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Crop Disease Prediction Using Web Application

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Abstract: Agriculture plays a very vital role in our life. Without agriculture, the existence of human beings is not possible as it is the main source of our food supply to sustain on the earth and it also helps to grow our economy across the world. Plant disease detection is one of the most important aspects of maintaining an agriculturally developed nation. The timely and efficient detection of plant diseases is essential for a healthy and productive agricultural sector. Various diseases like Common Rust, Bacterial Spot, Leaf Mold, Mosaic Virus, Powdery Mildew and others that could affect a plant and cause farmer to lose a substantial sum yearly. Deep Learning (DL) can play a crucial role in helping farmers to prevent crop failure by early disease detection in plant leaves. In the experiment, examination conducted by Convolution Neural Network (CNN) model on dataset (which consists of images of healthy and infected leaves) to detect plant diseases and Web Application is used for real-life crop disease prediction. The proposed Web Application aims to assist farmers in detection of plant diseases by analyzing images of the plant leaves. The proposed application uses the CNN model to distinguish healthy and infected leaves. The goal is to help farmers and prevent economic loss by detecting plant diseases early.

I. INTRODUCTION

Agriculture, often considered the backbone of any nation, plays a crucial role in sustaining both human life and economic stability. But the modern era is beset by significant obstacles, chief among which is the widespread food insecurity that exists today. Crop diseases are a significant cause of food poverty and a serious danger to both food safety and economics. In order to build a strong framework for forecasting and recognizing agricultural illnesses, this research explores the field of deep learning, acknowledging the vital necessity for early diagnosis and efficient treatment.

Conventional techniques for diagnosing diseases, which frequently depend on farmer's expertise and experience, are labour- and time-intensive. The development of deep learning and artificial intelligence (AI) has opened the door to creative solutions that have simplified the challenges involved in identifying agricultural diseases. Using machine learning techniques to solve problems like feature extraction, pattern recognition, and picture categorization, smart farming stands out in this environment. This proposal introduces a deep learning-based system for crop disease identification in an attempt to support existing research. It is impossible to exaggerate the importance of deep learning in agriculture considering how it might improve crop quality and output while influencing leaves.

The importance of deep learning is immense, not to mention its growing popularity. It contributes immensely by making people's daily lives more convenient and will continue to do so in the future. The quality and yield of the crop, as well as the leaves, fruits, stems, and roots, are all impacted by plant disease. This results in a shortage of vegetable consumption around the globe. Crop diseases cause a 16% loss in crop yield annually. Smart farming uses deep learning extensively as it adapts novel algorithms, equipment, and methods in the field. Machine learning solves challenging issues in agriculture, like extracting features, transformation, pattern recognition, and image classifications. To detect crop infections and determine the type of disease, an attempt has been made in this research to develop a CNN-based approach. The goal of this proposal is to create a deep learning-based detection which is capable of producing highly accurate results.

II. LITERATURE REVIEW

In [1], An Analysis of Deep Learning Techniques for Plant Leaf Disease Detection: The Algorithm used by them was Deep Learning - Convolutional Neural Network. First they went with ML technique this methodology includes five steps Image Acquisition, Image pre-processing, Image segmentation, Feature extraction, Classification and Detection of diseases. But it failed because feature extraction was biggest challenge. So, they tried with Deep learning this includes pre-processing, Feature extraction, Classification and testing and evaluating. In this paper they used 150 different classes of 12 variety of plants with different architecture and accuracy rate also vary for each plant, for example they have tried with Traditional CNN, AlexNet, Googlenet, VGG16, VGG-19, Lenet.

In [2], Plant Disease Detection using Deep Learning: The Algorithm used by them was Deep Learning - Convolutional Neural Network. They implemented by three steps CNN detection, Dataset discussion, Model description. They designed only for 38 classes and accuracy 95%.

In [3], Plant Leaf Diseases Detection and Classification Using Image Processing and Deep Learning Techniques: A convolutional Neural Network algorithm used in this proposed method. The steps are as followed Dataset, Image preprocessing Augmentation Training Images, CNN, Classification. The objective of this project is to recognize abnormalities that occur on plants in their greenhouses or natural environment. Only 28 classes used accuracy is approximately 90%.

In [4], Plant disease detection using deep learning and image processing: The Fuzzy C-means clustering (FCM) Algorithm was used for the project, The steps included were Image Preprocessing, Segmentation, FCM Clustering, Feature Extraction, Classification. The main objective of the system is used to detect the disease in the leaf by using Image Processing using MATLAB. Experimental results obtain the Better Performance, when compared to other system.

