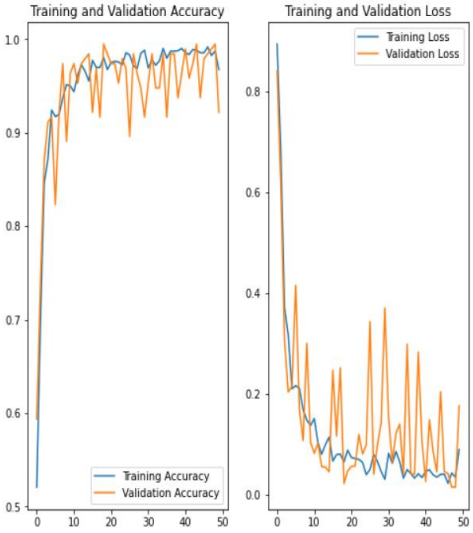
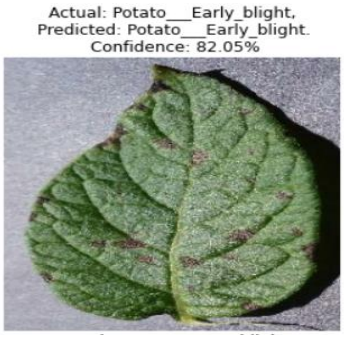


Fig. 5.Training and validation

(a)

(b)



(c)

Fig. 6. Outputs

5. CONCLUSION

In this project, with the help of deep learning techniques and convolution neural network classification based approach is proposed to detect the late blight, early blight and healthy leaf images of potato plant. We found that CNN is the best way to perform this type of classification object. This model gains 91.41% of validation accuracy. We think this type of project will play a vital role in our agriculture sector. Most of the farmers of the village in India are not literate and they don't know about the disease properly. We think that, this work can change the situation of

the potato grower in India. The experiments have been carried out on healthy and diseased leaf images to perform classification. It is concluded that the proposed method effectively recognizes three different types of potato leaf diseases.

6. FUTURE WORK

In future, our aim is to create an android application that can detect the disease of every types of crop and can provide the proper solution for those diseases of the crop. And also, by increasing our database, we will able to get better accuracy. By building an android app we will continue the development process. And we will create a system where the farmers of India can easily get instant service and advice on their problem by detecting the disease. The whole project can be put up on the internet and user can simply sit at home and use the system to detect the disease and spray the required disinfectant.

The interface will be connected with the internet and then to the database. Also, we will try that these types of proposed method will be applied in various applications such as another leaf plant recognition.

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