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Image classification based plant disease detection

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ABSTRACT

Agriculture is one of the important aspects in the world, also the contribution of agriculture to the GDP of India increased to 19.9 percent in 2020-21 from 17.8 percent in 2019-20. Globally crop disease becomes a major cause of concern, so to overcome this concern a plant disease detector should be there which gives good results and increases the yield for farmers. In this scenario, the best option for dealing with crop disease identification is an Image Classification based disease detection system. The key goal of this project is to identify the disease in real-time by uploading an image of the infected plant leaf to the system. Aside from that, the system suggests remedies for the particular disease that is identified by the system. Our proposed research paper includes various phases of implementation namely dataset creation, image pre-processing, image post-processing, and finally disease classification and grading. Overall, we are using machine-learning techniques to train the dataset and finding the disease for that particular plant.

Keywords: *Image Classification, Pre-processing, Post-processing, Extraction*

1. INTRODUCTION

Various technologies have been developed to minimize the post-harvest processing, to fortify agricultural sustainability and maximize the productivity. There are various laboratory-based approaches but that methods are a bit time consuming as the samples are sent to the lab and after 2-3 days the results arrive whether the crop is healthy for consumption or not. As most of the people in India depend on agriculture this process should be quick as possible also it should be cheap. Here we have used machine-learning techniques to solve this problem. It is a modern way to approach this problem to increase the recognition as well as high accuracy of the results. Various researches have taken place under the field of machine learning for plant disease detection, such as traditional machine learning method being artificial neural network, support vector machine (SVM), fuzzy logic, K-means method, convolutional neural networks etc.

In the field of agriculture, the word machine learning based systems and image classification have recently gained popularity. Machine learning in the agriculture field uses different algorithms to train the model for designated purposes. Machine learning based convolutional neural network (CNN) models are prevalent in the image data. They work mainly on vision-based tasks like image classification, object detection, image recognition etc.

In this project, a web application is connected to the trained model through an API (Application Programming Interface). User can upload an image of infected leaf disease through the user-friendly web application. Our system compares an uploaded image with the trained model connected with the system and the predicted output will be displayed on the web application page. Our system contains unique features such as identifying the disease type and suggesting remedies for the particular disease. The predicted disease name and remedies are then displayed to the web application page. As a result, user or concerned persons can observe through that platform and take appropriate action if necessary. Our system is not only for farmers or agriculture industry; anyone can use.

2. PROBLEM STATEMENT

Agriculture plays a serious role in providing food stock for swelling population of the world. Annual food supply lose due to plant diseases is 40%, on an average. Sometimes, farmers can lose almost 100% of their crop due to plant disease; this makes crop disease a major threat to food security around the world.

The stoppage and control of plant disease have always been generally discussed because plants are unprotected to outer environment and are extremely prone to diseases. Normally, the accurate and rapid diagnosis plays an important role in controlling plant disease. Since, useful protection measures are often implemented after the correct diagnosis of the plant disease.
In addition, these days' farmers need to send the sample of the infected plant to the laboratory, which is time consuming as well as expensive.

3. OBJECTIVE

Agriculture is the main source of national income for most developing and developed countries. Additionally, 70% of people rely directly on agriculture as a livelihood. Leaves are the delicate part of the plant and most important property of leaf is texture and color. Plants are open to natural environment hence they are prone to different disease. Therefore, our goal is to use machine-learning model to identify the plant disease at an early stage of their growth. This machine learning based Plant Disease Detection System was developed to create software that can identify the plant disease and suggest remedies to get rid from that specific disease. Agriculture industry, farmers and people associated with farming process may use this system for the disease detection of crops at an early stage.

4. SCOPE OF PROJECT

Since the past days and recent past too, farmers usually detect the crop disease with their naked eye which makes them take tough decision on which fertilizers to use. It required detail knowledge of type of disease and lot of experience needed to make sure the actual disease detection. The plant identification using image classification, as plant diseases affect the growth of their respective species, therefore their early identification is very important. If farmers failed to detect plant disease in early stage, they would have lost their entire filed. Our system is useful for anyone belongs to the farming industry because our system helps user to detect plant disease at an early stage. This system is user-friendly, which means that anyone can use it.