In [5], Plant leaf disease classification using grid scratch based SVM IEEE: The SVM is used as an algorithm to develop a plant disease identification and classification system. Method used Image acquisition, Noise removal, Image segmentation, Feature extraction, Classification (SVM and grid search based SVM) detection. The accuracy of SVM classifier was 80% and when applied with Grid Search hyper parameter tuning accuracy increased to 84%.

In [6], Plant Leaf Diseases Detection and Classification Using Image Processing and Deep Learning Techniques: The dataset consists of images of all kinds of leaf diseases that could influence the three types of plants, namely tomato, pepper, and potato crops, and the pictures in the dataset are resized to 128x128 resolutions. CNN is applied to unorganized image inputs and transforms them into the correct output categories for classification. The network was trained, and the datasets were tested. Plant leaf diseases were detected and classified according to three types of plants. Developed model obtained 98.029% accuracy.

In [7], Plant Disease Detection Using Machine Learning: The proposed method includes dataset creation, feature extraction, training the classifier, and classification. The datasets of diseased and healthy leaves are trained under Random Forest to classify healthy and defective images. For extracting features of an image, the histogram of an oriented gradient (HOG) is used. Developed model achieved 70% of accuracy.

In [8], Detection of Leaf Diseases and Classification using Digital Image Processing: The proposed method contains four parts, namely image pre-processing, to determine the diseased areas. Segmentation of the leaf using K-means clustering, feature extraction, and classification of diseases Statistical Gray-Level Co-Occurrence Matrix (GLCM) features are used to extract texture features and support vector machines (SVM) for classification. This method achieved 90% accuracy.

In [9], Disease Detection of Plant Leaf using Image Processing and CNN with Preventive Measures: The proposed method includes plant leaf disease detection and preventive methods in agricultural fields using image processing and two well-known CNN models, AlexNet and ResNet-50.

First, this technique is applied to Kaggle datasets. Then the feature extraction and classification processes are performed on dataset images to detect leaf diseases using CNN models. This method achieved 97% accuracy.

In [10], Leaf and skin disease detection using image processing: In this proposed method K-Means Clustering and Support Vector Machine Algorithm is used in MATLAB through which they distinguished and detected different types of leaf and skin diseases. The framework is implemented using MATLAB and successfully detects and classified skin and leaf diseases based on their physical appearances using the K-Means Clustering and SVM algorithms. By varying the training data, we can extend the disease detection capability. The achieved accuracy is 70%.

In [11], Sunflower leaf disease detection using image segmentation based on particle swarm optimization: In this paper, author used image segmentation with particle swarm method for improving the image segmentation. Image segmentation includes object recognition & detection, feature extraction and classification. accuracy of this method is 98.0%. using different method for image segmentation will more efficient.

In [12], Paddy leaf disease detection using optimized deep neural network: In this paper, authors used Deep neural network (DNN) classification to detect paddy leaf disease and to optimize the error crow search algorithm (CSA) was used, collected images were first pre-processed and followed by segmentation, feature extraction classification. For segmentation, K-means clustering method is use. DNN was trained using deep learning technique which include pre-training step and fine-tunning step. Accuracy is 96.96%. Compared the results with SVM method and it was found that this DNN CSA was more accurate then the SVM method.

In [13], Diagnosis and classification of grape leaf disease using neural network: In this paper author used image processing and artificial intelligence techniques on images of grape plant leaf. It includes pre-processing, segmentation, lesion extraction, feature extraction and classification of disease. Two classes of disease were detected.

In [14], Maize Leaf Disease Detection and Classification Using Machine Learning Algorithms**:** In this paper, author used different supervised machine learning classification techniques such as Navie Bayes, K-nearest neighbors, Decision tree, Support vector machine and Random forest for disease detection and classification from plant leaves. All the techniques include image acquisition, image pre-processing, image segmentation, feature extraction and classification. Here images were collected from a plant site and divided into 4 classes.

The accuracy of each technique is then compared and found out that random forest has most accurate output.

In [15], Rice Leaf Diseases Recognition Using Convolutional Neural Networks: In this paper, the method used by author is convolutional neural network and the process is divided into different stages such as novel training dataset, development of a novel CNN model, deep feature extraction for training the model and finally, classification of the rice leaf disease. Dataset of 5 different leaf disease were collected. Accuracy of this method is 97.82%.

In [16], A Convolution Neural Network based approach to detect the disease in Corn Crop: In this paper, disease identification in corn crops is done by analyzing the leaves in the very early stage. Plant Village data sets are used. Data sets are trained and tested. In proposed work, they developed a CNN based model for disease identification in corn leaf and compared the performance with pre trained CNN model as well as traditional machine learning approaches. Developed model is able to achieve the accuracy of 94%.

