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ReLeaf: A plant leaf disease detection system

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Abstract – *Agriculture is one of the most important factors in deciding a country's growth. It constitutes the maximum amount of GDP for most of the countries. In India, 65% of the population depends on agriculture for livelihood and is one of the driving factors for the country's economy. The contribution of food crops and cash crops is very important. But every year many crops succumb to various kinds of diseases which in turn affects the quality and quantity of products. These diseases firstly affect the leaves and then the entire plant. If the farm has multiple crops, it becomes difficult for humans to recognize disease for each plant and take necessary precautions so that it doesn't spread out. So we propose an AI based system for automatic detection of plant leaf diseases and suggesting remedies for automatic detection of plant leaf diseases and suggesting remedies for the same. The above system uses Deep CNN for maximum accuracy. The AI model (CNN) was trained with large plant disease datasets. By implementing the above technology we will help the farmers in increasing productivity for the crop which in turn will be helpful for INDIA's economy.*

Key Words: Classification, Convolutional Neural Network (CNN), Deep Learning, Detection, Flask, Image Processing, Plant Disease

1. INTRODUCTION

Technology has many positive aspects in our life. Humans have 3 basic needs of Food, Shelter and Water. Agriculture is fundamental to human survival. It is the backbone of the nation. Current world's population makes a huge demand for all food products. Hence, it becomes very important to increase the productivity of crops, fruits and vegetables. Along with productivity, the quality of produce needs to stay high for better public health. As agriculture endeavors to support the rapidly growing population, plant diseases reduces the production and quality of crops. It becomes very necessary to save the crops from diseases. Agricultural crops are damaged by a wide variety of plant diseases. About 42% of the world's total agricultural crops are demolished by diseases and pests per year. If the diseases are correctly diagnosed and identified at early stage, crop loss can be minimized. The traditional method for identifying plant diseases is through visual examination. This is done by the agricultural expert. This procedure is time consuming. It may lead to further damage, if not treated on time. To overcome this problem, it becomes important to build an automated system which can perform accurate disease diagnosis and introduce a low-cost machine assisted system for farmers. We have developed an Artificial Intelligence based solution for the plant leaf disease identification. The suggested model will help framers identify the disease by scanning the leaf. The entire model is connected using flask framework. Farmers can thus be alert about the disease in an early stage. We are using techniques such as image processing, feature extraction, segmentation and CNN.

2. LITERATURE SURVEY

In this work [1], lesion image segmentation is performed. With integration to image segmentation, methods such as clustering algorithms, supervised classification algorithms, feature extraction of lesion images, feature normalization and feature selection were conducted. The disease recognition models were built by using pattern recognition methods A feasible solution was provided for diagnosis and identification of alfalfa leaf diseases.

In this work [2], they have proposed a very accurate artificial intelligence solution for detecting and classifying different plant leaf disease. It makes use of Convolutional Neural Network for classification task. The presented model used the dataset consisting more than 20,000 images with 19 total classes. The model can be extended by using even larger dataset with more categories of diseases. It also compares accuracy of different machine learning and deep learning algorithms like logistic regression, KNN, SVM and CNN in training.

In this work [3], they proposed plant disease prediction method. Preprocessing of data is done by resizing the input images. A NumPy array is created for the same.. The model has been trained on data set consisting of images of the different diseased plant leaves. The labeled data is stored in files which are extracted during the training period of the model. It follows the steps of CNN. The entire output is flattened. It is further given as an input to the dense network. The last layer has an activation function to predict the disease of the given leaf.

3. CONVOLUTIONAL NEURAL NETWORK

Convolutional Neural Network also knows as CNN/ConvNet is a Deep Learning Algorithm. It is a feed forward neural network, widely used for image recognition. It is designed to map the image data to some output variable. It is made up of one input layer, multiple hidden layers, and an output layer. The hidden layers consists of convolutional layer, ReLU (activation function) layers, pooling layer and fully connected layer. It requires much less preprocessing and can provide better results.

1. Input Layer

It consists of the input image data. Image is represented as 3D matrix.

2. Convolutional Layer

Features of the image are extracted in this layer. A mathematical operation of convolution is performed between the input image and a filter. By sliding filter over the input image, dot product is taken. Output is called as feature map.

3. ReLU (Rectified Linear Unit)

This function will replace all the negative values by zero and retain all the positive values.

4. Max Pooling Layer

It decreases the size and summarizes the features of the feature map. Max Pooling selects the maximum element form feature map. It selects the most prominent feature.

