IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

DEEP LEARNING BASED PLANT DISEASE PREDICTION USING CONVOLUTIONAL NEURAL NETWORK

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Abstract: Plant disease diagnosis is a huge issue in increasing the production of yield in the agriculture sector. Identifying plant diseases is crucial to prevent loss of yield and quantity of agricultural products. The recent advances in computer vision helps the researchers in using the Artificial intelligence technology for finding and detecting the type of plant disease of the crop. In this current research, a deep learning technology is used for detecting and to classify the type of disease through image processing technique. Convolutional Neural Network (CNN) is utilized for image processing for detection of diseases, including image acquisition, image preprocessing, image segmentation, and feature extraction and classification. This describes a method for detecting the disease of plants by using the image of their leaves. It also describes the algorithm for extracting some segmentation and functionality used in the detection of plant diseases.

***Index Terms* - Artificial Intelligence, Convolutional Neural Network, Image Processing.**

1. INTRODUCTION

Plant pathology is the scientific study of diseases in plants caused by pathogens and environmental conditions. Organisms that cause infectious disease include fungi, oomycetes, bacteria, viruses, viroids, virus-like organisms, phytoplasmas, protozoa, nematodes and parasitic plants. The focus of this research is to develop a technology in the field of agriculture that is based on engineering techniques. Crops are now subjected to a wide range of characteristics and diseases. One of the key traits/diseases is the damage produced by the bug. Because pesticides can be hazardous to birds, they are not always shown to be effective. It also has an adverse effect on natural animal food systems. Plant scientists frequently assess the damage to a plant (e.g., leaf, stem) based on the proportion of the diseased region seen by naked eye on a large scale. This research presents an advanced strategy for employing image processing to analyse plant diseases and characteristics. The strategies investigated are for boosting throughput and lowering inaccuracy in plant disease detection caused by human specialists. Engineering technology is used to detect leaf illness, and mathematical theory is used to interpret the results.

