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Web Based Leaf Disease Prediction in Crops and Fertilizer Recommendation System Using Deep Learning Technique

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ABSTRACT

Agriculture is the considered as the back bone of India. Agriculture is the most important sector in today's life. Many plants are affected by various diseases which naturally drops the yield of the crop production in turn farmers are seriously affected. A web-based tool Flask is used to create an application for routing the web pages and also the designing part involves HTML, CSS and static pages. The Data set contains images of the diseased plants of both vegetables and fruits. These images are trained and tested using Deep learning Model building and the appropriate model is created and saved. This saved model is interlinked with the web page for Prediction and recommendation system. An automated system is introduced in the form of identifying different diseases on plants by checking the symptoms shown on the leaves of the plant. Deep learning techniques are used to identify the diseases and suggest the precautions that can be taken for those diseases. To make the system user friendly a User Interface is created for easy access and usage by the farmers. This application will be very useful for farmers.

Keywords : Agriculture, Leaf Disease, Fertilizer Recommendation, Deep Learning, Image Processing

I. INTRODUCTION

Agriculture is the most important sector in today's life. The economy of or country is mainly dependent on Agriculture. In today's Agriculture, the farmers experience a major threat and that because of the crops being affected by various diseases which includes bacterial and fungal. The disease on the plant placed a major constraint on the production and a major threat to food security. Hence, early and accurate identification of plant diseases is essential to ensure high quantity and best quality. In recent years, the number of diseases on plants and the degree of harm caused has increased due to the variation in pathogen varieties, changes in cultivation methods, and inadequate plant protection techniques. Plant pathology can and should contribute in each of these respects--by assessing the immediate and potential dangers to crops from diseases, by forecasting their incidence and severity, by deploying.

II. LITERATURE SURVEY

The system [1] finds the area of leaf that has been affected and also the disease that attacked the leaf. This is achieved by using Image Processing; there are systems that predict the diseases in the leaf. Our system uses K-Medoid clustering and Random Forest algorithm to produce more accuracy in the detection of disease in the leaf.

A software solution for fast, accurate and automatic detection and classification of plant diseases through Image Processing is presented in [2].

Agriculture fills in as the spine for economy of a nation and is essential. So as to stay aware of good and malady free creation of yields various strategies are being actualized. Steps are being taken in the rustic territories to assist ranchers with best nature of bug sprays and pesticides. In a harvest, ailment generally influences on the leaves by which the yield doesn't get legitimate supplements and because of which its quality and amount additionally gets influenced. In this paper [3], we are utilizing programming for naturally recognizing the influenced region in a leaf and furnishing with a superior arrangement. For knowing the influenced region of a leaf we are utilizing different picture handling methods. It incorporates a few stages viz. picture procurement, picture prepreparing, division, highlights extraction

Diseases in plants cause decrease in both quality and quantity of agricultural products. The main problem of farmers is the detection of leaf diseases. The leaf disease detection has very important role nowadays. Thus, it is of abundant prominence to diagnose the plant diseases at initial stages so that suitable and timely action can be taken by the farmers to avoid further losses. Early information on crop health and disease detection can encourage the control of diseases through appropriate administration systems. This technique will improve productivity of crops. This paper [4] presents the technique to detect the leaf disease also compares the benefits and limitations of these potential methods

This paper [5] introduces a compelling technique for estimation of nutrient dimension in soil and suggestion for appropriate fertilizer. The proposed methodologies comprise of four stages: soil analysis, data pre-processing, data analysis and Recommendation. The soil sample is analysed using an IOT based device. This venture is extremely valuable to farmer to pick the right fertilizer toward the start of product cycle and amplify the yield

Agriculture is the main aspect of country development. Many people lead their life from agriculture field, which gives fully related to agricultural products. Plant disease, especially on leaves, is one of the major factors of reductions in both quality and quantity of the food crops. In agricultural aspects, if the plant is affected by leaf disease then it reduces the growth of the agricultural level. Finding the leaf disease [6] is an important role of agriculture preservation. After pre-processing using a median filter, segmentation is done by Guided Active Contour method and finally, the leaf disease is identified by using Support Vector Machine. The disease-based similarity measure is used for fertilizer recommendation.

This paper deals with [7] Leaf disease detection requires huge amount of work, knowledge in the plant diseases, and also require the more processing time. So we can use image processing for identification of leaf disease in MATLAB. Identification of disease follows the steps like loading the image, contrast enhancement, converting RGB to HSI, extracting of features and SVM.

