PLANT DISEASE DETECTION USING TEACHABLE MACHINE

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Abstract-

Plant diseases cause a serious problem to agriculture production and food security. Timely identification and explicit diagnosis of plant diseases are critical for successful health prediction. In the present years, convolutional neural networks (CNNs) have become known as a dynamic mechanism for image analysis and classification function. This paper describes an outline of the demand of CNNs in plant disease detection. The proposed course of action requires gathering a large dataset of images containing healthy plants as well as plants damaged by several diseases. Pictures of various plant leaves, roots are captured using high resolution cameras. These images serve as data set for classification. In order to improve the model performance, the dataset undergoes pre-processing which is further split into training, validation, and testing subsets. The design of CNN architecture involves multiple convolutional layers, pooling layers, and fully connected layers. By merging the cutting-edge technologies with machine learning concepts, the paper contributes to the development of robust and intelligent agricultural system. The application of CNNs in plant disease detection offers significant advantages, including high accuracy, scalability, and potential for automation. It can aid in early detection and timely intervention, leading to improved crop management and reduced economic losses.

Key words: Machine learning, Convolution Neural Networks, Plant disease, Teachable machine.

1. Introduction

Indian economy heavily relies on the agriculture sector. As the population grows and food consumption increases, there is a constant and substantial demand for food production. However, addressing this issue goes beyond simply providing more land for agricultural use; it also involves maximizing crop yield on existing agricultural land.

India is a cultivated country and about 70% of the population depends on agriculture. Farmers have large range of diversity for selecting various suitable crops and finding the suitable pesticides for plant. Disease on plant leads to the significant reduction in both the quality and quantity of agricultural products. The studies of plant disease refer to the studies of visually observable patterns on the plants. Monitoring of health and disease on plant plays

an important role in successful cultivation of crops in the farm. In early days, the monitoring and analysis of plant diseases were done manually by the expertise person in that field. This requires tremendous amount of work and also requires excessive processing time. The image processing techniques can be used in the plant disease detection. In most of the cases disease symptoms are seen on the leaves, stem and fruit. The plant leaf for the detection of disease is considered which shows the disease symptoms. This paper gives the introduction to image processing technique used for plant disease detection [4].

The survey on different classification techniques that can be helpful for plant leaf disease classification based on morphological features is presented [1].

Disease detection from the images of the plant leaf, fruit can be predicted by various methods. Machine learning approach of analyzing data collected from different aspects is described different dimensions [2].

Implementation and prediction of an image-processing-based software solution for automatic detection and classification of plant leaf diseases [3]. Providing fast, automatic, cheap and accurate image-processing-based approaches for detection is great realistic significance.

An image-processing based method that detects the visual symptoms of plant diseases, from an analysis of coloured images by converting the RGB image of the image into H, I3a and I3 b colour transformations [4].

An algorithm for image segmentation technique for automatic detection and classification of plant leaf diseases covers survey on different diseases classification techniques [5].

This project harnesses Convolution Neural Networks (CNNs) and Teachable Machine to automate disease detection through image processing. Through image processing techniques, this paper aims to create an automated system capable of swiftly and accurately detecting and classifying plant diseases in real-time, thus improving agricultural practices and contributing to global food security.

2. Leaf Diseases & Symptoms

Leaves are basically affected by bacteria, fungal and viral. A symptom of leaf disease is a significant impact of sickness on the plant. Side effects may remember a noticeable change for shading, shape or capacity of the plant as it reacts to the pathogen [6].

Apple Scab

Leaves infected with the apple scab fungus usually fall from trees in autumn or early winter. The fungus continues to live within the leaves during winter, forming small, flask-shaped bodies, in which spores (ascospores) develop. These ascospores mature in spring and are forcibly ejected during spring rains

Citrus Canker

Citrus canker, caused by the bacterium Xanthomonas citri subsp. citri, affects the leaves, twigs and fruit of citrus plants causing the leaves to drop and unripe fruit to fall to the ground

Late Blight

Late blight is a potentially devastating disease of tomato and potato, infecting leaves, stems,

tomato fruit, and potato tubers. The disease spreads quickly in fields and can result in total crop failure if untreated.