2. LITERATURE SURVEY

A smart agricultural system with the necessary infrastructure is a new technology that may increase the quality and quantity of agricultural produce in the country, such as tomatoes. Since tomato plants are cultivated from various variables such as environment, soil, and amount of solar radiation, the presence of the disease cannot be avoided. Deep learning has enabled improvements in the field of computer vision in recent years, opening the door for camera-assisted illness detection as mentioned. This study produced a novel technique for effective disease detection in tomatoes. To detect and identify leaf diseases, a motor-controlled image capture box is utilised to record images of all four sides of each tomato plant. A specific tomato variety, Diamantemax, was used for testing. The system is designed to identify diseases that are spot rot and target spotlights. Using controlled conditions on the affected and healthy tomato plant leaf collection image dataset. We trained a deep convolutional neural network to recognize three diseases. In farming, plant diseases are the first criminals. Another tomato disease can be encountered by agronomists and farmers. It can be detected or the leaves can be located on the roots of stem fruits and plants. Common symptoms of plant damage are mycoses, bacteria, viruses, and spots where nematodes are the source of leaves, brown or black lesions, last death of lower leaves, and lower leaves and dark spots. It has a yellowing stem. This is caused by changes in the environment such as humidity every day in the world. Each disease has another designated control or prevention to avoid the disease. Common methods used are cultural practices, the use of disease resistant varieties and chemicals [1]. Real-time image processing is related to the typical frame rate of all processed frames required after the image is captured. This paper proposes a real-time edge detection technique for identifying images and their hardware trefoil disease (rubber leaves). The leaves of the three large rubber trees are the spots of Corynespora leaves, the spots of the bird's eye and the disease of Collectotrichum leaf disease in the image comparison used in this study. Diseases on the leaves can be detected by edge detection using the Sobel edge detection algorithm. This is to compare the real-time edge detection results that occur through the FPGA Cyclone IV E through a monitor that is compared to the Sobel Edge Detection Algorithm generated by MATLAB. The algorithm is implemented in FPGA, and the result of the image on the VGA monitor can be processed in the embedded system of many applications such as MATLAB simulation of object detection, X-ray image intensifier, character recognition, etc. as it is now [3]. A diagnostic system for plant leaf diseases presented from color images using unsupervised neural networks. The image is processed using the color and texture features. Disease Feature Extraction and Disease Classification: The system consists of two main steps. The disease feature extraction process analyzes the appearance of features using a statistically based gray-level simultaneous occurrence matrix and texture feature equations. The disease classification process deploys an unsupervised simplified fuzzy ARTMAP neural network for disease classification types. It is used to test the classification performance of four systems of vine leaf disease. Rust prevention is scab, downy mildew and disease-free. The desired result was achieved with an accuracy of 90% or higher. The proposed system can be completely applied to diagnose other types of plant diseases. Vegetables and fruits are one of the most important agricultural products in many countries. This is clear because the world always needs more food. Product quality control is basically required to produce higher value-added products. One of the most important effects of such A quality is plant disease. Therefore, minimized plant diseases provide a significant improvement in product quality. It requires the ability to detect diseases and diagnose plant diseases in a timely, accurate and responsive manner to minimize damage. Today, precision agriculture and smart farming technologies are widespread and are being developed in two aspects: product growth and quality control of the most agricultural products. Image processing and computer vision are the most effective technologies for different types of applications. This work uses color images and disease feature analysis to propose a plant leaf disease diagnostic system. Simultaneous treatment of the I and H components allows the appearance of features to be effectively significant. The gray level simultaneous occurrence matrix and texture feature equations are used as statistical data for fuzzy simplified ARTMAP to completely classify image types of vine leaf disease. Results are desired and can be appropriately applied to the detection and classification of leaf diseases in real-world plants [4]. Rice is the most significant crop in Asian nations. Most people eat rice since it is considered the staple diet of Asian countries. Many illnesses impair rice yields, causing farmers to lose money. This approach suggests a technique for detecting blast furnace and brown spot infections. To categorise data, the global threshold approach and the k-nearest neighbour classification were utilised. Consequently, the recommended strategy was successful. Brown spot disease is discovered utilising image processing and pattern recognition algorithms in this method and rice blast. Plant diseases may substantially reduce output and even kill crops. Direct and indirect losses are both types of losses. Reduced plant stands, accommodation, spotted kernels, fewer per plant, and a general decline in smaller grain and plant output are examples of direct losses. The expense of fungicides needed to control the illness is one example of an indirect loss. This use has various limitations, including the high cost and low return associated with cultural practices related with disease reduction. In terms of greatest output, this is ineffective. Image processing has been used to develop methods for identifying leaf diseases in agricultural plants. The author begins by photographing the diseased leaf with a digital camera and then converting the RGB picture to an HSV colour model. As there is no lack of infected regions, the segmentation of the infected area is further separated into several significant information patches chosen by the author, taking into consideration the HSV colour space and the partial sound components of the segmentation. GLCM was used to extract the statistical function. Based on typical morphological changes, identify, and diagnose leaf diseases in agricultural plants. Images were preprocessed, and image contrast analysis histograms were created by performing threshold modifications. The traditional fuzzy C-means (FCM) method can be used for segmentation. Color, shape, and texture aspects of images are employed for segmentation. Artificial neural networks (ANN) should be classified [5]. Image capture, picture preprocessing, image segmentation, feature extraction, and classification are all phases in detecting and identifying plant leaf diseases. This method can be used in the description and leaf disease classification image segmentation algorithms to preprocess the images used in the study of automatic identification and leaf disease classification algorithms for various plants. Therefore, fast, low cost and accurate methods have practical significance for large farms to consider automatic identification and identification of diseases from plant leaves. This decision support system (DSS) is needed to establish a call center, and farmers need to give detailed information about the foliage of the plant verbally. DSS based on image processing helps improve agricultural productivity. This study proposes a system focused on the detection and identification of diseases that are useful for decision making. The proposed system includes four main stages: pretreatment, segmentation, feature extraction and classification. In this method, we focus on image classification techniques that are different from image splitting [6].

3. RESEARCH METHODLOGY

3.1 Existing System

It is planted disease identification is an important issue in the existing system. Generalized problem identified plant leaf disease makes your computer more intelligent and reducing the workload of humanity. Something in common with these two works have a clear-cut picture of the lesion. The problem can be resolved with the diversity of data limitations. The difference is that the leaves can be converted into a healthy image to various types of diseases. This is the image of the conversion method to the image from the image, but the existing one is converting the image from the noise to generate a marked image conversion. The same type of image. There is a problem with the difficult process of classification or regression of noise on the existing system.

