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CNN based Disease Detection Approach on Potato Leaves

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***Abstract*—Potatoes are a well-known vegetable to all of us. If the other countries are taken into consideration, it can be easily concluded that potatoes are the number one vegetable all over the world, which has been increasingly claimed by many Agricultural departments. Despite the hype, potato leaf disease causes significant damage to the potatoes.. Various types of diseases such as early blight, late blight, septoria blight etc. will attack potato plants and exhibit their syndrome in the leaf of these disorders. The farmer would not face incurring major economic losses if these outbreaks are detected at the primary stage and sufficient action is taken. The proposed model will strongly identify and detect diseases of potato leaf stand on image processing methods in this research paper. Machine Learning includes several algorithms, but the CNN model is used for this research to detect the disease from images of the potato leaf because in CNN is used for image classification & it gives the best result than others. There are 5 algorithms is used for this research they are AlexNet, VggNet, ResNet, LeNet & Sequential model which is our offered one. Normal & disorder-impacted leaf were used for the model provided in order to segregate normal and abnormal aspects of potato leaf. Those kind of photographs are then analyzed through the algorithm provide & the potato plant leaf is labeled as either diseased or normal. This provided model established 97% of great precision.**

***Keywords*—Potato Disease Detection, Image Processing, Neural Network**

I. INTRODUCTION

Potatoes are well known all over the world's people and also an important basic food in many countries around the world too. Potatoes are also called the root of all vegetables. As already known that, Bangladesh is an agricultural country and grows different kinds of crops, potatoes occupies a significant part in our country. Bangladesh is known as the 7th largest country for producing potatoes. Almost 5lakh hectares of land are used for cultivating potatoes every year and produced a minimum of 0.70 and a maximum of 1.09 crore tones according to the Department of Agricultural Extension (DAE). Potatoes play an important role in our economical balance system and agricultural economic situation too. The level of 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 in the last few years the export and produced level is decreasing because of some serious disease of potato leaf-like early blight, late blight, Brown spot, bacterial wilt, septoria blight etc. In that case, the production level is hampered badly. The farmers also have to suffer for this reason. Sometimes the disease is visible on the affected potato leaf. Sometimes spots come out on the leaf of the plant as well. Some diseases like brown spots, early blight, and late blight come out as small, oval, circular, and many other shapes. The symptoms of bacterial wilt can be seen in all parts of infected plants. The symptoms of septoria leaf spot can be seen with grey center & dark margin on leaves. 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, a deep learning model will be offered and this will be very beneficial for farmers. This study is primarily focused on images, so that a large number of images are required. Three various types of processed images are accessible. They are early blight, healthy & late blight. The overall number of photos is isolated into two sections, one for training and the other for testing. Approximately 70% of the photographs are in the training portion and the remainder will be in the test section. The normal and diseased potato leaves would be classified by the proposed model. So that the diseases could not split across the civilized state, farmers can easily enhance their growth momentum.

II. RELATED WORK

To explore crop diseases forecasting, researchers used the machine learning, Support vector machines, RGB image analysis and so many other machine learning methods. Islam et al [1], a multi-class model of Support vector machine has also been conducted to determine potato diseases suppositions. The model was being used for 300 various pictures. Different operating parameters have been used to evaluate the efficiency of the model investigator, such as sensitivity, precision, F1-score and recall. Dubey et al [2] had used a multi-class Support vector machine forecasting model to train and verify pictures for apple diseases classification. Sladojevic et al [3], a deep Convolutional Neural Networks model has also been conducted to determine the infection of 13 folio considering apple & tomato flora. The method was used to determine the separation of 13 various illnesses among normal & injured leaves. Ferentinos et al [4], used AlexNetOWTBn's deep learning platform as well as VGG to distinguish 25 different diseases. For real-time recognition of tomato plant disease classifications Region-based fully convolutional network, Regions with convolutional neural networks & Solid State Drive were also exploited. A few studies [5-8] have been performed using deep learning for most of those classification task. Leemans et al [9], used K-Means clustering. They have proceeded many pattern to convert the actual picture against RGB formation to a picture of CIELAB color space. Finally, the researchers conducted a feature level development. With random forest classification methods, the researchers supplied segmented images. After recognition, by marking each pixel, fruit disease was seen and this approach was used.