5. Fully Connected Layer

In this layer, every node in one layer is connected with the every node another layer. The flattened matrix goes through the fully connected layer to classify the images.

6. Output Layer

In this layer, we get the predicted class.

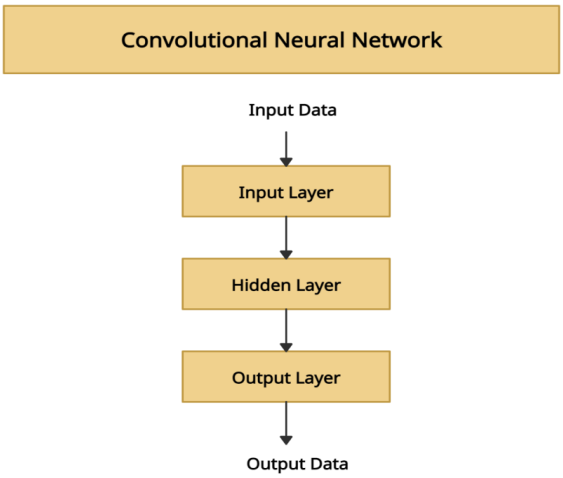

Fig -1: CNN block diagram

3. PROPOSED METHODOLOGY

In this section the proposed methodology for detection of plant diseases is depicted. Fig 2 represents the block diagram for the proposed methodology. Firstly the input image is provided by the user to the system. The input image undergoes several steps such as preprocessing, feature extraction, etc. Finally the disease is detected. The entire model is trained with a large dataset.

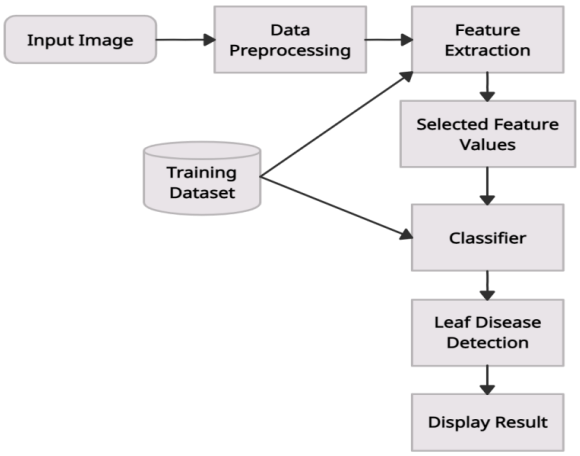

Fig -2: System Architecture

Below figure represents the use case diagram for the proposed system:

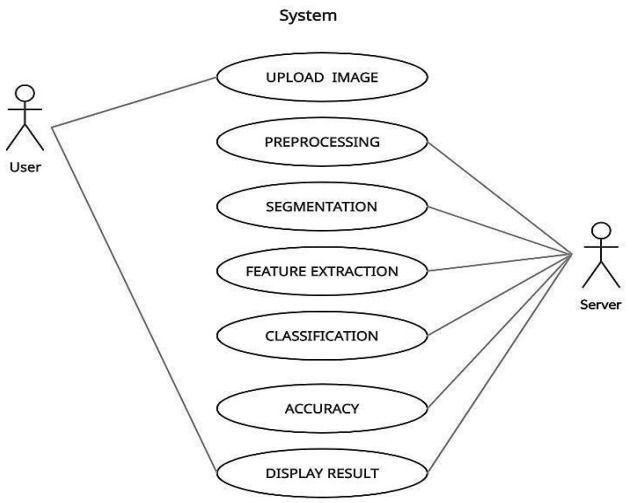

Fig -3: Use Case diagram

Our proposed system includes following steps:

Step 1: User uploads the image of the leaf on the portal. Figure 4 shows the user portal.

Step 2: After uploading, the image will be preprocessed. The image is reshaped and edited by the system.

Step 3: The entire Dataset is portioned into training and testing set. It includes 80% training set and 20% testing set.

Step 4: The model uses CNN algorithm for accurate classification of the diseases.

1. User Portal

The user can drag and drop the image of the leaf on the portal from the device.