5. METHODOLOGY

5.1 Proposed System

The core objective of this project is the design and implementation of a plant disease detection system based on Image Classification. Farmers and individuals related to agriculture industry are familiar with the problems of disease detection. The conventional methods of identifying crop diseases include hectic and expensive approaches. A person have to submit the samples of infected plants to the laboratory and after applying serval tests user can collect the result of the disease. This process is extremely time taking.

Our Image Classification based plant disease detection system helps the user to identify the disease as well as remedies such as which fungicides or insecticides to use. This machine learning based plant disease detection system is developed to design the software that identifies disease as well as suggests remedies. A farmer or agriculture industry can use the system to detect the disease of infected plants and take necessary actions to safeguard the entire field.

5.2. Schematics

5.2.1. Project Flow: Figure1 shows the project flow of this project. Our system consisting of several modules. Among them, the first one is user interaction with our system. User can upload an image through our web application. Our web application is connected to the trained model through an API (Application Programming Interface). Which compares the uploaded image with the trained model and predict the output. Predicted output along with remedies will be visible to the user through the web application interface. Thus, based on predicted values user can take actions to avoid the entire field from being infected.

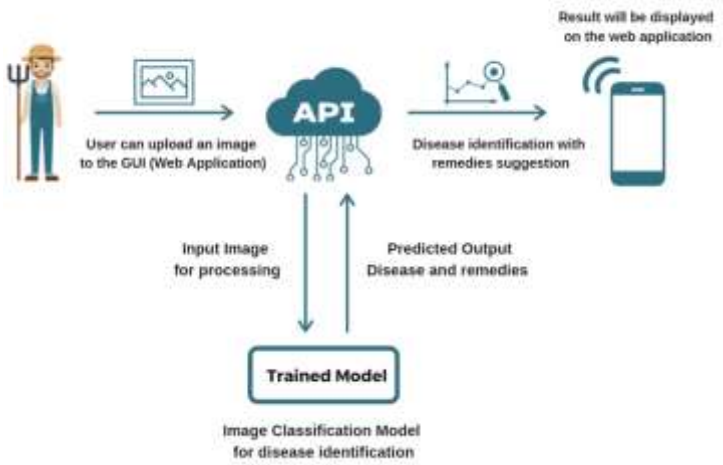

Fig. 1: Project Flow

The proposed design of our image classification-based plant disease detection is built around machine learning model Convolutional Neural Network (CNN), which is the brain of our project.

Web application collects image uploaded by the user, which acts as an input for the trainer model. After processing in the trained model, it returns predicted disease and remedies for that disease. The API (Application Programming Interface) collects the response and provides output to the web application through which user can collect the data and take necessary actions.

Figure 2 below shows the system block diagram of this project. To detect if the plant is diseased or healthy, a few steps should be followed. i.e., Pre-processing, feature extraction, training of classifier and classification. Image processing can be utilized for measurement of the affected areas of crops with diseases and it can be used to determine the difference on the affected part.

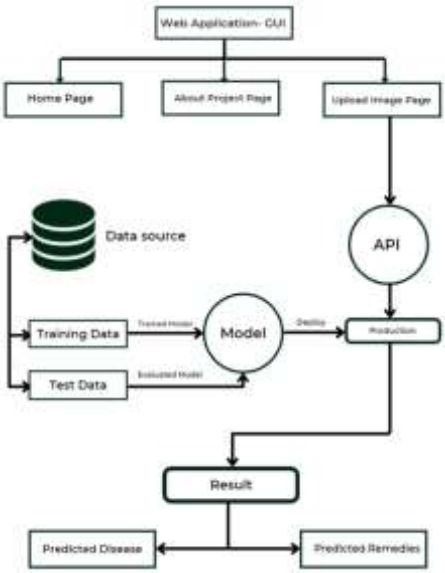

Fig. 2: System Block Diagram

Image separation is largely used for grouping of an image also to separate an image into numerous parts. There are various ways through which we can do image segmentation mainly ranging from the simple thresholding method to that of an advanced colour image segmentation method. Pre-processing of image means to bring all the images size to a reduced uniform size. Then comes extracting features of a pre-processed image, which is also called post-processing. Then finally comes the classification step where we get to know what disease is prevalent in the plant. Disease detection by eyes is more difficult and it may not be accurate whereas using machine learning we can speed up this task with accurate results.

