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LEAF DISEASE DETECTION AND REMEDY RECOMMENDATION

V.Uma Srihitha[1], G.Tejaswi Sai Lakshmi[2], I.Mohan Kumari[3] , B.Sabarish[4] , R.Venkata Ramana[5]

[1-4]B.Tech Student , [5] Assistant Proffessor ,LIET

[1,2,3,4,5] Computer Science and System Engineering ,Lendi Institute of Engineering and Technology,Vizianagaram

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ABSTRACT

Agriculture impacts life and economic status of the people. Improper management of diseases results in annual loss of agricultural yield which will have serious effects on the quality, quantity and productivity if no proper care is taken. By using some automatic technique such as image processing, detection of leaf disease is quite significant and beneficial. The use of the most utilized deep learning classification mechanism, Convolutional Neural Network, helps in this regard. This paper proposes an innovative machine learning approach for automated leaf disease detection. By utilizing image processing and deep learning algorithms, the system analyzes leaf images taken with digital cameras or smart phones. Through training a convolutional neural network (CNN) on a comprehensive dataset containing healthy and diseased leaves, the system becomes adept at distinguishing between various disease types [1] . Leveraging tagged images of healthy and diseased leaves, our system showcases robustness and high accuracy. The automated image processing, particularly involving deep convolutional networks, ensures rapid and accurate results. The system's effectiveness will be gauged through extensive experimentation, comparing its performance against existing methods. Ultimately, this project contributes to the progress of precision agriculture and sustainable crop management practices.

***Key Words*:** Convolutional neural network (CNN), Pre-Processing, Deep Learning, Image Processing, Classification, Remedy Recommendation .

1.INTRODUCTION

In India many people are farmers and grow a different crops. Plants play a crucial role in providing energy and are a key component in addressing the global warming crisis [1]. Agriculture is the main source of livelihood and primary occupation. India is ranked second in the world agricultural production. Many people depend on manufacturing agriculture directly or indirectly. Producing agricultural high quality yield is essential for sustainable development Earth. Factors such as climatic conditions, soil conditions and diseases affect plant production. Due to population growth, political instability and changing climate conditions, the agricultural industry is looking for new and better ways to increase food production. Produce crops with better productivity and quality, we must monitor and control requirements such as temperature, humidity and light. Another major threat to food security is leaf blight. It reduces the quality and reduces the yield of the crop. Pathogens such as insects, pests, fungi, bacteria and viruses cause disease leaves. They eat the upper and lower part of the leaf, which affects whole plant gradually. For the prevention of huge agricultural loss in the future, detection of foliar diseases in the initial stage is necessarily. It helps farmers to improve crop yield which in turnover improves GDP. Identifying the condition of the plant is essential. There are leaves basic parts for disease identification. Irregular shaped black spots or spots appear above the surface of the leaf and mold can occur on surfaces in damp conditions. These patches are small in size but will start later covering the entire leaf area, resulting in rotten leaves. It is necessary to accurately detect foliar diseases in a particular one in the initial state, before basic operations plants, such as pollination, fertilization, transpiration, photosynthesis, germination, etc. are affected. Ineffective disease detection leads to inexperienced use pesticides that lead to long-term pathogen resistance, thereby reducing the crop's ability to defend itself. A precise and accurate diagnosis of foliar disease was a a significant challenge . In recent times, server based and mobile based approach for disease identification has been employed for disease identification. Several factors of these technologies being high resolution camera, high performance processing and extensive built in accessories are the added advantages resulting in automatic disease recognition [2] . Deep learning is widely used because it helps the computer learning the most appropriate functions autonomously without human intervention. A neural network is computational Model. CNN is mostly used for image recognition on storage effort and time . Unlike traditional methods which to use hand-crafted features, CNN optimizes the hidden layers filter the parameters and weights and generate the required functions solve the classification problem. CNN consists of different layers and uses different foci for identification, detect, classify and predict diseases. Provides fast, accurate and reliable results and faster treatment that reduces negative impact on harvest. Agricultural yield is higher and productivity is increased with a minimum expenses.

2. Proposed Method

Plants are susceptible to many different types of diseases. There are variety of factors which can influence plant growth, including disturbances caused by external factors such as temperature, moisture, food, light, and disease. Since we use the CNN algorithm in our model to identify disease, we employ it for good data [4]. Convolutional Neural Networks are a class of feed forward neural networks that have the ability to process multidimensional data [3] . Predicting those leaf diseases through advanced technology like machine learning enables early detection, preventing widespread crop damage. Automated systems analyze plant health data, identifying potential issues promptly. Moreover, these systems can recommend targeted remedies, optimizing agricultural practices and minimizing the need for broad-spectrum pesticides. This not only enhances crop yield but also promotes sustainable and eco-friendly farming methods.