This paper [8] proposes and implements a system to predict crop yield from previous data. This is achieved by applying machine learning algorithms like Support Vector Machine and Random Forest on agriculture data and recommends fertilizer suitable for every particular crop. The paper focuses on creation of a prediction model which may be used for future prediction of crop yield. It presents a brief analysis of crop yield prediction using machine learning techniques

Our proposed system was organized in such a way, to analyse the soil type, diseases in the leaves and finally to recommend the appropriate fertilizer to the farmers, that may be of great help to them. Plant disease, especially on leaves, is one of the major factors that reduce the yield in both quality and quantity of the food crops. Smart analysis and Comprehensive prediction model in agriculture helps the farmer to yield right crop at the right time. The main benefits of the proposed system are as follows: Yield right crop at the right time, Balancing the crop production, control plant disease, Economic growth, and planning to reduce the crop scarcity. Hence to Detect and recognize the plant diseases and to recommend fertilizer it is necessary to provide symptoms in identifying the disease at its earliest. Hence the authors proposed [9] and implemented new fertilizers Recommendation System for crop disease prediction.

This paper [10] provides survey on plant leaf disease detection using image processing techniques. Disease in crops causes significant reduction in quantity and quality of the agricultural product. Identification of symptoms of disease by naked eye is difficult for farmer. Crop protection especially in large farms is done by using computerized image processing technique that can detect diseased leaf using colour information of leaves.

This paper [11] provides survey on leaf disease detection technique by using image processing. India is an agricultural country and most of peoples wherein about 70% depends on agricultural. So leaf disease detection is very important research topic. Number of crops caused by fungi, bacteria etc. To overcomes this by using automatic leaf detection of plant by different image processing technique. India is a highly populated country and randomly change in the climatic conditions need to secure the world food resources. Framers face serious problems in drought conditions. Type of soil plays a major role in the crop yield. Suggesting the use of fertilizers may help the farmers to make the best decision for their cropping situation. The number of studies Information and Communication Technology (ICT) can be applied for prediction of crop yield by the use of Data Mining, we can also predict the crop yield. By fully analyse the previous data we can suggest the farmer for a better crop for the better yield. This application [12] also provide model which predicts the type of crop disease based on textural similarity of leaves.

III. HARDWARE / SOFTWARE DESIGNING

HARDWARE SPECIFICATION

Table 3.1 Hardware Specification

Processor	Intel(R) Core(TM) i3-3227U CPU @ 1.90GHz 1.90 GHz
Ram	4 GB.
HDD	100 GB.
Monitor type	15 Inch VGA.
Keyboard	110 Keys Keyboard

SOFTWARE SPECIFICATION

Table 3.2 Software Specification

Operating system	Windows 10
Web Browser	Chrome, Mozilla firefox
Open Source Distribution	Anaconda Navigator
Language	Python
Development	Google Colab Jupyter Notebook and Spyder
Packages Required	Numpy, Pandas, Tensor Flow,

JSON	VS Code
Web Application Tool	Flask
Front End Designing	HTML, Java Script and CSS

IV. THEORETICAL ANALYSIS

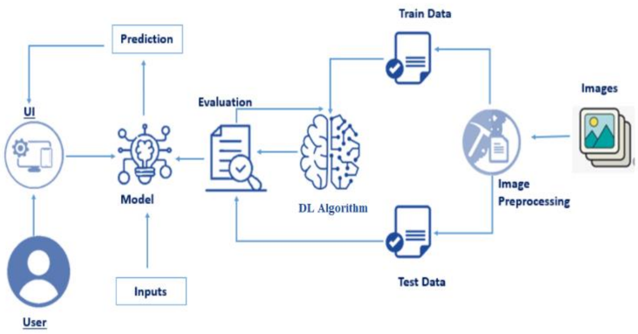

Figure 4.1 Block Diagram

V. EXPERIMENTAL INVESTIGATIONS

5.1 DATASETS

The dataset contains 2 divisions one for identifying the vegetables leaves and the other one for fruit leaves. In this paper with respect to fruit 6 classes are created called as Apple___Black_rot', 'Apple___healthy', 'Corn_(maize)___Northern_Leaf_Blight', 'Corn_(maize)___healthy', 'Peach___Bacterial_spot', 'Peach___healthy' out of which 3 divisions represents the diseased dataset and 3 represents the healthy dataset.