III. METHODOLOGY

A. Working Diagram

A number of effective steps are required to detect potato leaf disease. Below the model block diagram is presented:

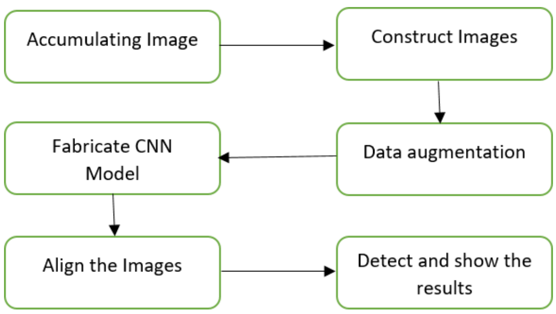

Fig. 1. Block Diagram.

At first, the images are gathered and then constructed for augmentation of the dataset. After augmented the dataset CNN model created for training and testing purposes. After completing the train and test the model finally detects and shows the result.

B. Gathering Datasets

The major component of this project is data. Since we deal with photos, we need to obtain a large number of images. So we need to be aware of some important things like image sizes, resolutions, image quality when the images are gathered and also about the syndrome of the diseased leaves of potato. At first, the image data is collected from Kaggle, Dataquest and some manual images are taken as much as possible. Almost 3000 images were collected and merged. But not all the combined pictures are so helpful for us. The resolution of certain images is too low, some are hardly detected as affected and unaffected. It is why for the training ambition, 500 images are assigned for early blight, healthy & late blight. Similarly, to evaluate ambition, 300 images are selected per directory. The dataset used for this analysis is not reasonably safe. This is why a system of data processing should be completed to get our preferred modeling data.

C. Neural Network

The CNN learning architecture is both monitored and unmonitored. It is possible to use them to forecast something or classification. But CNN mainly used a monitored process. CNN classifies pictures according to their characteristics [10]. CNN computes potential maps through the use of activation functions. The function was given below:

$$y_j^l = f(z_j^l) \tag{1}$$

Where, y_j^l is called forthcoming graph, & $f(z_j^l)$ is called activation function. Documents are treated in convolutional neural networks (CNN) in two dimensional convolution operations.

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

Where height / length, input height / length, filter size, padding & stride are expressed in cooperation with O, W, K, P, S. [11-12].

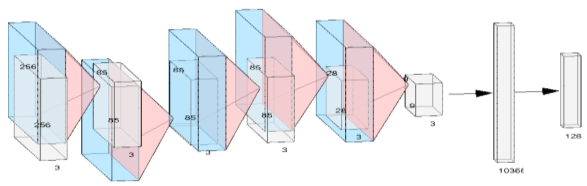

Fig. 2. Convolutional Neural Network (CNN)

Fig. 2. Indicates the model's basic CNN structure by the surface, lining, height, depth & thickness used on the model.

D. Building the Model

Using the CNN algorithm [13], the sequential model is formed. Keras helps to construct this model section by section [14], Convolution two dimensional layer for handling images & image input size (256,256) whatever the size image inputted. There was a flat layer among the two dimensional layer of convolution as well as the dense layer acting both as bridge between them. For this model, ReLU or rectified linear units used in the form of an enabling function [15]. In framework [16], SoftMax was introduced like an activation for forecasting depend on the maximum likelihoods. The equation for the SoftMax function is given below:

$$P(x) = \frac{e^{x^T w^l}}{\sum_{k=1}^{k} e^{x^T w^l}} \tag{3}$$

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

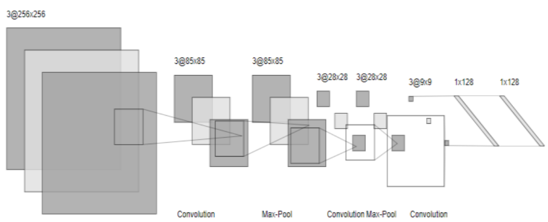

Fig. 3. The sequential model's photographic view.

E. Compiling the Model

The use of "adam" as an optimizer. This is an effective optimization tool throughout the training period to change the learning rate. For our loss function to make things easier to realize, 'categorical cross-entropy' is used to train the system and include 'accuracy' metric to represent the accuracy score on the validation set.

F. Training & Testing

On the model, the function 'fit ()' is used to train. Testing of the Dataset used as validation data. The number of epochs are set in the fit function that rhythms the system over the data. The testing procedure is configured after the training procedure is concluded. It condones the potential of the CNN model which is trained.

