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PLANT LEAF HEALTH PREDICTION USING CONVOLUTIONAL NEURAL NETWORKS

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Abstract

The control of plant diseases is a major challenge to ensure global food security and sustainable agriculture. Several recent studies have proposed to improve existing procedures for early detection of plant diseases through modern automatic image recognition systems based on deep learning. Disease detection in plants at early stage is hard and challenging task. The image database is increasing day by day. This all happens due to raid development in technology and high speed internet increasing in capacity and storage. Farmers are influenced with yield of agriculture product that emerges because of various leaf health diseases. Diagnosing the plant diseases caused in enormous farming regions by manually analysing the plant diseases is tedious task. With the significant advancement and development in deep learning have opportunity to improve the performance and accuracy of object detection, recognition system. We designed a Convolutional neural network (CNN) system that automatically predicts the plant health in advance and alerts the farmer for the best spray of correct fungicide or insecticide at the right time to prevent the damage of plant health and leaves and hence to increase the yield.

Keywords – Classification, Prediction, Convolutional neural networks, leaf disease

I. Introduction

Due to the current development in technology, there is an increase in the utilization of multimedia devices such as cameras, cellular phones, and internet. The shared and stored plant leaf dataset are growing and to look, classify and predict is a challenging research problem. At present the visual inspection done following the conventional technique by humans makes it impossible to classify and predict plant diseases and due to the advancement in computer vision models which address these issues and offers fast, normalized and accurate solutions. Numerous research papers from past five years involving plant classification and prediction using Convolutional neural network has been published and achieved the results not more than 93-95%. In machine learning and cognitive science, ANN is an information-processing paradigm that was inspired by the way biological nervous systems, such as the brain, process information. The brain is composed of a large number ofhighly interconnected neurons working together to solve specific problems. An artificial neuron is a processing element with many inputs and one output. Although artificial neurons can have many outputs, only those with exactly one output will be considered. Their inputs can also take on any value between 0 and 1. Also, the neuron has weights for each input and an overall bias. The weights are real numbers expressing importance of the respective inputs to the output. The bias is used for controlling how easy the neuron is getting to output 1. For a neuron with really big bias, it is easy to output 1, but when the bias is very negative then it is difficult to output 1. The output of the neuron is not 0 or 1. Instead, it is $\alpha\cdot(w\cdot x + b)$, where α is called the transfer function. There are different types of transfer function: step, linear, sigmoid, and so forth. The smoothness of α means that small changes Δwj in the weights and Δb in the bias will produce small change Δoutput in the output from the neuron. Small output changes approximated by :

$$\Delta\text{output} = \frac{\sum\Delta\, output\, \Delta wj}{\delta wj} + \frac{\sum\Delta\, output\, \Delta b}{\delta b}$$

Neural networks, with their outstanding ability to derive meaning from complex or imperfect data, can be applied for extracting patterns and detecting trends that are too difficult to notice by humans or computer techniques. Other advantages of ANNs are adaptive learning, self-organization, real time operations, and so forth. There are two main categories of ANNs when speaking about architecture: feed-forward ANNs

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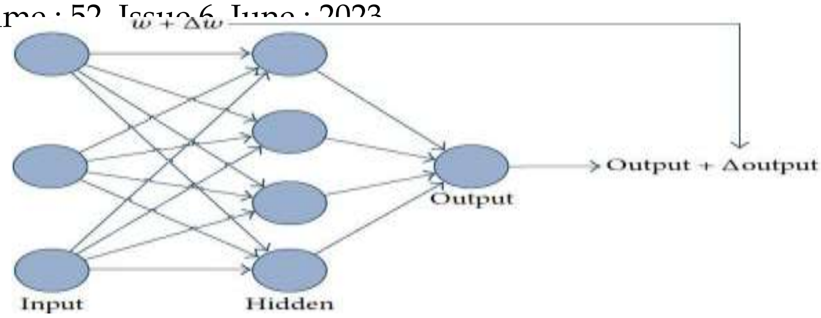

Fig 1Simple Model of ANN

where the output of any layer is unlikely to influence that same layer and feedback ANNs where signals travel in both directions by involving loops in the network.

The research gap exists as most of the research published from past five years based on leaf diseases prediction and classification uses simple Convolutional neural network, region based Convolutional neural network etc. The advance and novelty of the developed model lie in its simplicity; health leaves and background images are in line with other classes, enabling the model to distinguish between diseased leaves and healthy ones from the environment by using Convolutional neural network (CNN) for our work we have used Kaggle pretrained dataset. The dataset consists of 3200 leaf images of size 256×256. The dataset is divided is divided into four classes like healthy, unhealthy. The overall composition of dataset is shown in figure 2.