Dataset of Fruit is given in the Table 5. 1 with the split of test and train data count

Table 5.1 Fruit Leaf Test and Train Image Count

Type of Fruit Leaf	Test Image Count	Train Image count
Apple___Black_rot	181	439
Apple___healthy	445	1200
Corn_(maize)___Northern_Leaf_Blight	301	861
Corn_(maize)___healthy	217	768
Peach___Bacterial_spot	493	1804
Peach___healthy	49	311
Fruit Leaf train and test count	1686	5383
Total Fruit Leaf Count	7069	

Dataset of Vegetable is given in the Table 5.2 with the split of test and train data count.

Table 5.2 Vegetable Leaf Test and Train Image Count

Type of Fruit Leaf	Test Image Count	Train Image count
Pepper,_bell___Bacterial_spot	317	997
Pepper,_bell___healthy	448	1478
Potato___Early_blight	300	1000
Potato___Late_blight	52	152
Potato___healthy	290	1000
Tomato___Bacterial_spot	667	2127
Tomato___Late_blight	599	1909
Tomato___Leaf_Mold	322	952
Tomato___Septoria_leaf_spot	421	1771
Vegetable Leaf train and test count	3416	11386
Total Vegetable Leaf Count	14802	

5.2 WEB APPLICATION FRAMEWORK

Python uses Flask Framework in this paper which serves as a foundation for developing web applications. Web Server Gateway Interface (WSGI) has been adopted as a standard for Python web application development. WSGI is a specification for a universal interface between the web server and the web applications.

Werkzeug

It is a WSGI toolkit, which implements requests, response objects, and other utility functions. This enables building a web framework on top of it. The Flask framework uses Werkzeug as one of its bases.

jinja2

jinja2 is a popular templating engine for Python. A web templating system combines a template with a certain data source to render dynamic web pages.

The flask folder contains static folder which contains necessary css, image files and javascript files. The template folder contains HTML files.

The server side scripting file app.py helps to perform request response operations and also helps in routing between web pages.

Keras is a simple and powerful Python library for deep learning. Deep learning models takes hours, days to get trained and the trained model is saved and used for prediction purpose. In the model folder two .h5 files are created one for vegetable and other fruits which is trained in the Google colab jupyter notebook and the appropriate models called as vegetable.h5 and fruits.h5 are created and saved for model building. Precautions excel files contain the precautions for all kinds of diseases

The Analysis or the investigation made while working on the solution is depicted as project structure given in the Figure 5.1

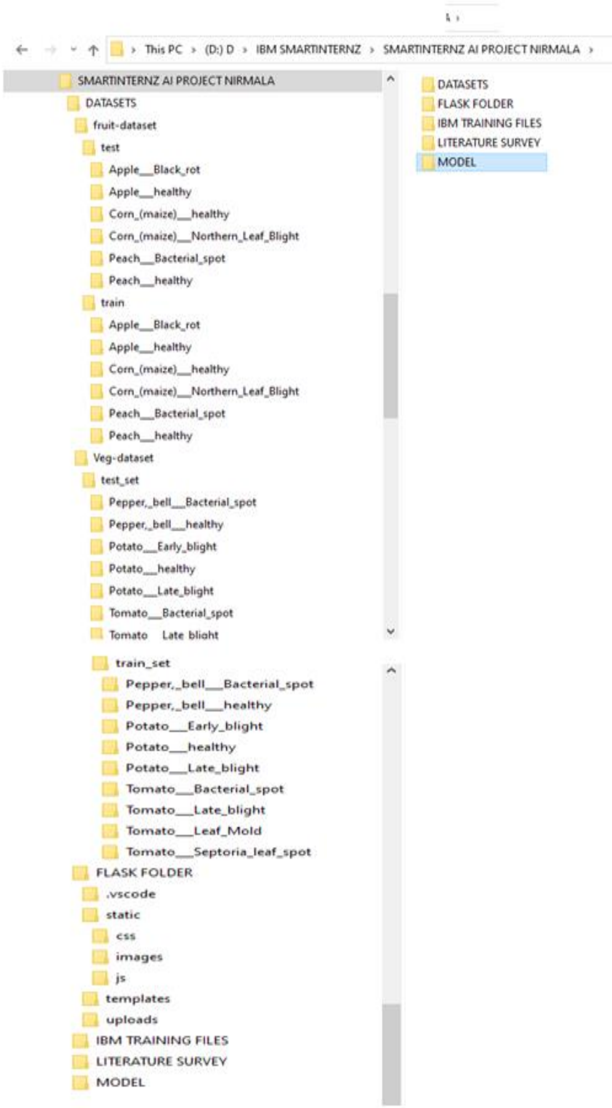

Figure 5.1 Project Structure

5.3 RESEARCH STEPS

Image Preprocessing

Image preprocessing are the steps taken to format images before they are used by model training and testing. The preprocessing steps includes resizing , orienting, color corrections gray, random flips, etc. When working on deep learning network, if the number of images for training model is less then Image Augmentation technique can be applied to expand the size of the data set.