5.2.2. Dataset Description: For the dataset, we mainly focused on two main crops. They are potato and tomato. More than 20,000 images have been collected in this dataset. We have focused on the main diseases prevalent in these crops. Mainly focused on the types of diseases that are more common in these crops.

5.2.3. Model Implementation: Figure 3 below shows CNN model block diagram of this project.In CNN it consists of an input layer, hidden layers and an output layer. In any feed-forward neural network, any middle layers are called hidden because their inputs and outputs are masked by the activation function and final convolution.The most important aspect of CNN is it helps in reducing the parameters in ANN (Artificial Neural Network). In CNN primarily the input will be comprised of images. So, its architecture is setup in such a manner to provide with the best suited output based on the input.

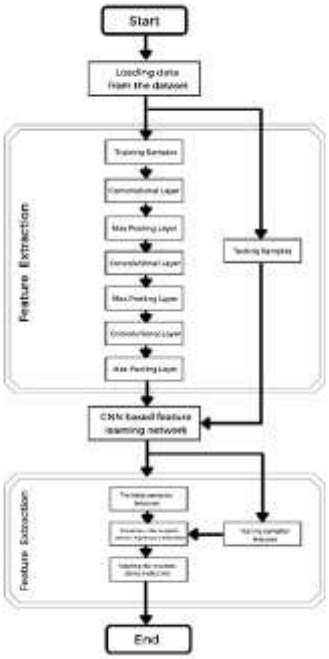

Fig. 3: Flow Chart of CNN (Model)

In a CNN, the input is a tensor with shape (number of images) x (image height) x (image width) x (input channels). After passing through a convolutional layer, the image becomes abstracted to a feature map, with shape (number of images) x (map height) x (map width) x (map channels).

5.2.4. UI Implementation: For the GUI, responsive Web Application has been designed using the latest web development technologies. There are multiple advantages of Responsive Web Application. The foremost one is, it will deliver the best user-experience across all devices and attract a wider audience. Additionally, a Responsive Web Application is just one website used for analytics and for the source of information. With reference to changes in the Web Application, in responsive web application we only have to make the change once.

For the model connection with the web application, Flask technology has been used. It is a web framework mainly used to build a web application, blog or commercial websites. Advantages of using flask is it has little or no dependencies on external libraries.

6. RESULTS

Machine learning model has been trained with the dataset of more than 20,000 images. Figure 4 below shows the result of model accuracy including training and validation accuracy. Test accuracy of the model is around 80-82% and probability of disease identification varies from 98% to 99%.