Fusarium Wilt

Fusarium wilt, widespread plant disease caused by many forms of the soil-inhabiting fungus Fusarium oxysporum. Several hundred plant species are susceptible, including economically important food crops such as sweet potatoes, tomatoes, legumes, melons, and bananas (in which the infection is known as Panama disease

Powdery mildews

Powdery mildews are easily recognized by the white, powdery growth of the fungus on infected portions of the plant host. The powdery appearance results from the superficial growth of the fungus as thread-like strands (hyphae) over the plant surface and the production of chains of spores (conidia).

Root Rot

Root rot is a disease that attacks the roots of trees growing in wet or damp soil. This decaying disease can cut the life short of just about any type of tree or plant and has symptoms similar to other diseases and pest problems, like poor growth, wilted leaves, early leaf drop, branch dieback, and eventual death.

Leaf Blight

Leaf blight disease is caused by the fungus Helminthosporium turcicum Pass. The disease develops on sorghum leaves particularly under humid conditions by producing reddish-purple or tan spots that coalesce to form large lesions. It attacks seedlings as well as older plants.

Black Spot

The fungus infects leaves and green fruit. After penetration it can remain dormant in the tissues. Black spot may develop in fruit when they begin to ripen and in leaves when disease development. The main source of infection is spore masses produced on old, undecomposed leaves and shrivelled fruit.

Verticillium wilt

Verticillium wilt is caused by the soil-borne fungi Verticillium dahliae and V. albo-atrum. Both infect a very wide range of garden plants through the root and then grow upwards in the water- conducting tissues, causing wilting of the upper parts due to water stress.

3. Proposed Method

First, the digital images are acquired from the environment using a digital camera. Then image processing techniques which will be applied to the acquired images to extract useful features that are necessary for further observations [7]. After that, several techniques are applied to classify the images according to the specific disease.

Image Acquisition: Image acquisition is the first step in image processing. This step is also known as preprocessing in image processing. It involves retrieving the image from a source, usually a hardware-based source.

Pre-Processing of Image Sample: In the pre-processing stage, the contrast of the input image is increased. The points which are not visible are highlighted. The second stage is the segmentation which can help in selecting the region of interest. The feature extraction phase will extract relevant features of the plant.

Training sets: Training sets for plant disease detection, there are a few options you can explore. This can be checked out at websites like Kaggle, which offer datasets for various machine learning tasks, including plant disease detection.

Validation sets: Validation sets are an important part of machine learning! They're used to evaluate the performance of your model during training. You can create a validation set by splitting your dataset into training and validation subsets. The training set is used to train the model, while the validation set helps you assess how well your model generalizes to new data. It's crucial to have a separate validation set to avoid over fitting[3].

CNN: CNN, or Convolutional Neural Network, is a type of deep learning algorithm commonly used for image recognition and analysis tasks. It is inspired by the visual processing of the human brain and consists of multiple layers of interconnected neurons. CNNs excel at capturing spatial relationships and patterns in images through the use of convolutional layers pooling layers, and fully connected layers. They have been widely successful in various computer vision applications, including object detection, image classification, and, as we discussed earlier, plant disease detection.

Detect Disease of Leaf: To detect diseases in plant leaves, you can use image processing and machine learning techniques. First, you'll need a dataset of images that include healthy leaves and leaves affected by various diseases. Then, you can train a deep learning model, such a convolutional neural network (CNN), on this dataset. The model learns to identify patterns and features in the images that distinguish healthy leaves from diseased ones. Once trained, you can use the model to classify new leaf images as healthy or diseased. It's a fascinating field with lots of potential.

Test: Now after foreground detection, the bitwise AND operation on binarised image and original color image is performed to get RGB image of segmented leaf. Now after image segmentation shape, texture and color features are extracted from the image. By using contours, area of the leaf and perimeter of the leaf is calculated.

Defect: Plant disease detection refers to the process of identifying and diagnosing diseases that affect plants. It involves using various techniques, such as visual inspection, image analysis, and machine learning algorithms, to detect signs of disease in plants. By analyzing plant symptoms, leaf discoloration, growth patterns, or other visual cues, experts and researchers can identify the specific disease affecting the plant. This detection helps in taking timely actions to prevent further spread and minimize crop losses.