Image augmentation is a technique of applying different transformations to original images which results in multiple transformed copies of the same image. Each copy, however, is different from the other in certain aspects depending on the augmentation techniques applied like shifting, rotating, flipping, etc. On applying small amount of variations on the original image does not change its target class but only provides a new perspective of capturing the object in real life. This helps us to expand the data set size and is quite often used for building deep learning models.

Augmentation techniques with Keras ImageDataGenerator class

Random Rotations

Image rotation allows the model to perform rotation of the object invariant to the orientation of the object.

Random Shifts

It helps to shift the pixels of the image either horizontally or vertically by adding a certain constant value to the pixels

Random Flips

ImageDataGenerator class has parameters horizontal_flip and vertical_flip for flipping along the vertical or the horizontal axis

Random Brightness

It randomly changes the brightness of the image. It is also a very useful augmentation technique because most of the time our object will not be under perfect lighting condition. So, it becomes imperative to train our model on images under different lighting conditions.

Random Zoom

The zoom augmentation either randomly zooms in on the image or zooms out of the image

Image Pre-processing includes the following main tasks

- Import ImageDataGenerator Library and keras into the python script
- Configure ImageDataGenerator Class.
  - The Keras deep learning neural network library provides the capability to fit models using image data augmentation via the ImageDataGenerator class
  - ImageDataGenerator class is used to load the images with different modifications like considering the zoomed image, flipping the image and rescaling the images to range of 0 and 1.
  - The ImageDataGenerator accepts the original data, randomly transforms it, and returns only the new, transformed data.
  - from tensorflow.keras.preprocessing.image import ImageDataGenerator
  - train_datagen=ImageDataGenerator(rescale=1./255,zoom_range=0.2,horizontal_flip=True,vertical_flip=False)
  - test_datagen=ImageDataGenerator(rescale=1./255)
- Applying ImageDataGenerator functionality to the train set and test set.

  flow from directory helps to read from the specific directory

  #target size for all images have to passed as 64 height and 64 width

  #The type of object is categorical

  #Batch size : in every batch size how many images are passed.

  x_train=train_datagen.flow_from_directory('/content/drive/mydrive/project/datasets/veg-dataset/train_set',target_size=(128,128), class_mode='categorical',batch_size=8)

Table 5.3 Training and Test Data Details

Description	Number of images	Divided into classes
Number of images in Training set of Fruit_data	5384	6
Number of images in Test set of Fruit_data	1686	6
Number of images in Training set of Veg data	11386	9
Number of images in Test set of veg data	3616	9

Model building for Disease Prediction

The model building Activity includes the following

Descriptions	Vegetable	Fruit
Import the model building Libraries	from tensorflow.keras.models import Sequential from tensorflow.keras.layers import Dense,Convolution2D,MaxPool2D,Flatten	from tensorflow.keras.models import Sequential from tensorflow.keras.layers import Dense,Convolution2D,MaxPool2D,Flatten
Initializing the model	model=Sequential()	model=Sequential()
Adding CNN Layers To create a convolution layer, Convolution2D class is used. It takes a number of feature detectors, feature detector size, expected input shape of the image, and activation function as arguments. **Max Pooling** selects the maximum element from the region of the feature map covered by the filter. Thus, the output after the max-pooling layer would be a feature map containing the most prominent features of the previous feature map. The flatten layer is used to convert n-dimensional arrays to 1-dimensional arrays.	model.add(Convolution2D(32,(3,3),input_shape=(128,128,3),activation='relu')) model.add(MaxPool2D(pool_size=(2,2))) model.add(Flatten())	model.add(Convolution2D(32,(3,3),input_shape=(128,128,3),activation='relu')) model.add(MaxPool2D(pool_size=(2,2))) model.add(Flatten()