IV. RESULT AND OUTCOME

A. Learning rate

A graphical diagram of changing the weights of the system regarding the loss gradient is shown in the learning rate. The interaction given below among weight, gradient, & learning rate:

$$\text{New weight} = \text{existing weight} - \text{learning rate} \times \text{gradient} \quad (4)$$

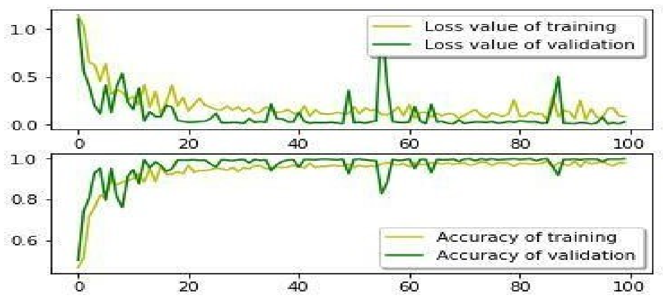

Fig. 4. Precise & Loss graph.

Fig. 4. Shows our model's precise and losses feature charts when training data sets. The precision of training is very minimal at the initial stages, but the precision is enhanced after time. The validation error is comparatively very massive for the loss function graph, but the error rate falls after time.

B. Confusion matrix

The confusion matrix demonstrates optically the output of an algorithm. The values of right and wrong assumptions are evaluated. Precision of Classification rate equation and model equation error are presented below:

$$Accuracy = \frac{TP+TN}{TP+TN+FP+FN} \quad (5)$$

Where,

TP= True Positive, TN= True Negative, FN= False Negative, FP= False Positive.

$$ERROR = 1 - Accuracy \quad (6)$$

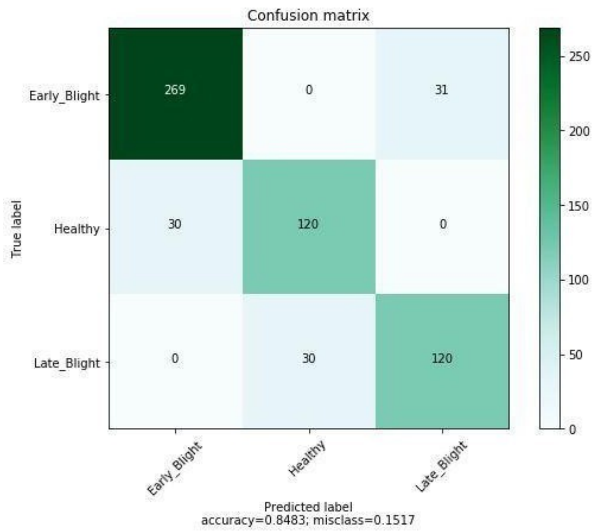

Fig. 5. Confusion matrix

Fig. 5. The confusion matrix displays our classification model. It indicates the crosswise gain is the maximum in every one of the rows. So, our offered algorithm will give the best accuracy.

C. Classification

The whole process is implemented in the Jupyter notebook. In the first stage, different septic potato leaf images were computed to classify them. The photos are selected from the folder of a dataset. When the photos are entered, the outcome of the prediction is shown.

Fig. 6. Early Blight.

Fig. 6. Shows that the leaf is Early Blight affected. A yellowish or bright green-yellow circle which overlaps the spots is often noticed. When the dots get very big, they sometimes make's entire leaves turned yellow and expire.

Fig. 7. Late Blight.

Fig. 7. Shows that the foliage is affected by late blight. Leaf flecks begin as tiny, light to dark green, irregularly shaped spots. The fleck grow rapidly into large brown to purple-black areas at cool, moist weather. The disease may destroy whole leaflets or grow down the petioles and into the stem, killing the above plant.

Fig. 8. Healthy

Fig. 8. Shows the Healthy leaf. So, our offered model strongly identifies the diseased and healthy images accurately.

V. CONCLUSIONS

We have represented a convolution neural network based upon the classification algorithm called legitimate sequential model as potato disease identification. Two-stage testing was also carried out and incorporated to achieve the required precision. Comprehensive research on various forms of potato diseases have been carried out. There are a large number of photographs of potato plants obtained from the field where potatoes are grown. Multiple types of algorithms were conducted to find the maximum performance based on the CNN architecture. The offered model distinguishes the diseased & healthy plants appropriately. We only mentioned two forms of diseases, but this is not enough for farmers or those connected to the agricultural sector. So we decided to increase the number of diseases so that it will be more reliable for them and also increase the number of image datasets to perform the best result. We plan to develop an Android application in the future so that it will be simple for all.

VI. FUTURE WORK

Predicting potato disease detection is not a very easy task. From the output of our research result, we will implement a system that will predict if the leaf is healthy or unhealthy. It is both a software and hardware-based project. So, in the future, we will work with both software and hardware for getting the better and real-time output

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