3.2 Proposed System

Deep learning is an artificial intelligence subfield. In recent years, the benefit of extraction of autonomous learning and function has garnered a wide variety of academic and corporate interest. Image and video processing are commonly employed in speech processing and natural language processing. Simultaneously, it is artificial deep learning of the application plant disease recognition and pest range assessment of plant disease recognition that it is possible to avoid the disadvantages caused by selection, the hot spot of research in the field of agriculture plant protection, such as and it has become a disease of the spot is equipped with a more feature extraction of objective makeup plant diseases, and improve the exchange rate.of efficiency and technology of research. The Proposed system is as shown in Figure.1.

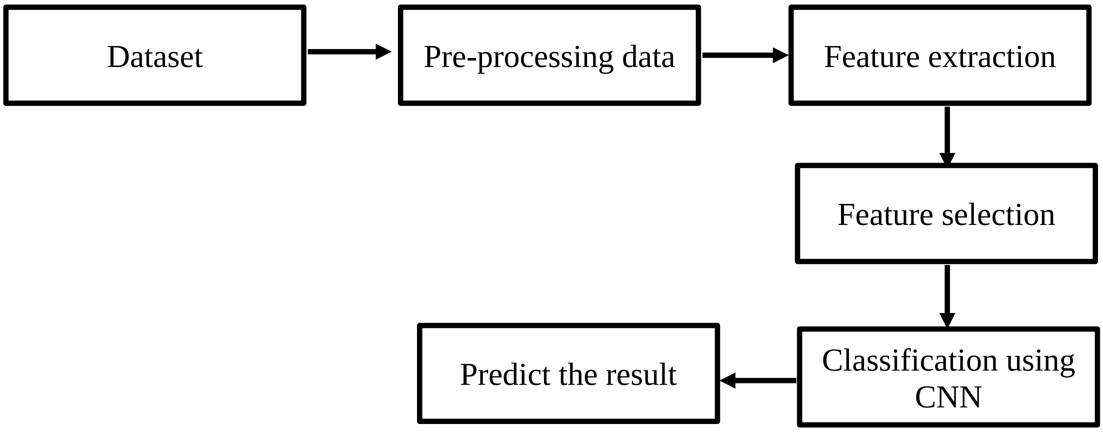

Figure 1: Proposed diagram

3.2.1 Use case diagram

A use case diagram is a graphical representation of the interactions between system parts as shown in Figure.2. The intended behaviour and the means for achieving it will be specified in use cases. Once defined, use cases can have both written and visual representations.