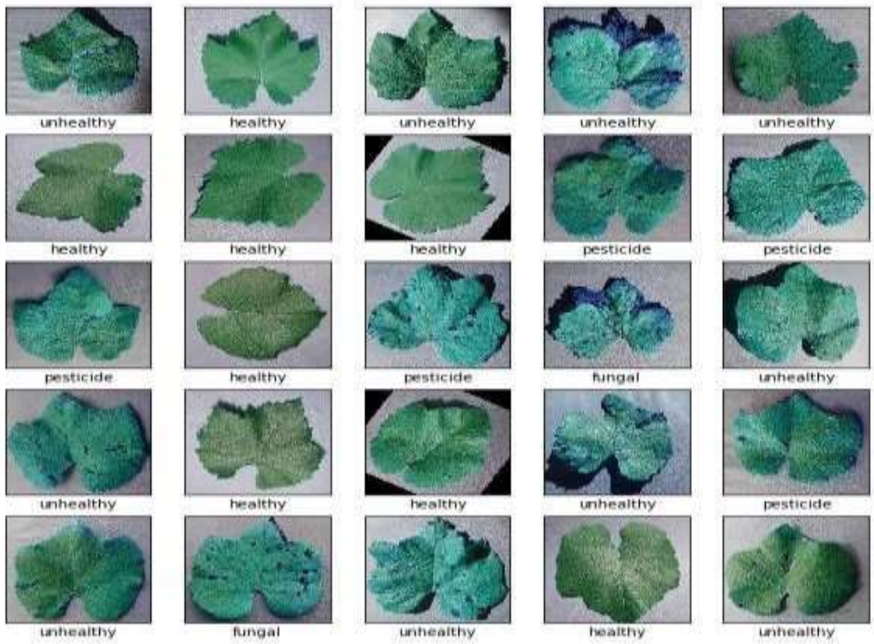

Fig 2 Overall Plant leaf Dataset

II. Background

Mohanty et al Crop diseases are a major threat to food security, but their rapid identification remains difficult in many parts of the world due to the lack of the necessary infrastructure. The combination of increasing global smartphone penetration and recent advances in computer vision made possible by deep learning has paved the way for smartphone-assisted disease diagnosis. Using a public dataset of 54,306 images of diseased and healthy plant leaves collected under controlled conditions, we train a deep convolutional neural network to identify 14 crop species and 26 diseases

Savary, Serge, et al Crop pathogens and pests reduce the yield and quality of agricultural production. They cause substantial economic losses and reduce food security at household, national and global levels. Quantitative, standardized information on crop losses is difficult to compile and compare across crops, agro ecosystems and regions. Here, we report on an expert-based assessment of crop health, and provide numerical estimates of yield losses on an individual pathogen and pest basis for five major crops globally and infood security hotspots.

Fujita, E., et al. An accurate, fast and low-cost automated plant diagnosis system has been called for. While several studies utilizing machine learning techniques have been conducted, significant issues remain in most cases where the dataset is not composed of field images and often includes a substantial number of inappropriate labels.

III Proposed Methodology

The entire procedure for developing the model for plant disease classification and prediction using Convolutional neural network (CNN)is described further in detail. The complete process is divided into several necessary stages in the subsections below, starting with image classification process using CNN.

A) Dataset

Appropriate datasets are required at all stages of plant classification and prediction starting from training phaseto evaluate the performance of recognition algorithms. Images in the dataset were grouped into four different classes. Two classes represent healthy and unhealthy, while as other two represent pesticide affected, and fungicide affected leaves.

Table1. Dataset for image classification and prediction Plant health

S.NO	CLASS
1	Healthy
2	Unhealthy
3	Pestiside
4	Fungal

B) Image pre-processing and labelling: In order to get better feature extraction, final images intend to be used as dataset for convolution neural network (CNN) were pre-processed in order to gain the consistency.

Many resources can be found by searching across the internet, but their relevance is often reliable. In the interest of confirming the accuracy of classes in the dataset, initially grouped by keywords search agriculture experts examined leaf images and labelled the images with appropriate disease acronym. As it’s known, it is important to use accurately classified images for training and validation dataset. Only in that way may an appropriate and reliable detecting model be developed. The convolution is essential building block of Convolutional neural network.