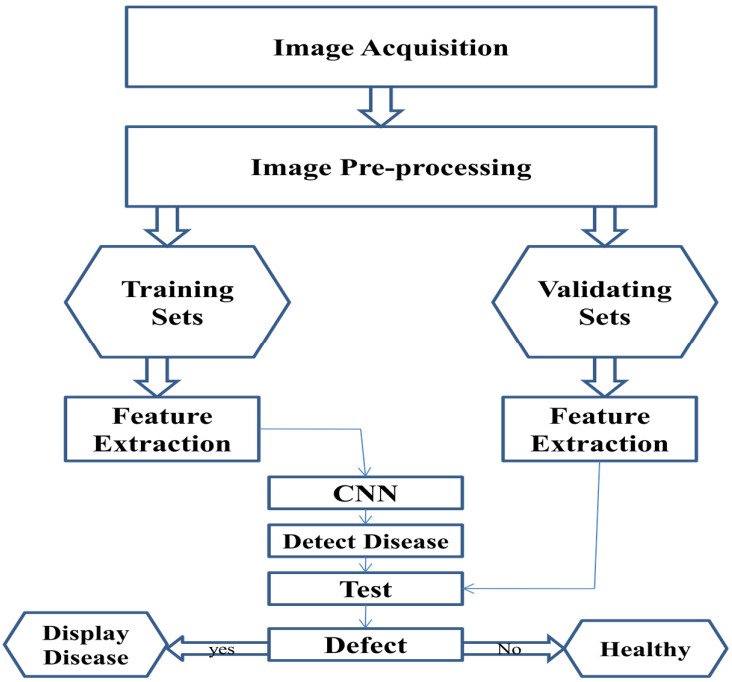


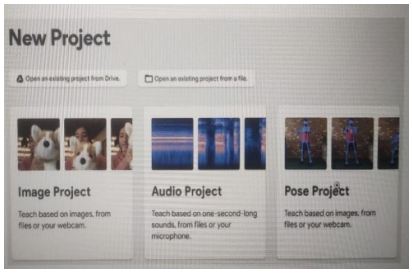
Figure 1 Block diagram of proposed method

4. Implementation

Teachable Machine is a user-friendly web-based tool developed by Google that allows users to easily train machine learning models without writing any code. It's designed to be accessible to people with varying levels of technical expertise and enables them to create custom machine learning models for tasks like image classification, sound classification, and pose estimation.

The process of using Teachable Machine typically involves three main steps:

- **Gathering Data**: Users collect and organize data relevant to the task they want their model to perform. For example, if they're creating an image classification model to distinguish between different types of fruits, they would need to gather images of each type of fruit.
- **Training the Model**: Teachable Machine provides an intuitive interface for users to upload their data and train their machine learning model. Through a series of interactive steps, users label their data, choose a model architecture (such as a neural network), and train the model using their labeled data.
- **Testing and Deployment**: Once the model is trained, users can test it using new data to evaluate its performance. Teachable Machine also provides options for deploying the model, such as generating a link to share it online or exporting it for use in other applications.



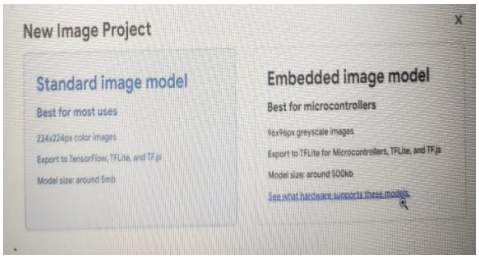


Figure 2 New Project selections **Figure 3. Select standard image model**

Teachable Machine offers two options to cater to different environments where image classification applications can be deployed. These environments include embedded systems with limited computing power and computers with high computing power.

Collecting Data (Images)

As shown in the image above, on the left side we can add the classes and their data samples. You can provide samples using camera or from stored images on your computer. We will upload our image samples using camera for each class.