Adding Hidden Layer This step is to add a dense layer (hidden layer). We flatten the feature map and convert it into a vector or single dimensional array in the Flatten layer.	model.add(Dense(300,activation='relu')) model.add(Dense(150,activation='relu')) model.add(Dense(75,activation='relu'))	model.add(Dense(128,activation='relu')) model.add(Dense(64,activation='relu'))
Adding Output Layer This step is to add a dense layer (output layer) where you will be specifying the number of classes your dependent variable has, activation function, and weight initializer as the arguments.	model.add(Dense(9,activation='softmax'))	model.add(Dense(6,activation='softmax'))
Configure the Learning Process	model.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accuracy'])	model.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accuracy'])
Training and testing the model	model.fit_generator(x_train,steps_per_epoch=len(x_train),validation_data=x_test,validation_steps=len(x_test),epochs=20)	model.fit_generator(x_train,steps_per_epoch=len(x_train),validation_data=x_test,validation_steps=len(x_test),epochs=10)
Number of Epochs	20	10
X_train	1424	673
Accuracy	90	95

5.4 FLOW CHART

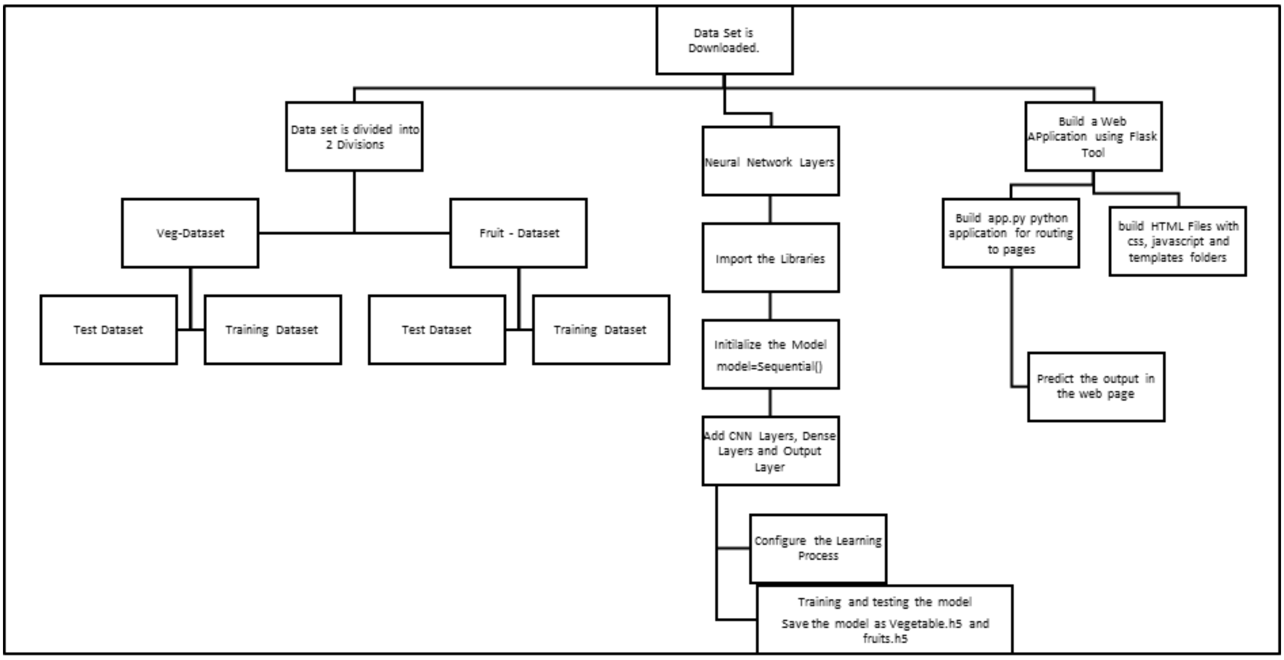

Figure 5.2 : Flow Chart

VI. EXPERIMENTED RESULTS

The Experimented Results was able to give the better prediction. The Web page output and the predicted results are given both for vegetable and fruits.