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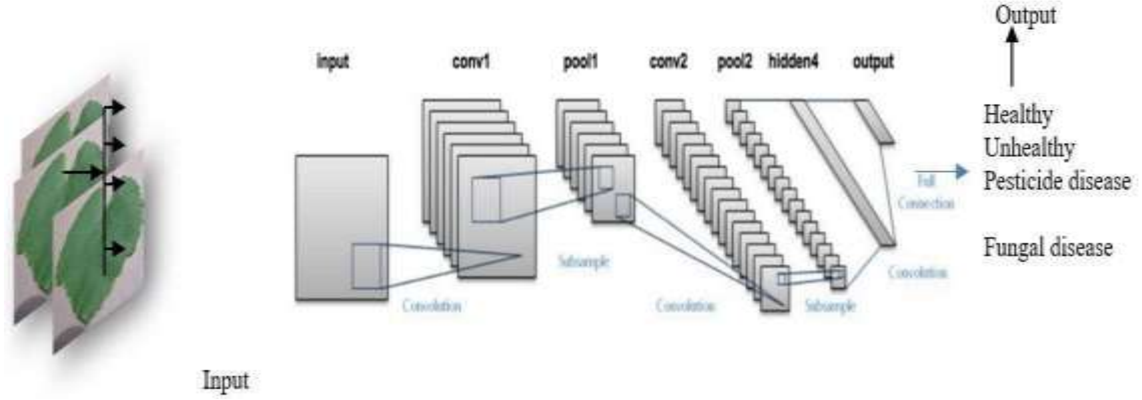

Fig 3 Convolutional Neural Network

C) Architecture Description: The CNN architecture consists of input layer, convolution layer, pooling, and output layer respectively. Here the input images of size 256*256 are fed to the input layer, and then the input will be passed to the Convolution layer. The main purpose of the convolution step is to extract features from the input image. The pooling or sub sampling layers comes after the convolution layers; it has same number of planes as the Convolutional layer. The purpose of this layer is to reduce the size of the feature map. It divides the image into blocks and performs maxpooling. Sub sampling layer preserves the relative information between features and not the exact relation.

Pooling is of three types namely minimum pooling, Max pooling, Average pooling respectively. Minimum is to choose the minimum value from the feature map, Max pooling is to select the maximum value from the feature map and average is select the average value from the feature map of an image and hence we are estimating the excellent predictions in terms of Healthy, Unhealthy, Pesticide disease, Fungal disease.

D) Machine used: A single PC was used for the entire process of training and testing the plant disease detection model described in this research work. Training of the CNN was performed in Graphics Processing Unit(GPU) mode.

IV. Simulation Results

To implement this project we have designed following modules

1) Upload Leaf Disease Dataset: using this module we will upload leaf dataset to application
2) Image Preprocessing: using this module we will read all images and then resize images to equal size and then normalize all pixel values
3) Segmentation & Features Extraction: using this module we will apply KMEANS algorithm to segment infected part of the leaf and then apply PCA features extraction algorithm to extract important features from all images
4) Train CNN Algorithm: Extracted features will be input to CNN algorithm to trained a model and this model can be applied on test images to detect and classify diseases
5) Disease Classification: using this module we will upload test images and then apply CNN model to detect disease from that image

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Fig 4 Splitting of Dataset into 80-20 (80% used for training and 20% used for testing)