Apple Scab:

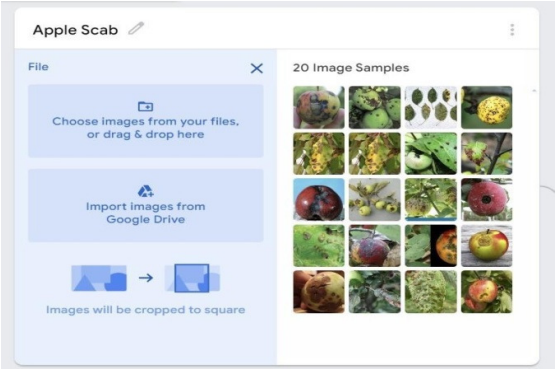


Figure 4 Disease Title: Apple Scab

Late Blight

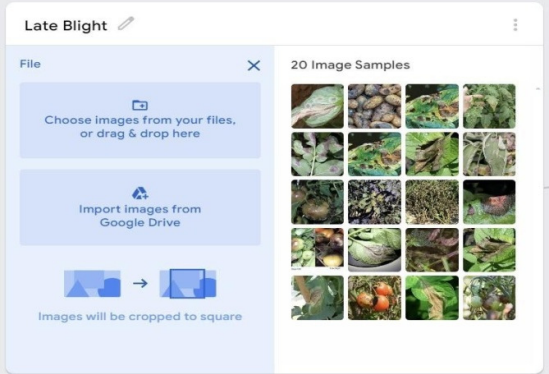


Figure 4 Disease Title: Late Blight

Citrus Canker

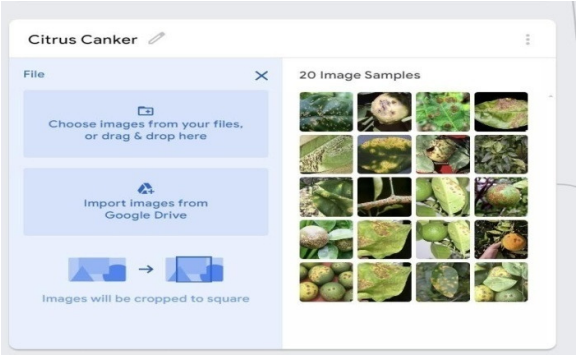


Figure 5 Disease Title: Citrus Canker

Fusarium Wilt

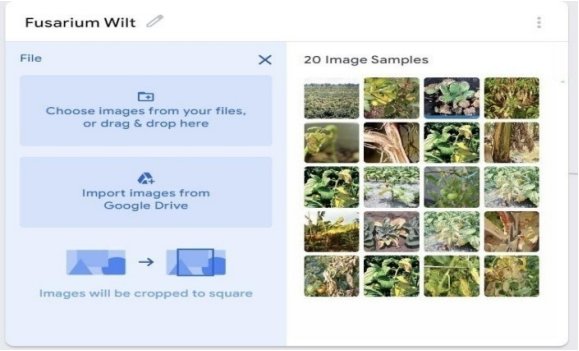


Figure 6 Disease Title: Fusarium Wilt Data

Training Model:

The training of our model is effortlessly accomplished as Teachable Machine takes care of it automatically in the background. All that is required from us is to patiently await the results.

Click on the Train Model button and patiently wait for a few seconds until the training process is completed. It is important to note that you must keep your browser open on the Teachable Machine tab, as switching tabs will terminate the training session and require you to restart thetraining from the beginning.