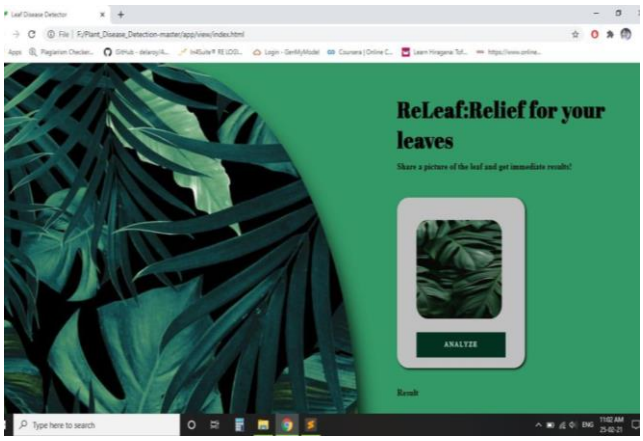

Fig -4: User Portal

2. Preprocessing

After uploading the image, it is preprocessed. It includes suppressing and removing the noise and distortion from the image. It also enhances the various image features which are required for further processing. It improves the quality of the image.

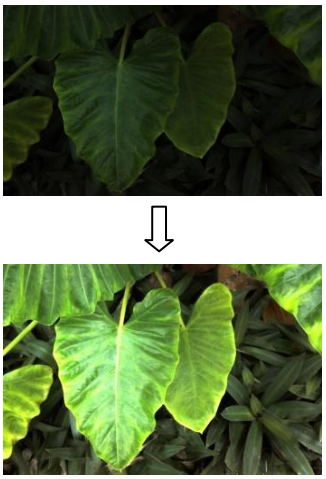

Fig -5: Correction of under exposed image

Fig -6: Correction of over exposed image

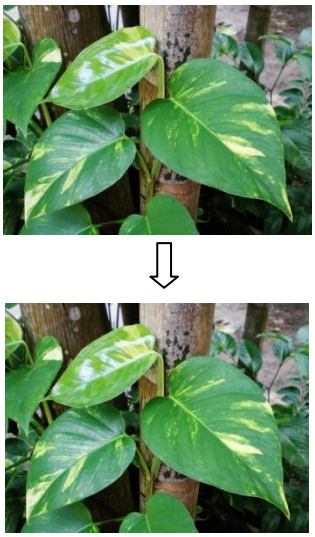

Fig -7: Correction of good image

In the fig 5, fig 6 and fig 7, we can observe that the images are corrected as per the system requirements. After improving the quality of the image, it is converted to numpy array.

3. Deep CNN model

It is based on the CNN algorithm. The model is trained with the training dataset which includes 20,639 images of diseases of Potato, Tomato and Bell peppers. The database stores the metadata of images such as disease types, time stamps, etc. This application is based on python.

4. Disease Classifier

It classifies the diseases using the trained CNN model. It classifies the images as per the diseases in the training data set. The model is made ready for classification by training it. The output displays the disease name and the precautions for the same.

4. RESULTS AND DISCUSSION

The entire dataset is collected from Kaggle. The dataset is divided into training dataset and testing dataset. Dataset is divided as 80% training dataset and 20% testing dataset. The entire dataset includes 20,639 leaf disease images. It includes images of leaves of plants such as Bell peppers (2455), Potato (2152), Tomato (16,012). The accuracy of the model is 96.7%.