2.1. ALGORITHM :

We are pre-processing the database by picture reshaping, re-sizing, and by changing the image to an array shape. The test picture is additionally prepared. A database comprising of 78,000 different plants has been compiled, from which any image can be selected as a test picture for a computer program. You are going to have to train your machine learning algorithm with a huge amount of data. The training database is the source from which the model learns to recognize the images of the test set. You don't want to use the same training dataset for both training and testing. Convolutional neural networks have diverse layers that are convolution, Dropout, Activation, Flatten, Convolution 2D,MaxPooling 2D. You can use them to detect objects in an image. After the model has been trained, it will then be able to determine the disease of the plant.

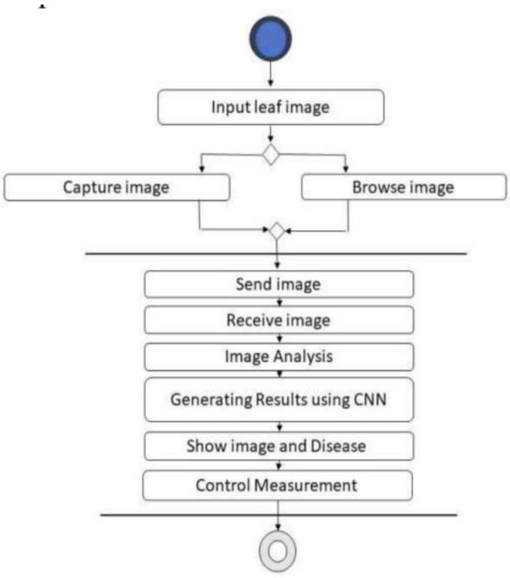

Fig-1:*Process model for detection of leaf diseases*

2.2. DATASET STUDY :

Based on species and disease, the 54303 healthy and unhealthy leaf images from the Plant Village dataset are divided into 38 categories. We attempted to predict the class of diseases by looking at more than 50,000 images of plant leaves with distributed labels from 38 classes. Prior to optimisation and model predictions, the image is shrunk to 256 x 256 pixels. We used six different augmentation techniques for increasing the data-set size. These techniques are 1)image flipping, 2) Gamma correction, 3) noise injection, 4) PCA color augmentation, 5) rotation, and 6) Scaling [5].

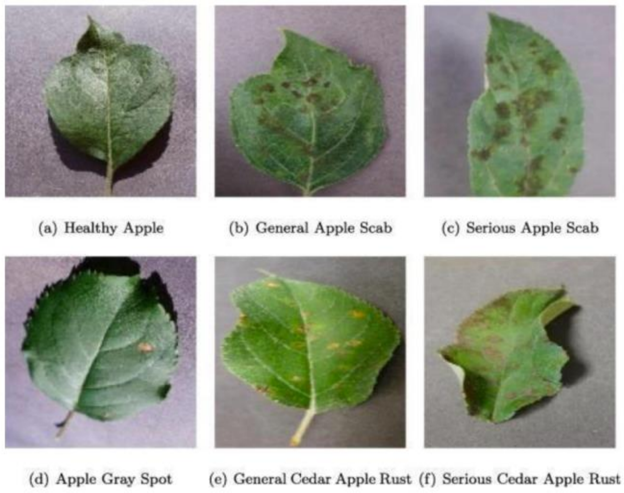

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Table -1: Plant Village Dataset

Plant Type	Diseases Classes	Total Samples	Training Samples	Test Samples	Validation Samples
Apple	Apple_scab	573	510	63	57
	Apple_black_rot	565	502	63	56
	Apple_cedar_apple_rust	250	222	28	25
	Apple_healthy	1497	1332	165	148
Blueberry	Blueberry_healthy	1366	1215	151	136
Cherry	Cherry_powdery_mildew	957	851	106	95
	Cherry_healthy	777	691	86	77
Corn	Corn_gray_leaf_spot	466	414	52	47
	Corn_common_rust	1084	964	120	108
	Corn_northern_leaf_blight	896	797	99	89
	Corn_healthy	1057	940	117	105
Grape	Grape_black_rot	1073	955	118	107
	Grape_black_measles	1258	1119	139	125
	Grape_leaf_blight	979	871	108	97
	Grape_healthy	385	342	43	38
Orange	Orange_haunglongbing	5011	4460	551	496
Peach	Peach_bacterial_spot	2090	1860	230	207
	Peach_healthy	327	291	36	33
Pepper	Pepper bell_bacterial_spot	997	807	100	90
	Pepper Bell_healthy	1478	1197	148	133
Potato	Potato_early_blight	1000	810	100	90
	Potato_healthy	1000	810	100	90
	Potato_late_blight	152	122	16	14
Raspberry	Raspberry_healthy	664	299	38	34
Soybean	Soybean_healthy	5295	4122	509	459
Squash	Squash_powdery_mildew	1669	1485	184	166
Strawberry	Strawberry_healthy	1009	898	111	100
	Strawberry_leaf_scorch	415	369	46	41