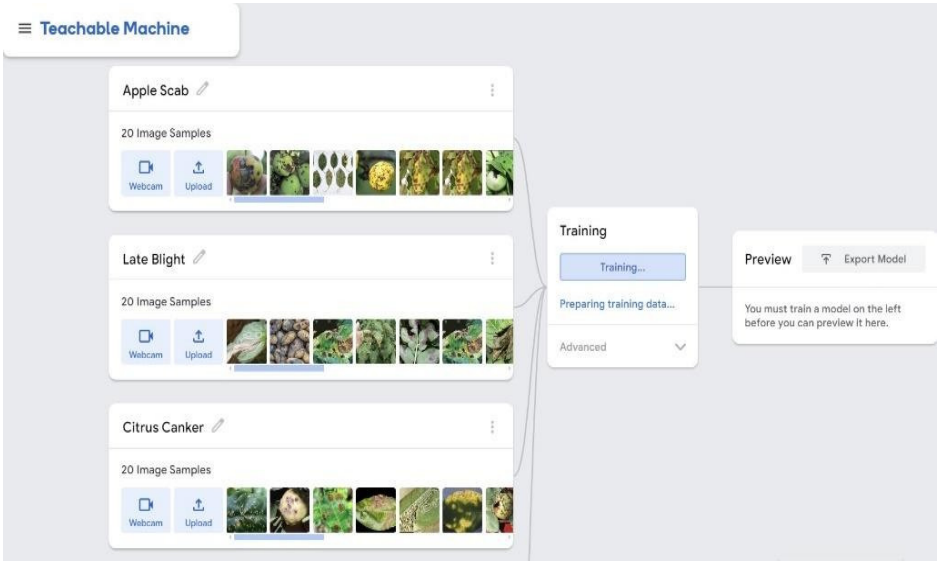


Figure 7 Training model using Teachable Machine

Testing Classification Results in Browser (Preview Results):

Once the training of the model is complete, you will observe that the camera is activated, enabling you to directly evaluate the outcomes within your web browser.

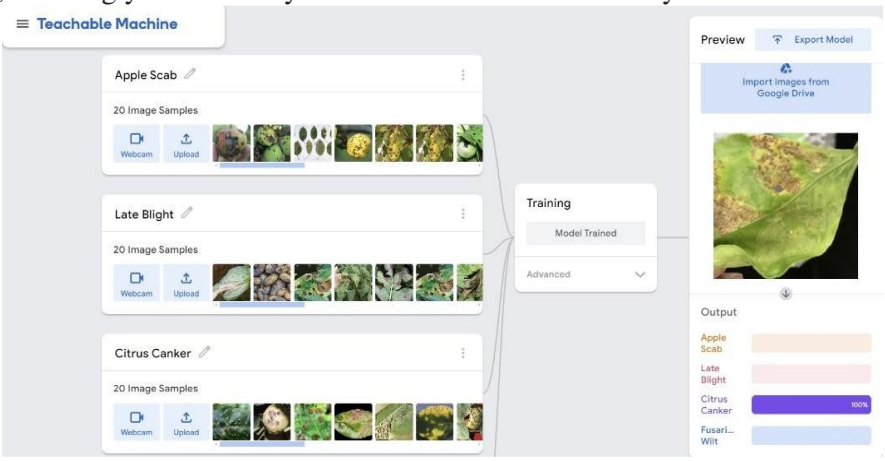


Figure 8 Testing Classification Results

Exporting Model:

By exporting the model, we can utilize the pre-trained model in various contexts, such as gamingclassification, scientific projects, and more.

In our scenario, we will export the model in Tensorflow format (.h5) to facilitate interactionwith it using image processing packages and libraries like OpenCV or Pillow

To proceed, simply click on the **Export Model** option and we aim to utilize the TensorFlow (Keras) .h5 format to export our model for Python usage. Select **TensorFlow**, **Keras** and click on **Download my model** button. After a period of waiting, you will observe the presence of a compressed file containing two items:

- keras_model.h5 (Our exported model)
- labels.txt (text file for class names with IDs)

After opening the labels.txt file, you should find its contents to resemble the following.

Classifying Images with Python:

In the same directory, create a new Python file (e.g. named app.py).

It is crucial to ensure that both keras_model.h5 and labels.txt reside in the same directory (relative path) as the Python file.

5. Results & Discussion

Late blight

Late blight is a devastating fungal disease that primarily affects plants in the Solanaceae family, particularly tomatoes and potatoes. It's caused by the pathogen Phytophthora infestans Symptoms of late blight include dark, water-soaked lesions on the leaves, stems, and fruits of affected plants. These lesions can rapidly expand, leading to the collapse of entire plant tissues.