In [17], Crop Disease Detection Using Deep Learning: In this paper, deep learning-based model is trained using public dataset containing images of healthy and diseased crop leaves. The model serves its objective by classifying images of leaves into diseased based on the pattern of defect. The implementation is done in different phases like collecting the dataset, pre-processing the dataset, training the Convolutional Neural Network (CNN) model to identify the type of crop, training CNN model to detect the disease, validation of model through obtained results. The proposed method was tested on five classes of crops and three types of crop diseases for each class.

The obtained results shows that the InceptionV3 model performs better than the MobileNet model in terms of accuracy and validation loss. Developed model is able to achieve the accuracy of 99.45%.

In [18], Detection of Plant Diseases using ResNet50 V2: In this proposed method, Artificial Neural Network (ANN), ResNet50 V2, Flask, Adam optimizers are used. The input image is Pre-processed to improve the quality of image and to remove the undesired distortion from the image.

For making predictions, Convolutional Neural Networks along with Transfer Learning is used. The labels are then extracted from the predictions and output is supplied to the webpage using Rest API. Using deep learning and transfer learning techniques we are able to achieve a higher accuracy with respect to previous researches made in the same field. Developed model is able to achieve the accuracy of 96%.

In [19], Machine Learning for Plant Leaf Disease Detection and Classification – A Review: In this proposed method, machine learning is applied to detect diseases in leaves of different plants as it analyzes the data from different aspects, and classifies it into one of the predefined set of classes.

The morphological features and properties like color, intensity and dimensions of the plant leaves are considered for classification. This paper presents an overview on various types of plant diseases and different classification techniques in machine learning that are used for identifying diseases in different plant leaves. CNN is used as classifier. Developed model is able to achieve the accuracy of 95%.

In [20], A Review of Machine Learning Approaches in Plant Leaf Disease Detection and Classification: In this proposed method, it provides a comparative analysis of various state-of-the-art ML and DL algorithms to identify and categorize plant leaf diseases. ML and DL algorithms such as Support Vector Machine (SVM), Neural Network (NN), K-Nearest Neighbor (KNN), Naïve Bayes (NB), other few popular ML algorithms and AlexNet, GoogLeNet, VGGNet, and other few popular DL algorithms respectively for plant disease categorization are used. InceptionV3 algorithm is able to achieve higher accuracy of 99.76% compared to all other DL algorithms.

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III. METHODOLOGY

The process of detecting the crop disease is presented in the block diagram shown in figure 1.

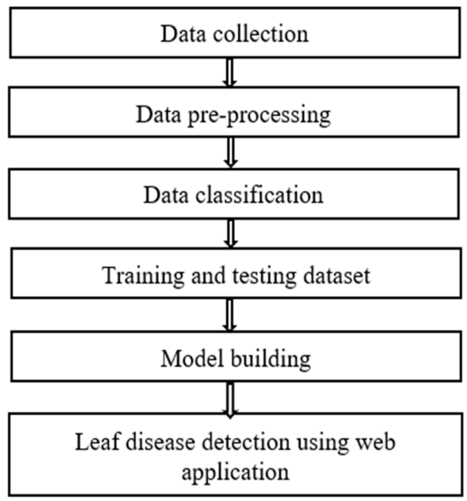

Figure 1. Block diagram of methodology

A. Input image

This method of detecting crop disease starts with collecting the input images representing different types of leaves like potatoes, tomatoes, peppers etc. These raw images can be collected using a real-time camera or mobile. For our utilize, the deep learning model was trained using a publicly accessible dataset during the testing and training phases.

B. Preprocessing

The raw images collected from the dataset might contain noises and it is essential to preprocess them before fitting them into the learning module. We apply resizing images, loading images in RGB color mode, shuffling the dataset, batching images into groups of 32 and encoding labels categorically to preprocess the image during the preprocessing phase.

C. Training and building the model

In the training and model building phase, the model undergoes two key stages. Initially, they are trained using a dataset of training images. Subsequently, the model's architecture is validated using a separate set of test images that are reserved specifically for evaluating its performance.

D. Model Construction

To build the predictive model, we apply the following steps:

1) Collecting images from the dataset.
2) Pre-process image data by resizing, loading images in RGB, shuffling, batching images into group of 32 and encoding labels categorically.
3) Form convolutional features that connect to fully connected layers. Typically, this involves flattening the features, converting them into a one-dimensional array or vector, and then connecting them to one or more fully connected layers.
4) Finally, extract the features for different classes of the input.