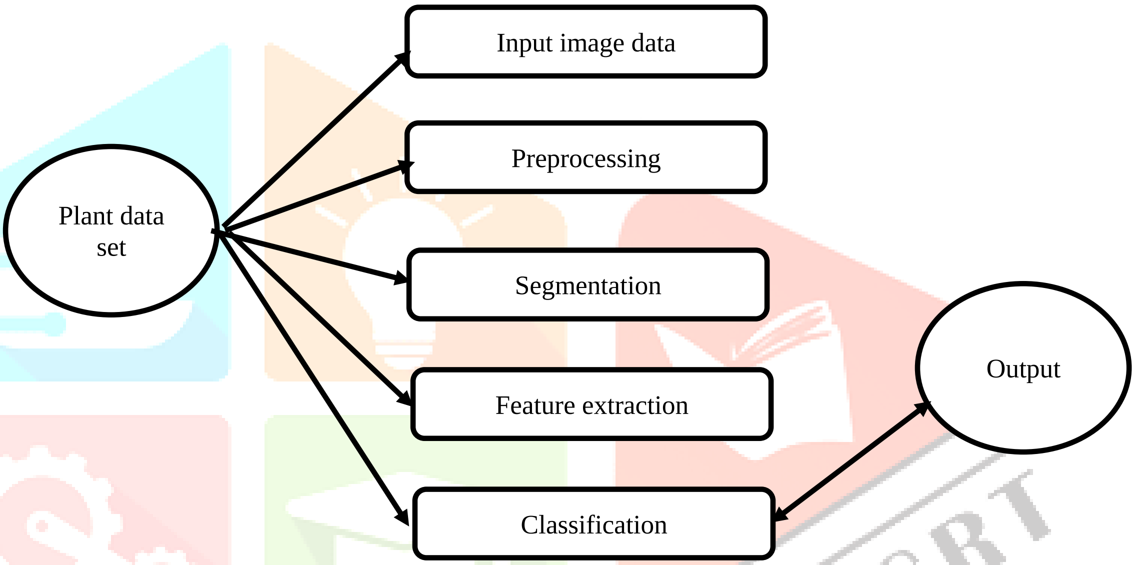

Figure 2. Use case diagram

3.2.2 Sequence diagram

A sequence diagram as shown in Figure.3. depicts distinct processes or objects that exist concurrently as parallel vertical lines (lifelines), and the messages passed between them as horizontal arrows in the order in which they occur.

3.2.3 Activity diagram

Another significant diagram in UML for describing dynamic characteristics of the system is the activity diagram. An activity diagram is essentially a flowchart that depicts the flow from one activity to another. The action can be defined as system functioning. The control flow is directed from one operation to the next. The above Figure.4 represents the flow from one activity to another activity, the activity starts from input leaf image through digital camera, and then input leaf is preprocessed and extract the features like color, shape, texture and so on. Now, the processed image is classified as Normal or Abnormal, if Abnormal is found in the leaf, then remedies will be suggested.