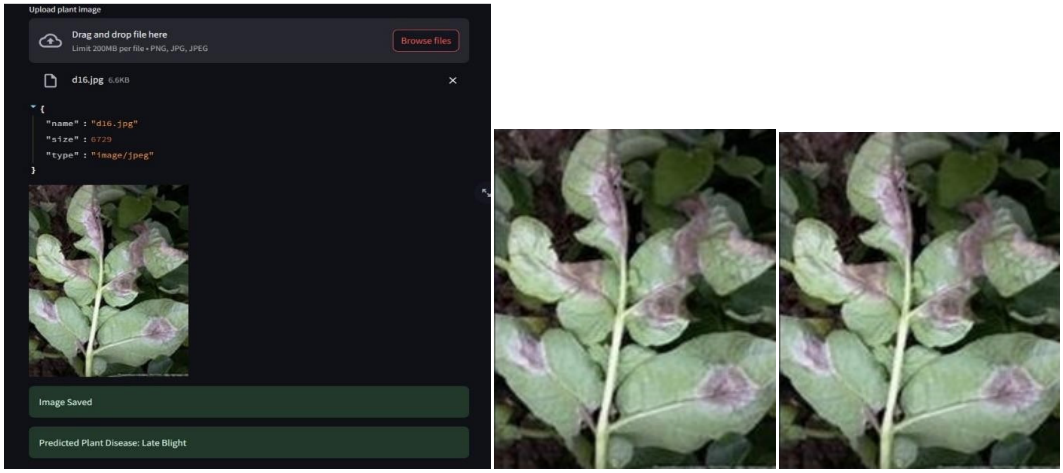


Figure 9 Test results for Disease late blight, Input image & Output image

Fusarium wilt

Fusarium wilt is a fungal disease that affects a wide range of plants, including many important crops such as tomatoes, bananas, cucumbers, and melons

Fusarium wilt is often characterized by the gradual wilting and yellowing of lower leaves, starting from the bottom of the plant and progressing upwards.

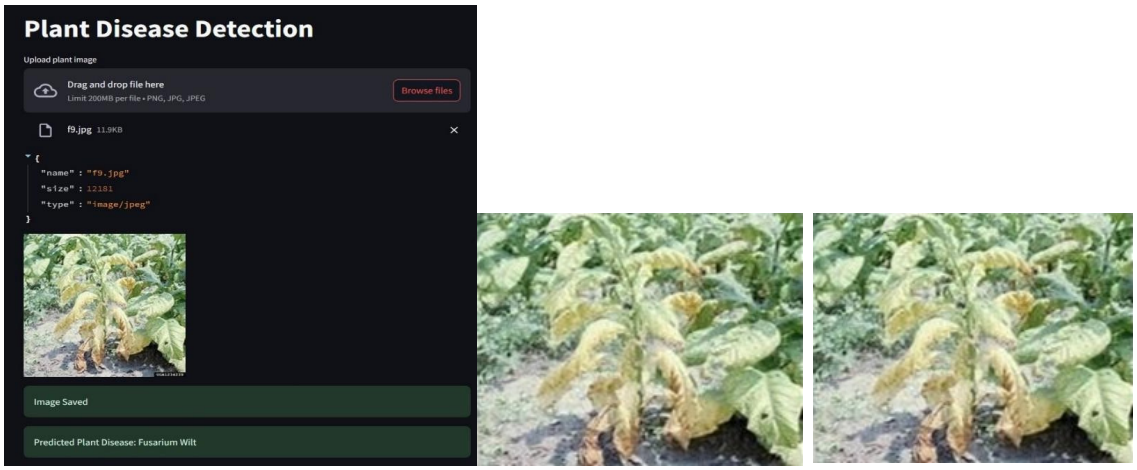


Figure 10 Test results for Disease apple scab, Input image & Output image

Apple scab

Apple scab is a common fungal disease that affects apple trees, as well as ornamental crabapple trees. It's caused by the fungus Venturia inaequalis. Symptoms of apple scab typically appear on leaves, fruit, and occasionally on young twigs. On leaves, you'll notice olive-green to black lesions with a velvety texture.