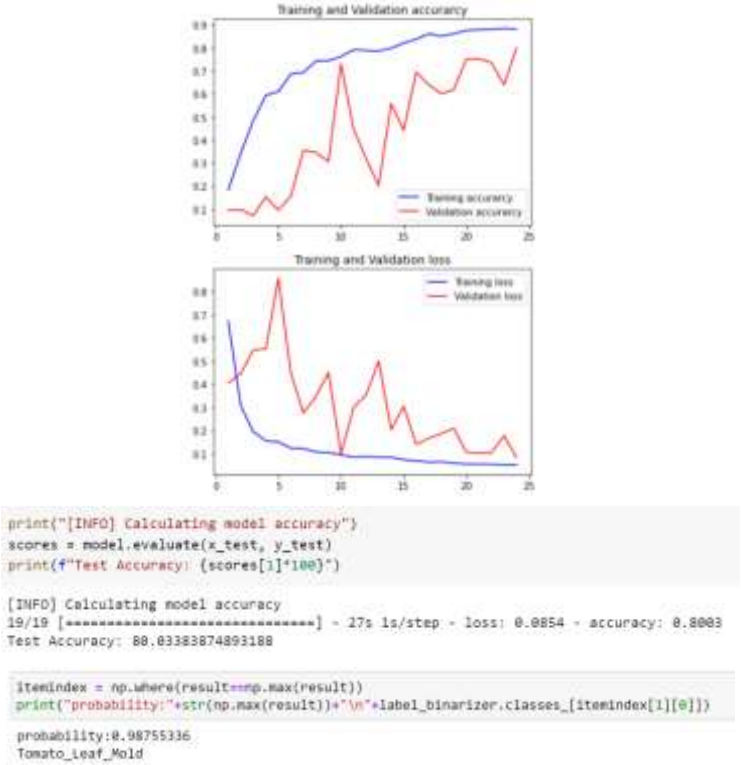

Fig. 4: Results

User can upload an image of infected leaf through the user-friendly web application. Web application is connected with our trained model through an API. It will identify the disease along with associated remedies and share output to the web application and it will be displayed on the page so that user can take precautionary actions to save the entire field from being infected.

Figure 5 shows the actual representation of our User Interface through which user can interact with our system. Our prediction accuracy is around 98-99% as shows in the above figure. Additionally, our system is responsive in design. As a result, user can interact through computer devices as well as mobile devices. Figure 5 displays the disease identification along with remedies.

Fig. 5: UI

Table 1: Analysis

S No.	Disease Name	Remedies
1	Pepper bell bacterial spot	Transplant treatment with "streptomycin", hot-water treatment, plant activator spray treatment.
2	Potato early blight	Thoroughly spray the plant with bonide copper fungicide concentrate
3	Potato late blight	Apply daconil fungicide which kills fungal spores and keeps blight from causing further damages
4	Tomato target spot	The product to use are chlorothalonil, copper oxychloride or mancozeb.
5	Tomato mosaic virus	Fungicides will not treat the viral diseases, spot treat with least toxic natural pest control products such as safer soap and bon-neem.
6	Tomato yellow leaf curl virus	Use a neonicotinoid insecticide such as dinotefuran(venom) imidacloprid or thiamethoxam
7	Potato septoria leaf spot	Fungicides containing copper and potassium bicarbonate will help to contain this fungal disease.
8	Tomato spider mites	Spray insecticidal soap on the plants.
9	Tomato early blight	Thoroughly spray the plant with bonide tomato and vegetables
10	Tomato leaf blight	Use fungicides that contain maneb, mancozeb, chlorothanolil or fixed copper can help to protect the plant
11	Potato healthy	Your plant is healthy.
12	Tomato healthy	Your plant is healthy.

Above is the table of analysis that our system carries out. It analyses the diseases according to the given table and gives a judgment for remedies. After identifying the disease type and remedies, user can take necessary actions to safeguard the plants from being infected.

7. CONCLUSION

The concept of image classification for agriculture industry based on machine learning architectures is a novel contribution to agriculture science. It will identify plant diseases at an early stage and save the entire field from the infection. This project will not only benefit farmers but to the entire nation, as there will be less diseases prevalent in the plants and the cultivated crop will be healthy to eat. Detecting the crop diseases will help for a healthier crop cultivation. In addition, the farmers will earn more money as their cultivation will be more. There will be less wastage of crops due to diseases. Our main aim was to develop this project and help the farmers as much as we can and make them prosperous. Using machine learning for this purpose adds the technology flavour to our mission.

8. FUTURE SCOPE

This system identifies the plant disease at an early stage and provide remedies to the user so that user can take precautionary actions. The recent system collects the input image and gives the decision according to it. For example, if an image is of tomato plant and have target spot infection then the device will provide output, as a disease name Tomato target spot and remedies will be to use chlorothalonil, copper oxychloride or mancozeb. Here, the variety of plants is the limitation, as it requires the data set of thousands of images. To overcome this limitation, continuous upgradation can be performed to include as much plants and disease as possible to the system. As a result, it will benefit large user base.

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