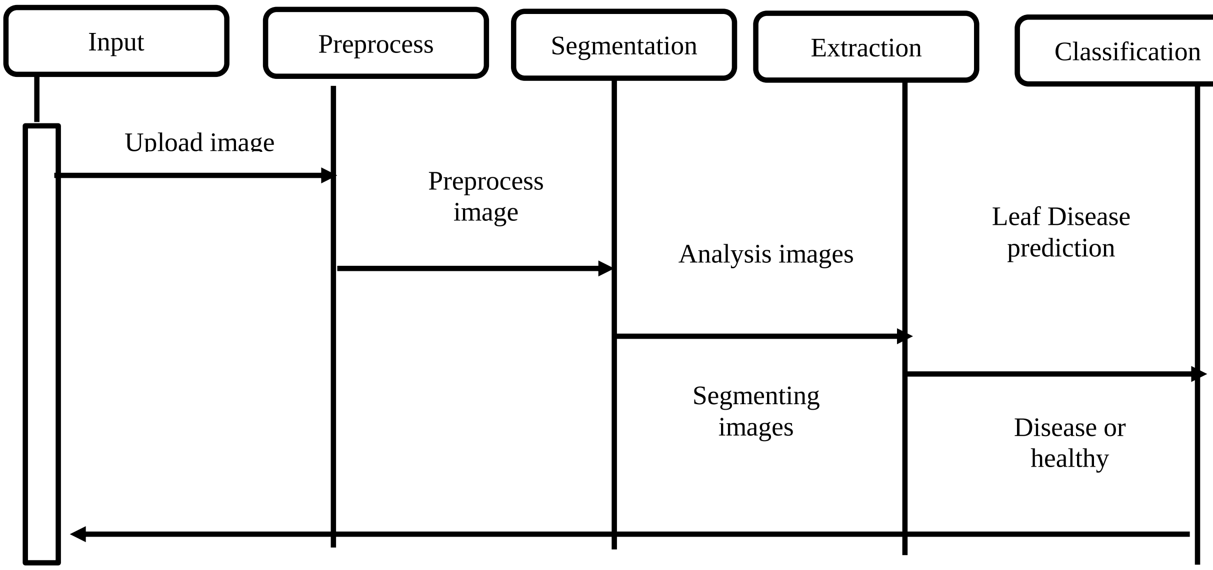

Figure.3 Sequence diagram

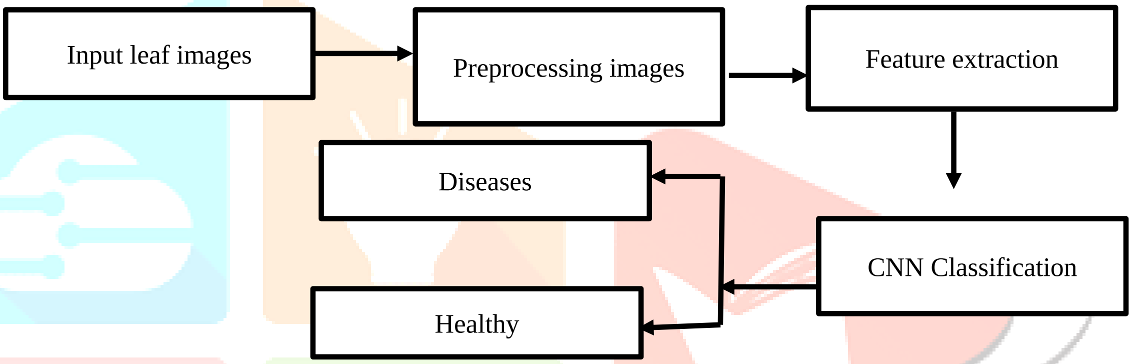

Figure.4. Activity diagram

3.2.4 Data flow diagram

A data flow diagram is the graphical illustration as depicted in Figure 4 of the "flow" of data through an information system that models the process characteristics of the system. A DFD is frequently used as a preliminary stage to produce an overview of the system that may subsequently be expanded.

3.3 Dataset for plant leaf

The data set collection is the plant leaf disease image data collected from the information on the performance. Then, data cleaning and data reduction are done from the collected plant leaf dataset records. These data of the plant disease, plant leaf information for the leaf size, leaf color, quality and then plant characters are collected from the dataset performance.

4. Results and Discussions

4.1 Process of data preprocessing using Gaussian filter

There is usually no complete and consistent data in the real world, which cannot be used for direct data mining or the effect is not ideal. To improve the quality of data pre-processing, Gaussian filter is used data cleaning and data integration, data conversions, and data compression are the many ways of preprocessing data.

4.2 Process of data cleaning

The plant disease using correction data clearing process means identify the record set, table, database, incorrect, data inaccurate records, please replace, then replace, delete data. This is divided plant disease prediction analysis has been used in the process for the information theory in the plant leaf for change color and sizes is divided into types are to predict the data and descriptive data cleaning prediction deployed the data structure.

4.3 Data Reduction process

The purpose is to reduce the data with a small compression volume data set, while maintaining its original integrity. This is an effective method but gives similar result this is useful for data analysis and the data reduction can be used as a subset of the evaluation function by the classifier CNN algorithms which are used for the prediction of result. It takes advantage of the improved accuracy of selecting the functions related to the CNN algorithm performance.

4.4 Classification using Convolution neural Network

The classification is performed using the proposed method Convolution Neural Network (CNN) performance on the plant disease prediction. Prediction of diseases includes image data, data preprocessing, data cleaning, data reduction and classification. This describes a method for detecting the disease of plants by using the image of their levels. It also describes the algorithm and functionality used in the prediction of plant diseases. The plant leaf is to be classified for the prediction and classification. The result is input image dataset for preprocessing and data clean and reduction for the data performance.

```python
import os
import datetime
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay
import tensorflow as tf
from tensorflow.keras import Input, Model
from tensorflow.keras.callbacks import EarlyStopping, TensorBoard
from tensorflow.keras.preprocessing.image import load_img, img_to_array, ImageDataGenerator
from tensorflow.keras.layers import Conv2D, DepthwiseConv2D, Dense, Concatenate, Dropout, MaxPooling2D, GlobalAveragePooling2D
from tensorflow.keras.utils import plot_model
from model_utility import plot_images
```

Figure 5 Python code for Implementing Package

```python
BASE_DIR = "E:\New folder\New Plant Diseases Dataset(Augmented)"
TRAIN_DIR = os.path.join(BASE_DIR, "train")
VAL_DIR = os.path.join(BASE_DIR, "valid")
TEST_DIR = os.path.join(BASE_DIR, "test")
IMG_SHAPE  = (256, 256)
BATCH_SIZE = 64
```

```python
INPUT_DEPTH_MULTIPLIER = 8
BASE_FILTER_COUNT = 32
DENSE_NODES = 512
DROPOUT_PERCENTS = [0.2, 0.2]
```

```python
EPOCHS = 30
PATIENCE = 5
QUEUE_SIZE = 25
TB_LOGS = "tensorboard_logs/fit/" + datetime.datetime.now().strftime("%Y%m%d-%H%M%S")
```