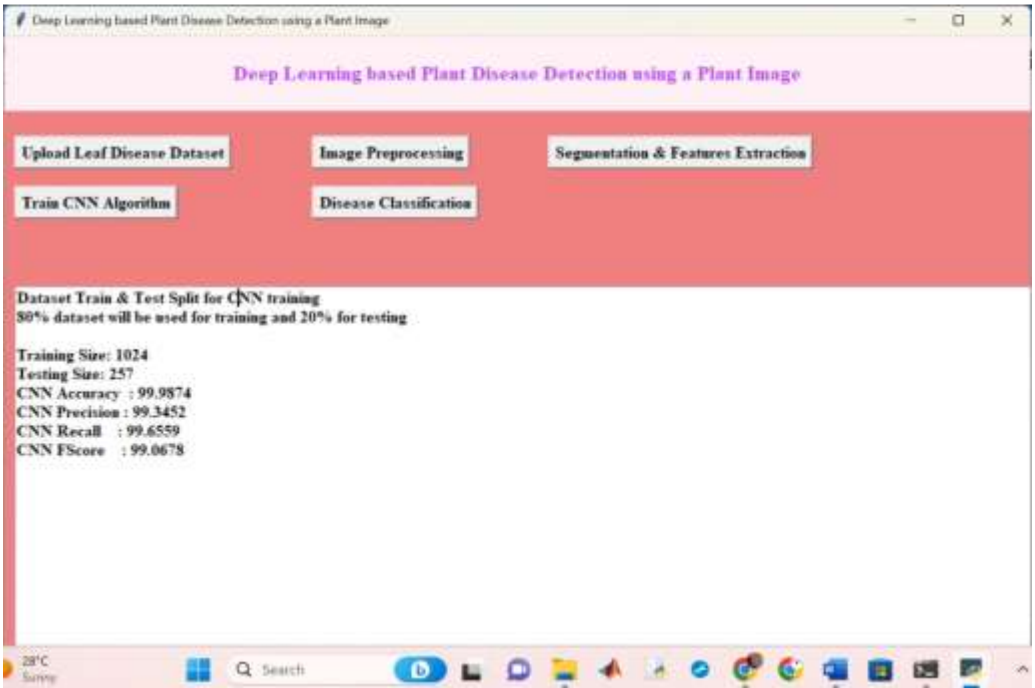

Fig 5 Performance Metrics obtained by proposed model

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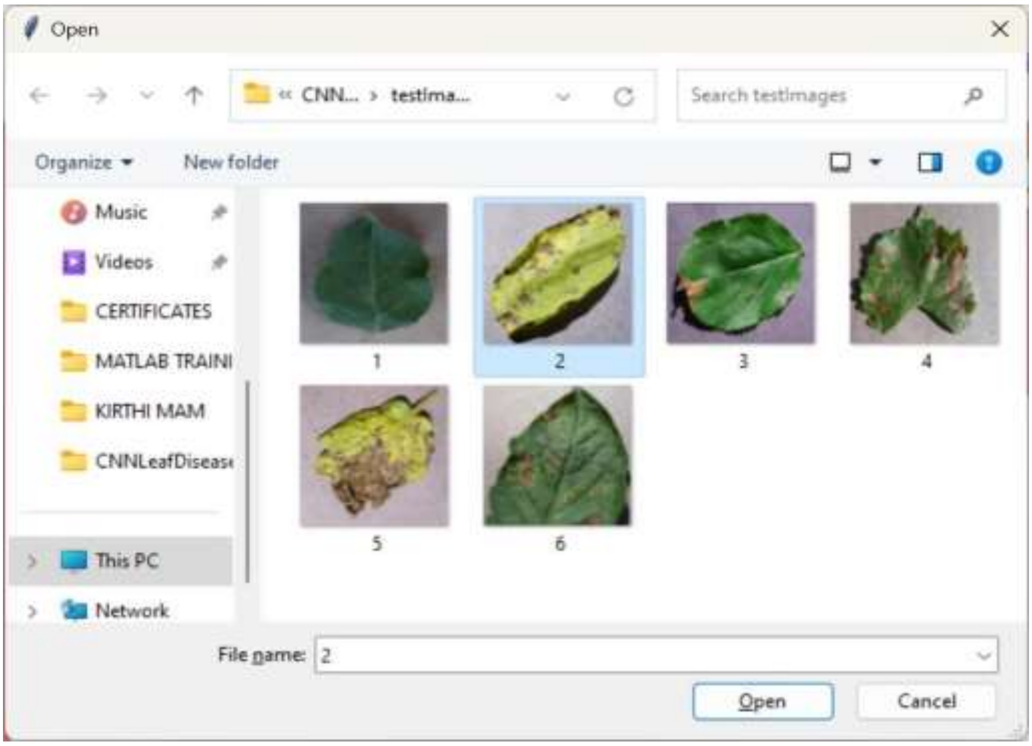

Fig 6 Uploading New Test Image

Fig 7 Segmented leaf

Fig 8 Disease is classified using CNN

V. Conclusion

Organic crop protection is not a straightforward issue. Knowledge of the crops farmed and the possible pests, diseases, and weeds is crucial. Leaves photos from healthy and sick plants are used to train our system's deep learning models for disease diagnosis. Our models are built on the architectures of convolutional neural networks. Images from a wide range of cameras and other sources were used in our detector. Our experiments and comparisons with other deep-architectures and feature extractors proved that our deep-learning-based detector accurately identified many disease categories across multiple plant species. Since healthy plants in good soil with balanced nutrition are better able to resist pests and diseases, they are not usually a major problem in organic systems. We believe our suggested approach may provide a useful suggestion to the study of agriculture.

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