2.3. DATA PROCESSING AND IMAGE AUGMENTATION :

Image augmentation is essential for developing an effective image classifier. Although datasets may contain hundreds to thousands of training examples, there may not be enough variety to produce a trustworthy model. The many image enhancement options include scaling, angular rotation, and vertical or horizontal flipping of the image. The amount of relevant data in a dataset is increased by these additions. One finds that each picture in the Plant Village dataset is 256 x 256 pixels in size. Both data processing and image enhancement are performed using the Keras deeplearning framework.
The following are the augmentation choices used for training:
• Rotation - Randomly rotate a training image through a range of angles.
• Brightness - When training, the model is fed images of varying brightness, which helps it adapt to changes in lighting.
This augmentation technique not only prevents the model from overfitting and model loss but also increases the robustness of the model so that, when the model is used to classify real-life plant disease images, it can classify them with better accuracy [6] .
We also use other techniques like rotation, shear, height zoom, width zoom, height shift, width shift, saturation, contrast, brightness, solarize, equalize, and dropout.

2.4. METHODOLOGY:

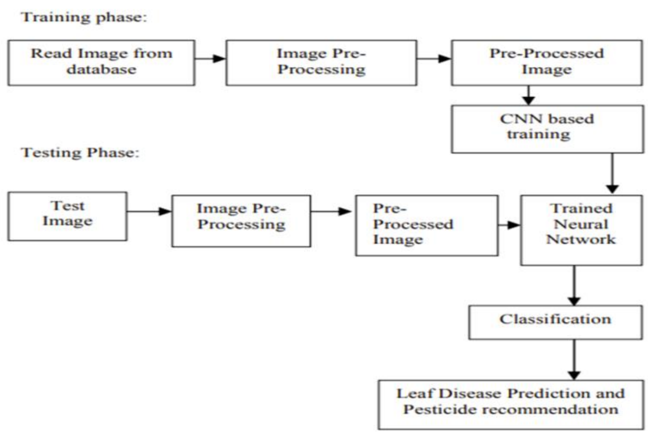

Fig-2:*System overview*

Image acquisition is the first step of a plant disease detection system. By using digital cameras, scanners, or drones, high-quality plant images can be captured. The images can also be taken from the web. Large numbers of image samples were collected from Kaggal datasets, which consists of diseased and healthy leaves. Image Preprocessing is used to increase the quality of leaf image and eliminate the unwanted noise. The segmentation process is used to partition the plant image in various segments to separate the diseased portion of the leaf [7] .
These Steps are for identifying plant diseases the entire process is mainly divided into two stages:

1.Training Phase
a)Pre-processing and segmentation of the dataset's input images will take place.
b)Image augmentation, image segmentation, and colour space conversion are all included in pre-processing.

First, a filter is used to enhance the image's digital representation. then make an array from each image. Each image name is changed to a binary field using the medical term for binarized diseases.
2.Testing Phase

After the same processes like which have been done in the training phase –
To identify each plant disease, CNN classifiers have been trained. The classifier, which has been trained to categorise various diseases in that plant, is called upon using Level 2 results. If they are missing, the leaves are considered healthy.
FINALLY Our model will recommend fertilisers to treat diseased leaves and safety precautions to prevent them.

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2.5. FEATURE EXTRACTION:

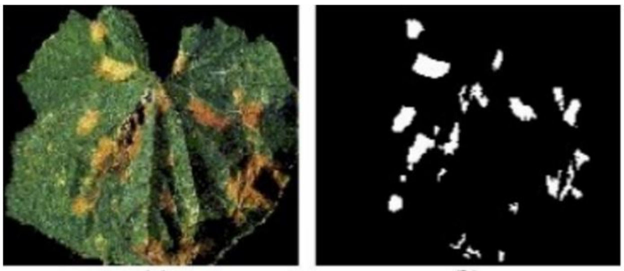
In leaf disease detection using Convolutional Neural Networks (CNN), feature extraction is a crucial step that involves identifying relevant patterns and characteristics of the leaf images that can be used to distinguish between healthy and diseased leaves.