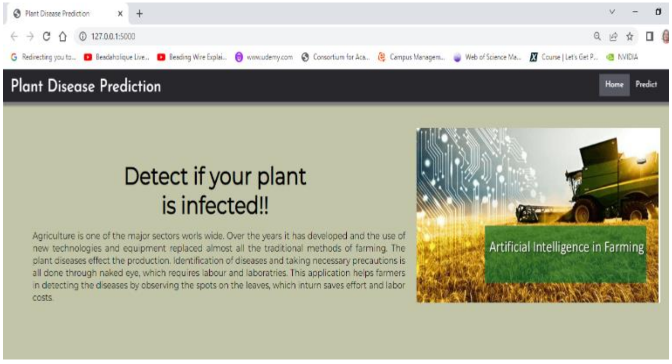

Figure 6. 1 : Home Page

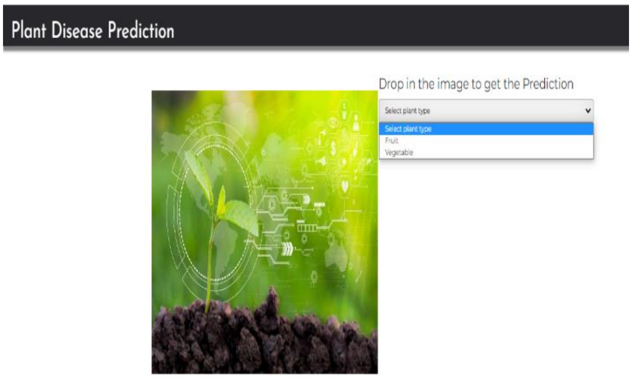

Figure 6. 2 : Choosing Plant Type

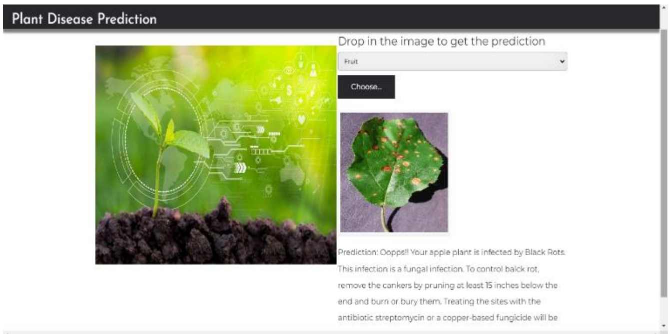

Figure 6. 3 : Apple Black_Rot Prediction

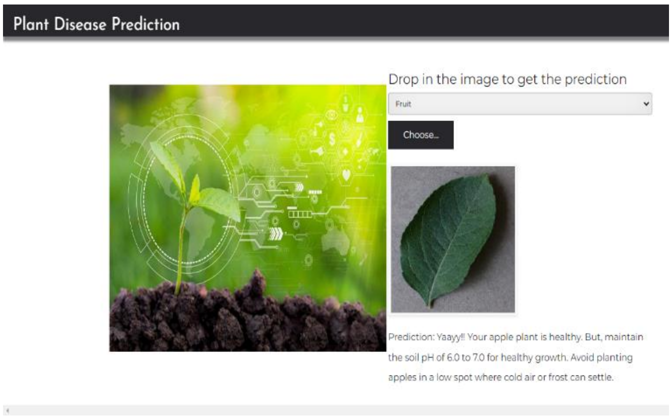

Figure 6. 4 : Apple Healthy Plant Prediction

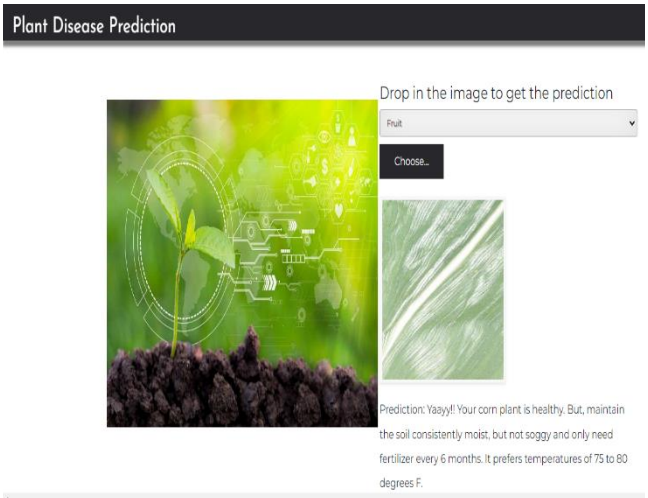

Figure 6. 5: Corn Healthy Plant Prediction

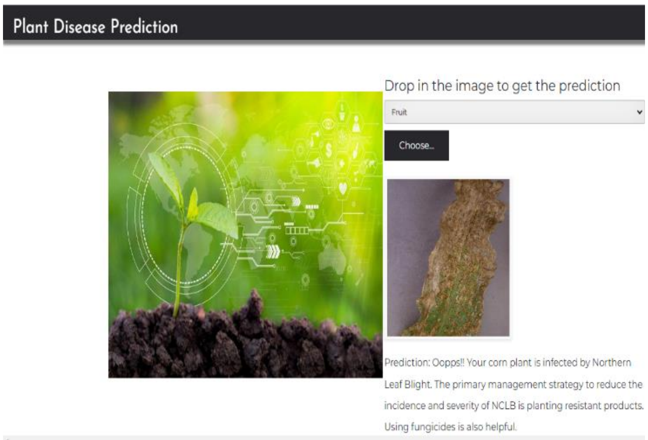

Figure 6. 6 : Corn Infected by Northern Leaf Blight Prediction

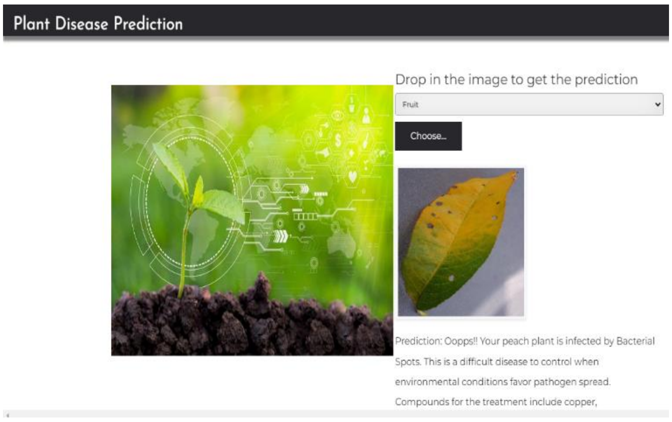

Figure 6. 7: Peach Infected by Bacterial Spots Prediction

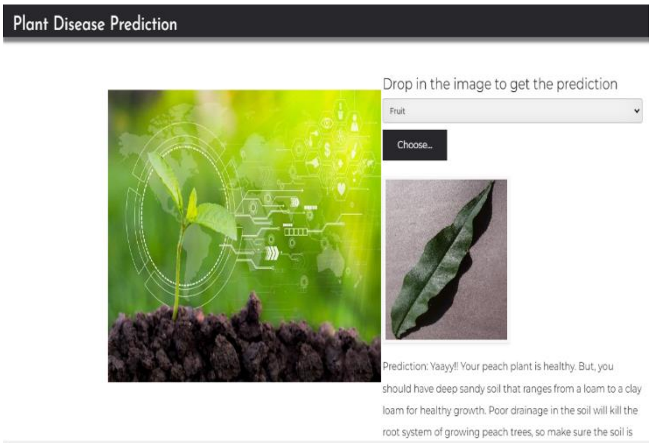

Figure 6. 8: Healthy Peach plant Prediction

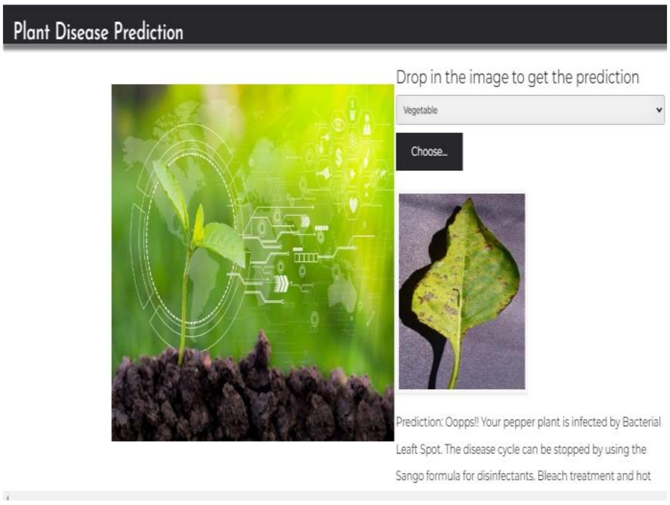

Figure 6. 9: Pepper Plant Affected by Bacterial Leaf Spot Prediction

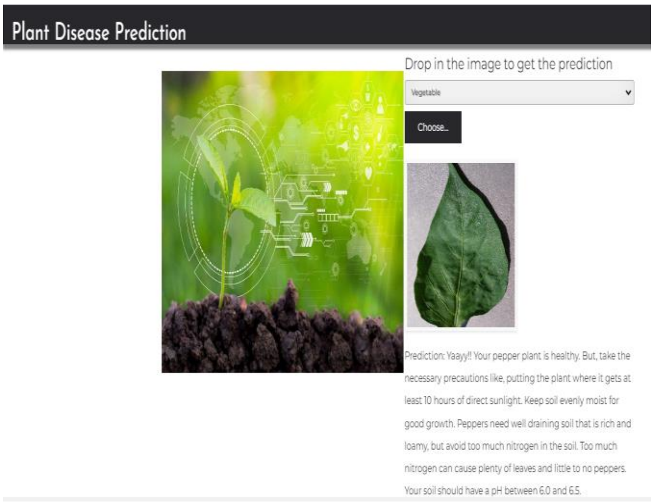

Figure 6. 10: Healthy Pepper Plant Prediction