E. Model Evaluation

1) An optimal dataset is divided into 80% training and 20% testing images for model development and evaluation, respectively.
2) Validation data is crucial for assessing model accuracy through feature extraction and prediction.
3) Images are captured to validate detection performance, ensuring consistent and reliable results.
4) Characteristic analysis is performed to identify signs of infection, aiding in the determination of leaf health

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F. Model Performance

The performance of the model was evaluated by using the confusion matrix and classification report obtained from the model. Confusion matrix report is shown in the table 1. Later web application is used to detect disease, where the input image is taken from the dataset. It checks whether the image is healthy or not and gives the output accordingly.

Table 1: Confusion matrix report

	precision	recall	f1-score	support
Apple___Apple_scab	0.98	0.94	0.96	504
Apple___Black_rot	0.99	0.98	0.98	497
Apple___Cedar_apple_rust	0.97	0.97	0.97	440
Apple___healthy	0.98	0.95	0.97	502
Blueberry___healthy	0.96	0.98	0.97	454
Cherry_(including_sour)___Powdery_mildew	1.00	0.98	0.99	421
Cherry_(including_sour)___healthy	0.98	0.99	0.99	456
Corn_(maize)___Cercospora_leaf_spot Gray_leaf_spot	0.96	0.89	0.92	410
Corn_(maize)___Common_rust_	1.00	0.99	0.99	477
Corn_(maize)___Northern_Leaf_Blight	0.92	0.97	0.95	477
Corn_(maize)___healthy	0.99	1.00	0.99	465
Grape___Black_rot	0.96	0.99	0.98	472
Grape___Esca_(Black_Measles)	0.99	0.98	0.99	480
Grape___Leaf_blight_(Isariopsis_Leaf_Spot)	1.00	0.99	0.99	430
Grape___healthy	0.99	1.00	0.99	423
Orange___Haunglongbing_(Citrus_greening)	0.99	0.99	0.99	503
Peach___Bacterial_spot	0.98	0.97	0.98	459
Peach___healthy	0.96	1.00	0.98	432
Pepper,_bell___Bacterial_spot	0.96	0.98	0.97	478
Pepper,_bell___healthy	0.90	0.99	0.94	497
Potato___Early_blight	0.98	0.99	0.98	485
Potato___Late_blight	0.97	0.94	0.95	485
Potato___healthy	1.00	0.90	0.95	456
Raspberry___healthy	0.98	0.99	0.98	445
Soybean___healthy	0.99	0.99	0.99	505
Squash___Powdery_mildew	0.98	1.00	0.99	434
Strawberry___Leaf_scorch	1.00	0.98	0.99	444
Strawberry___healthy	0.99	0.99	0.99	456
Tomato___Bacterial_spot	0.97	0.97	0.97	425
Tomato___Early_blight	0.90	0.93	0.92	480
Tomato___Late_blight	0.89	0.94	0.91	463
Tomato___Leaf_Mold	0.95	0.99	0.97	470
Tomato___Septoria_leaf_spot	0.98	0.81	0.89	436
Tomato___Spider_mites Two-spotted_spider_mite	0.88	0.98	0.93	435
Tomato___Target_Spot	0.93	0.91	0.92	457
Tomato___Tomato_Yellow_Leaf_Curl_Virus	0.98	0.99	0.98	490
Tomato___Tomato_mosaic_virus	0.98	0.96	0.97	448
Tomato___healthy	0.99	0.97	0.98	481
accuracy			0.97	17572
macro avg	0.97	0.97	0.97	17572
weighted avg	0.97	0.97	0.97	17572

The precision, recall, and F1-score values in the classification report for the model are derived from the confusion matrix using the terms—True Positive (TP), True Negative (TN), False Positive (FP), and False Negative (FN). There are four ways to determine:

1. TN (True Negative): Both the case and the prediction were negative.
2. TP (True Positive): The case was favorable and was anticipated to be favorable.
3. FN (False Negative): The case was affirmative, but the result was projected to be negative.
4. FP (False Positive): The result was negative but was expected to be positive.

Diseased leaf Healthy leaf

Figure 2: Sample images present in the data set

IV. CONCLUSION

Crop disease detection and classification problems are crucial and challenging problems in agriculture worldwide. Experiment is conducted on plant disease dataset which is publicly available. In conclusion, crop disease detection using Convolutional Neural Networks (CNNs) is a promising approach to efficiently identify and manage plant diseases. By leveraging CNNs, we can accurately classify images of crops to determine if they are healthy or infected. This technology has the potential to revolutionize agriculture by enabling farmers to detect diseases early, take timely actions to mitigate crop damage, and ultimately improve crop yield and quality. Integrating this technology into a user-friendly application can further empower farmers with real-time disease diagnosis and treatment recommendations, enhancing agricultural productivity and sustainability. The web app development is used to correctly detect plant leaf disease. The web application provides a smart agriculture system for detecting the disease. Hence, the proposed method produced better outcomes for detecting disease.

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