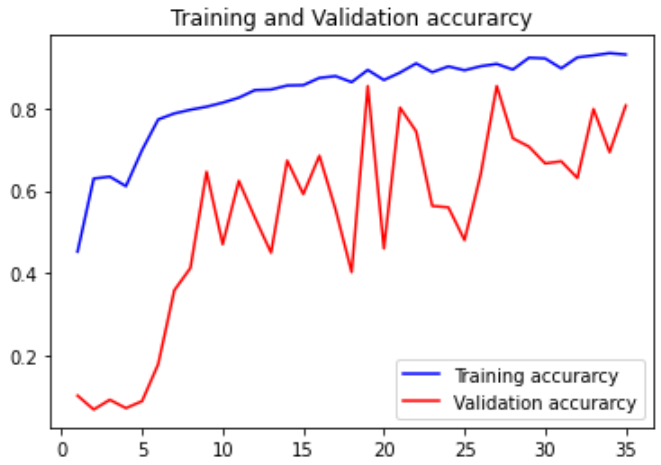

Fig -8: Training and Validation accuracy

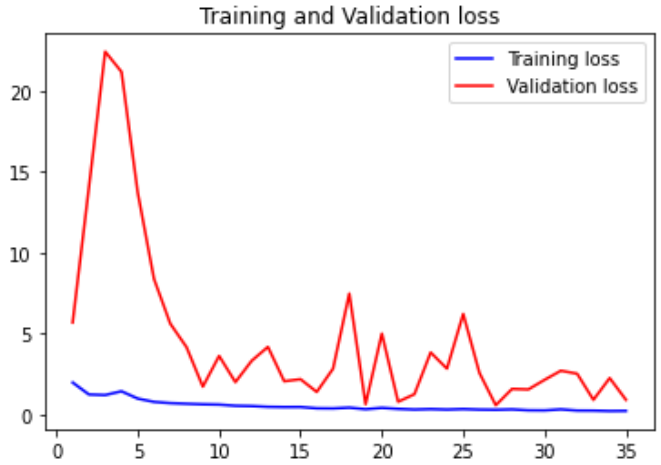

Fig -9: Training and Validation loss

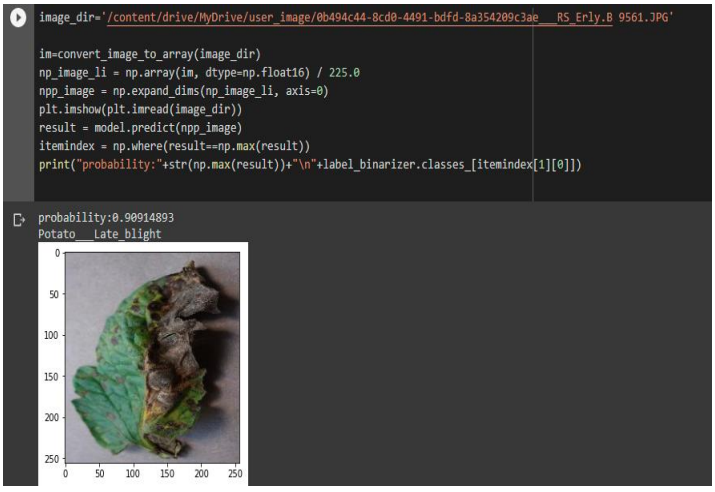

Fig -10: Detection of late blight in potato leaf

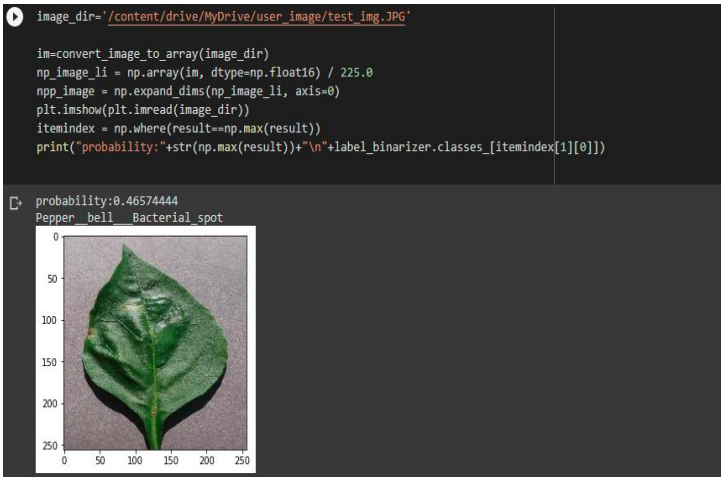

Fig -11: Detection of bacterial spot in pepper bell leaf

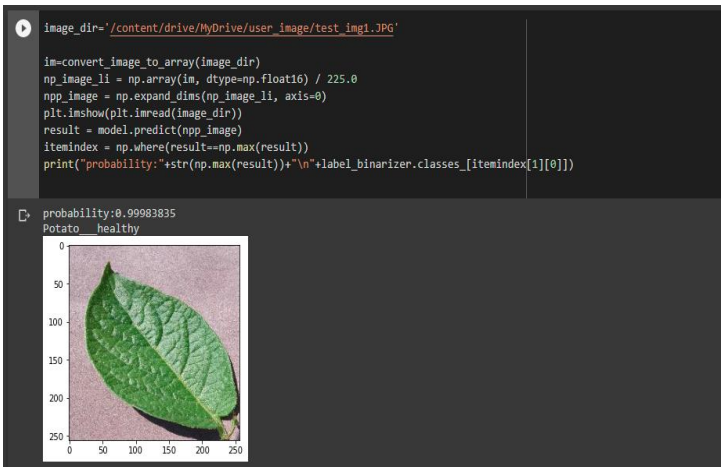

Fig -12: Healthy potato leaf

5. CONCLUSION AND FUTURE WORK

Thus the proposed model is low-cost and effective for detecting plant diseases with an overall accuracy of 96.7%. It provides a very easy interface and an end-to-end solution for farmers. It can be used to detect various plant leaf diseases by analyzing images. It could flexibly detect and pre-process such images improving the accuracy and reliability.

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