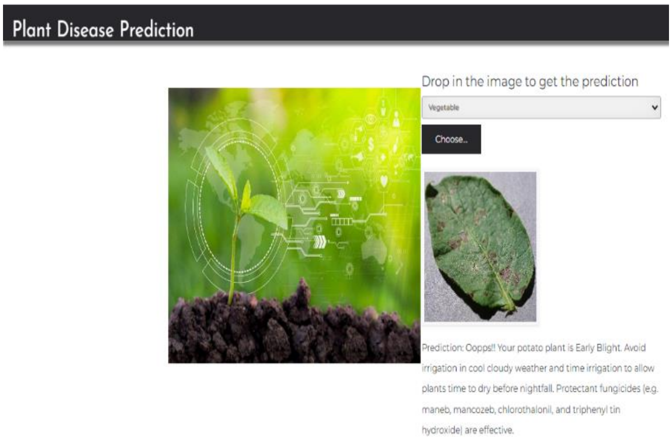

Figure 6. 11: Potato Plant Early Blight Disease Prediction

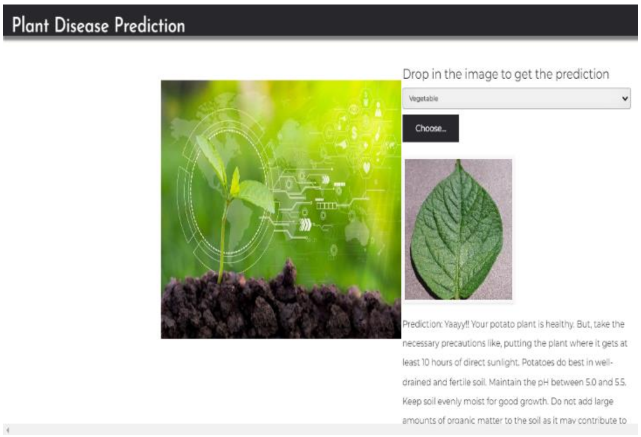

Figure 6. 12 : Potato Healthy Plant Prediction

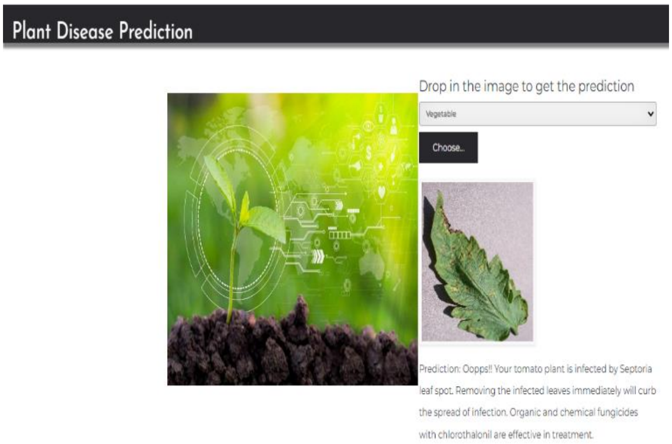

Figure 6. 13 : Tomato Plant infected by Septoria leaf Spot Prediction

VII. CONCLUSION

The problem of identifying the disease captured through the leaves and also the measures to resolve the disease is also explained in this paper through a web application. The training and testing of varied fruits leaves images and vegetable leaves images are done using ImageObjectGenerator and the various Neural Network layers are added to train the images and also appropriately tested to get the disease predicted and the measures to be followed by the farmers is appropriately outputted in the web page. The ImageDatagenerator requires lower memory usage and saves a lot of memory. The transformed images after applying Augmentation techniques with Keras ImageDataGenerator class only returns the transformed images and does not add it to the original corpus of images. The application is user friendly to the farmers.

VIII. FUTURE SCOPE

Further extension of this project should be done for all vegetables and fruits using the appropriate diseased and healthy leaves getting trained and tested. In this case the project is limited to only 6 classes with respect to fruits and 9 classes with respect to vegetables. Furthermore, new feature images should be trained and tested using ANN and the web page design can also be improved for further additions. The problem need to be further extended to support the farmers community to help them to predict the diseased crop and the applicability of required fertilizers to overcome the problem.

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