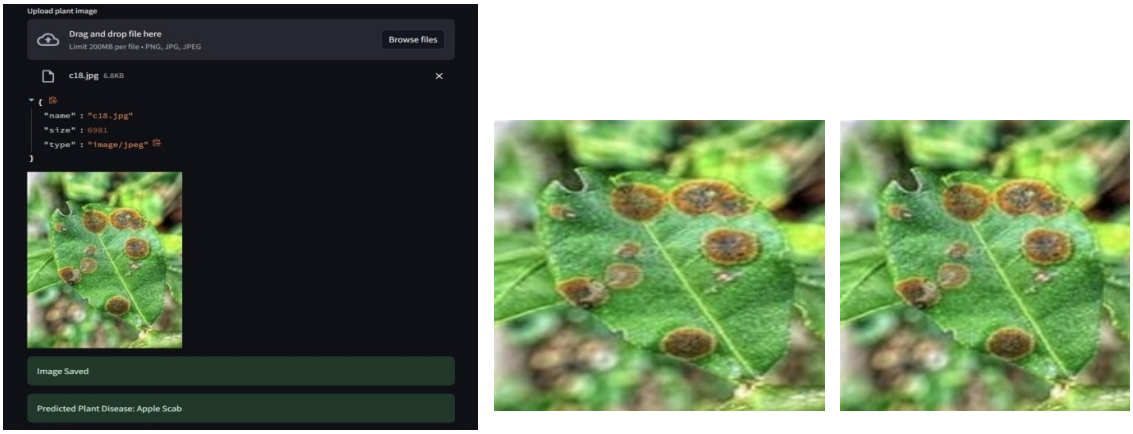


Figure 11 Test results for Disease apple scab, Input image & Output image

Citrus Canker

Citrus canker is a highly contagious bacterial disease that affects citrus trees. It's caused by the bacterium Xanthomonas citri subsp. citri. This disease primarily affects the leaves, stems, and fruit of citrus trees, causing characteristic lesions or sores on these parts.

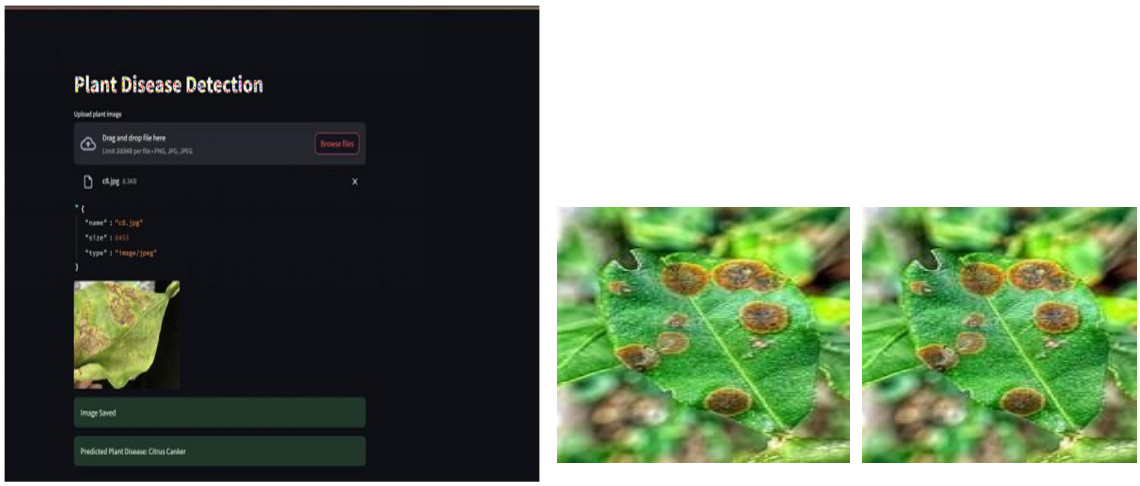


Figure 12 Test results for Disease Citrus canker, Input image & Output image

6. Conclusion

The present paper deals with detection of various plant diseases such as Late blight, Fusarium wilt, Apple scab and Citrus Canker etc using teachable machine. The spot on the leaves and roots are detected using image processing techniques in Python. It involves uploading an image, image processing, feature extraction and classification. Plant disease detection using CNNs has significant potential for plant disease detection using CNNs holds great promise for transforming agriculture by empowering early and accurate identification of diseases, thus contributing to improved crop health, increased yields, and sustainable farming practices.

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