CNN performs better than traditional learning methods and is widely used for machine vision and classification. In CNN architecture, an input layer is used to feed the input in the network, multiple hidden layers are used to analyze and finalize the most appropriate features of the input dataset, and an output layer is used to give output from the network [8].

The process of feature extraction in CNN involves several steps:

Input Image: The input image is first preprocessed to remove any noise or artifacts that could affect the accuracy of the detection model.

Convolutional Layers: The input image is then passed through several convolutional layers, which apply a set of filters to extract features at different levels of abstraction.



(a) (b)

Pooling Layers: After each convolutional layer, a pooling layer is added to reduce the
dimensionality of the output and capture the most important features.

Flatten Layer: Once the convolutional and pooling layers have been applied, the resulting output is
flattened into a vector of features.

Fully Connected Layers: Finally, the vector of features is passed through a set of fully connected
layers, which learn to classify the input image into the appropriate category (i.e., healthy or diseased).

2.6. OVERVIEW OF TECHNOLOGIES:

LIBRARIES-

NUMPY:
Multidimensional array objects and functions to manipulate them are found in the NumPy (Numerical Python) package. The Python library NumPy enables you to manipulate arrays mathematically and logically.

CV2:
The import name for the OpenCV module is cv2. An open-source library called Opencv is used for computer vision tasks like video and CCTV footage processing and picture analysis.

KERAS:
Keras is a robust and user-friendly open-source Python package. The Keras machine learning framework was created using TensorFlow, Theano, and Cognitive Toolkit. (CNTK). Quick numerical calculations are possible with a Python programme called Theano. The most popular symbolic math library used in TensorFlow neural network development.

MATPLOTLIB:
Matplotlib is a well-known Python data visualisation library. From array data, this cross-platform library creates 2D charts. It includes an object-oriented API for embedding plots in Python GUI toolkits like PyQt and WxPython Tkinter. It is compatible with Jupyter notebooks, web application servers, and other tools in addition to Python and IPython shells.

TENSOR FLOW:
The TensorFlow platform helps you implement best practices for data automation, model tracking, performance monitoring, and model retraining. Using production-level tools to automate and track model training over the lifetime of a product, service, or business process is critical to success.

2.7.TEST CASES:

TEST CONDITION	DISEASE IDENTIFIED	DISEASE DESCRIPTION	FERTILIZERS	STATUS
If the leaf is unhealthy	yes (our model will identify the leaf is unhealthy)	yes(it tells about the description of the disease)	yes(it prefers the fertilizers to use)	pass
if the leaf is healthy	yes(our model will identify it is healthy)	no(it does not contain any disease)	yes	pass
if the leaf contains multiple diseases	no(it will identify only one disease)	yes	yes	fail

Table -2: different testcases

2.8.RESULTS:

The dataset will be used to train the CNN model, which will then be used to determine whether a leaf is healthy or diseased. The developed model can recognize different types of diseased leaves out of healthy leaves and has the ability to distinguish the leaves from their surroundings in the image. After successfully detecting the leaf disease with a good level of confidence, the remedy corresponding to it i.e., the pesticide which is to be used as cure is displayed. This remedy acts as a defense mechanism against the disease. The remedy recommendation system was developed using saved pickle model by integrating it with flask. It has been observed that, compared to the existing traditional approaches, proposed CNN approach provides better accuracy and is an efficient method for diagnosis of leaf diseases.

3. CONCLUSIONS

The main goal is to identify and detect the leaf diseases accurately keeping in mind the benefits of farmers. Neural Networks help in generating a model which mimics human brain. Before neural networks, very few models were there that were actually trained in this way. A CNN model for automatic leaf disease detection using python gives an optimum accuracy of 96%. By the use of GPU for processing, accuracy and speed can be increased. The proposed method solves the problem of expensive domain expert. After successful prediction of the leaf disease, it also provides the remedy that must be taken as a cure in order to improve the health of the plant within a very less time. This model can be installed on drones so that aerial surveillances and live coverage of large agricultural fields can be done which will reduce manual work to be done and the time consumed. A camera with high resolution attached to the drone captures images of leaves which act as input for the model. For low scale farming purposes, the budget is very high, but for large scale farming it is valuable.

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