Jagadeesh V
Guvi / AIML-WE-E-B2
jagdeeshv@hotmail.com

Plant Disease Detection

Abstract

Agriculture has a high impact on life and economic status of human beings. In our country agriculture is important and about 70% of the population depends on the farming for their living. Plants are very essential in our life as they provide source of energy and play an important role in tackling many environmental issues that includes global warming.

There are several diseases that affect plants that may cause devastating economic, social and ecological losses. Plants are affected by diseases like Black rot, bacterial spot, early / late blight, and so on. The diseases effect the efficiency of crop yield. So, the early detection of diseases is important in agriculture. Detection of diseases as soon as they appear is vital step for effective disease management. Recognizing illness can prompt faster treatment to lessen the negative impacts on harvest.

Out of the methods available, a common approach in this case is the use of remote sensing techniques that explore multi and hyper spectral image captures. The methods that adopt this approach often employ digital image processing tools to achieve their goals. Image processing technology in the agricultural research has made significant development. Since 2016, applications for the automatic identification of crop diseases have been developed. These applications could serve as a basis for the development of expertise assistance or automatic screening tools.

In this project we have developed a Streamlit web application, machine learning-based solution, to input plant leaf images and detect disease affected the plant if any. This uses a well-trained New Plant Diseases (Augmented) dataset, powered by a Convolutional Neural Network (CNN) model. The web-based application allows users to upload images of plant leaves and receive predictions on potential diseases in real-time.

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Introduction

Plant diseases are a critical challenge in agriculture. Early and accurate detection of these diseases is essential for timely interventions and effective crop management.

Traditionally, farmers and agriculturists have relied on manual inspection to identify diseases, a time-consuming and error-prone method that often requires expert knowledge. As modern agriculture continues to evolve, the integration of technology offers a more efficient solution to this problem.

The development of computer vision models offers a quick, standardised and accurate solution to this issue. Once trained, a classifier can also be deployed as an application.

Leaf disease detection using deep learning is an emerging technique in agriculture that has shown promising results in detecting and identifying diseases that affect plants. Deep learning algorithms have improved plant disease detection by analysing images and identifying signs of disease quickly and accurately. We have used convolutional neural networks (CNN) in this project.

OBJECTIVE

The primary objective of this project is to develop a simple, practical, user-friendly tool for a real-time Plant disease detection. Using CNN techniques and an effective pre-processed and trained dataset model, this project is focused to build a reliable detection system.

The end goal is a fully functional web application, built with Streamlit, that allows users to upload images and receive immediate feedback on the disease name with accuracy percentage.

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Software Requirement

A Web browser, Python Jupyter LAB installed with required libraries. Libraries include

1. os
2. numpy
3. pandas
4. tensorflow
5. streamlit
6. keyboard
7. psutil
8. time
9. torch
10. onnx
11. torchvision
12. `scikit-learn`
13. PIL
14. shutil
15. Matplotlib

Application – Dataset & machine learning

This easy-to-use Plant Disease Detection from uploaded leaf image will benefit farmers to detect disease if any on real time to take early preventive actions.

This can be further used in Research for studying the impact of different diseases on crops and finding ways to mitigate them.

The system can be used by pesticides & fertilizer firms for identifying the disease and manufacture effective pesticides for the farmers.

1. Dataset

To recognise a leaf and the disease if any of an image, we should first have pre-processed, well trained ample models for each disease that will form library to map various plant diseased leaves and healthy ones. Thus, the preliminary step is the dataset model.

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Kaggle offers several datasets for plant disease detection, which are valuable resources for researchers and developers working on agricultural technology and plant pathology. These datasets typically contain images of healthy and diseased plant leaves, along with labels indicating the type of disease. We have taken the New Plant Diseases Dataset

New Plant Diseases Dataset: This dataset contains images of different healthy and unhealthy crop leaves. It is designed to help in the development of models for detecting plant diseases based on visual features.

This dataset consists of about 87K rgb images of healthy and diseased crop leaves which is categorized into 38 different classes. The total dataset is divided into 80/20 ratio of training and validation set preserving the directory structure. A new directory containing 33 test images is created later for prediction purpose.

2. Pre-processing, Training and saving Model

Source code: Jag Plant Data processing.ipynb executed in jupyter lab

The dataset was resized (to 150x150 pixels) and normalized. These were split into train (70%) and test (30%) and using CNN classification, flattening with relu forward function was trained.

Further pre-trained with vgg (Accuracy 84.89%), DenseNet (Accuracy 89.05%) & alexnet (accuracy 88.07%) and save the torch models as vgg16.pth, alexnet_model.pth & densenet.pth

The scores of Accuracy, Precision, Recall & F1 of all the three are:

	Accuracy %	Precision %	Recall %	F1-score %
CNN	86.98	87.54	86.98	86.94
vgg16	84.89	86.28	84.89	84.46
DenseNet	89.05	90.49	89.05	89.07
AlexNet	88.07	88.75	88.07	88.00

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Realtime Plant Disease prediction

Source code: Jag_Detect_Leaf_disease.py [Streamlit app executed in command prompt]

A simple and easy to use user interface is designed, for a quick and reliable detection for anyone in need. This is developed using **Streamlit** framework which allows for rapid development and deployment of interactive web applications interface

Image Upload Feature: The core functionality of the UI is the image upload option, where users can select and upload a plant leaf image. This feature includes drag-and-drop functionality for ease of use, file type validation (common image formats, including JPEG and PNG) and image validation (Throws message if not face).

Real-time Display of Predictions: Once an image is uploaded and PREDICT button clicked, the interface pre-process the image, through resizing, normalizing, etc with CNN and displays the model's prediction of leaf name and disease along with a confidence score, helping users understand the reliability of the results. The prediction is displayed on the click of Predict button. Exit button is provided to exit the application.

CONCLUSION

This project proposes an approach for recognizing the disease, if any, of the plant is useful for almost all in the agriculture field, such as farmers, researchers, pesticides manufacturers, Governmental bodies and so on.

In this project, around 38 categories of leafs / disease are trained and could be predicted. This project involves preprocessing of captured leaf images followed by feature extraction based on pre-trained datasets of healthy & diseased leaf images.

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To measure the performance of proposed algorithm and methods and check the results accuracy, the system has been evaluated using various metrics and training models.

Experiment results with this dataset, show that our proposed method can achieve a good performance. More efforts should be put to improve the classification performance and more leaf images and disease images to be added in the dataset to widen the reach and prediction.