Figure 6 Python code for Dataset implemented

```python
test_image_data = []
test_image_filenames = []

for img_name in os.listdir(TEST_DIR):
    img = load_img(os.path.join(TEST_DIR, img_name), target_size = IMG_SHAPE)
    test_image_data.append(img_to_array(img, dtype = 'uint8'))
    test_image_filenames.append(img_name)
    print(img_name)

test_image_data = np.array(test_image_data)/255
print(f'\nTotal testing images: {len(test_image_data)}')
```

```
AppleCedarRust1.JPG
AppleCedarRust2.JPG
AppleCedarRust3.JPG
AppleCedarRust4.JPG
AppleScab1.JPG
AppleScab2.JPG
```

Figure 7 Code for testing scanned images

```
plot_images(train_data_gen)
```

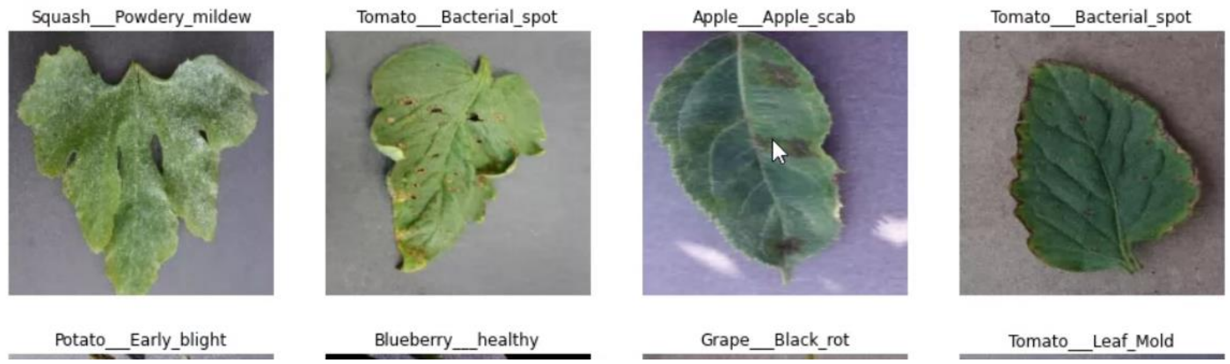

Figure .8 Result for Training images

```
dense_2 = Dense(total_classes, activation = "softmax", name = "Output")(dropout_2)
dense_2.shape

TensorShape([None, 38])

model = Model(inputs = inputs, outputs = dense_2, name = "Plant_Leaf")

model.compile(optimizer = 'adam',
              loss = 'categorical_crossentropy',
              metrics = ['accuracy'])

model.summary()

Model: "Plant_Leaf"
_________________________________________________________________________________________________
Layer (type)                    Output Shape          Param #     Connected to
=================================================================================================
Input (InputLayer)              [(None, 256, 256, 3) 0
_________________________________________________________________________________________________
DwC_1 (DepthwiseConv2D)         (None, 256, 256, 24) 120         Input[0][0]
_________________________________________________________________________________________________
PwC_1 (Conv2D)                  (None, 256, 256, 32) 800         DwC_1[0][0]
```

Figure 9 CNN-soft-max activation function

```
plt.title(f"True: {test_image_filenames[i][:-4]}\nPrediction:{test_pred_classes[i]}")

plt.show()
```

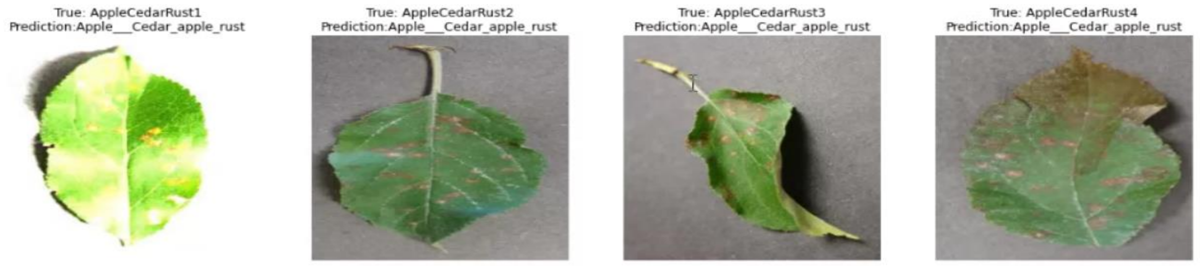

Figure 10 Prediction of effected leaf images

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