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PLANT PATHOLOGY TREATMENT SYSTEM USING MACHINE LEARNING

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Abstract: Crop diseases are a serious threat to food security, but identifying them quickly is still difficult in many parts of the world due to a lack of necessary infrastructure. Indian farmers face a significant decline in productivity because they don't select the appropriate crop based on their soil's needs. Precision agriculture is a cutting-edge farming method that uses research data on soil properties, soil types, and crop yield data gathering to advise farmers on the best crop to grow based on site-specific factors. Computer-assisted disease diagnosis has been made possible by recent developments in deep learning's computer vision.

Our system uses a deep convolutional neural network to identify 3 crop species and 15 diseases using a public dataset of 20,000 photos of sick and healthy plant leaves taken under controlled conditions. Our algorithm has an accuracy of about 90% for a dataset with three different crops. This technology can distinguish between 15 diseases with accuracy. The method of training deep learning models on progressively larger and publicly accessible image datasets presents a clear path for computer-assisted crop disease diagnosis on a worldwide scale.

Index Terms - **CNN, Disease Treatment, Fertilizer Recommendation, Image Classification, KNN, Plant Pathology Treatment, Random Forest, SVM.**

I. INTRODUCTION

India is one of the oldest nations that currently engages in agricultural production. However due to globalization, agricultural practices have recently undergone a significant evolution. India's agricultural sector has been impacted by a number of causes. To improve health, numerous innovative technologies have emerged. The Plant Pathology Treatment System is one such approach. In the Plant Pathology Treatment System, numerous inputs and databases are used to identify any diseases that exist in plants or crops. By utilizing several machine learning techniques like SVM, CNN, and Random Forest, it also delivers specific Illness Information and its Cure. Plant Pathology Treatment System offers the benefit of effective input, output, and superior farming decision-making.

The process has three main steps: Data collection, Data preparation and Image analysis. The data comes from the Plant village dataset, which has images of leaves from Potatoes, Tomato and Bell Pepper plants. The dataset has 15 kinds of plant diseases and healthy images. The images are resized and enhanced before being fed to the model that classifies them. The system has four layers: Disease Detection, which checks if a leaf image shows a healthy or diseased plant. Soil Classification, which identifies the soil type based on its Temperature, Humidity and Moisture. Crop Yield Prediction, which suggests the best crops to grow based on the previous results. And Fertilizer Recommendation, which advises the appropriate fertilizers based on the previous results.

The remainder of the paper is as follows. Section 2 discusses the literature that is reviewed for this work. Section 3 and 4 is about the Algorithms and Proposed System which are used in this project. Section 5 is about the Implementation process of the project. And finally, Section 6 talks about the Results and Conclusion along with the Future Scope.

II. LITERATURE REVIEW

There are many existing walks in this area. The paper cited describes how to find plant leaf diseases using image processing methods that include image capture, image preparation and image division. It also discusses the methods used for suggesting crops and fertilizers.

[1] In 2018, Shima Ramesh, et al.[2] presented Plant Disease Detection Using Machine Learning. The project aimed to classify healthy and diseased leaves images using Random Forest by training on both types of datasets. The HOG method was utilized for feature extraction with plain backgrounds, resulting in a maximum accuracy of 70.14%.

[2] Sammy V. Militante, et al.[5] proposed Plant Leaf Detection and Disease Recognition using Deep Learning in 2019. This paper showed an effective way to find multiple diseases in plants like apple, corn, grapes, potato, sugarcane, and tomato. The system used a dataset of 35,000 images to train deep learning models, getting 96.5% accuracy in finding if diseases were present or not and 100% accuracy in identifying plant type and disease kind.

[3] Jithy Lijo, et al.[12] proposed Analysis of Effectiveness of Augmentation in Plant Disease Prediction using Deep Learning in 2021. This paper evaluated three well-known techniques (InceptionV3, DenseNet169, and ResNet50) with and without augmentation. Different quality measures, such as precision, recall, accuracy, and F1-score, were used. ResNet50 was the best model with an accuracy of 98.2% using augmentation and 97.3% without augmentation.

[4] LILI LI1, et al.[4] proposed Plant Disease Detection and Classification by Deep Learning in 2021. This paper discussed the current issues and opportunities for finding plant leaf disease using deep learning and advanced imaging methods. They highlighted the need for collecting large datasets with high diversity, using data augmentation and transfer learning to increase classification accuracy, and showing CNN activation maps.

[5] S. Pudumalar, et al.[8] proposed the Crop Recommendation System for Precision Agriculture in 2016. This paper addressed the problem by suggesting a recommendation system that used an ensemble model with a majority voting method. This involved using Random tree, CHAID, K-Nearest Neighbor, and Naive Bayes as learners to correctly and quickly recommend a crop based on site-specific parameters.

[6] In 2017, Apeksha Thorat, et al.[9] presented An IoT Based Smart Solution for Leaf Disease Detection. This paper included various features such as detecting leaf disease, implementing a server-based remote monitoring system, and utilizing sensors to measure humidity, temperature, and soil moisture instead of relying on manual checks. The sensor network was deployed in various locations on the farms, and a Raspberry PI (RPI) was utilized as a controller to manage all the sensors.

[7] Kaushik Chandra Mitra, et al.[7] proposed Soil Classification using Machine Learning Methods and Crop Suggestion Based on Soil Series in 2018. This paper developed a model to estimate the soil series and recommend appropriate crops based on the land type. To classify the soil, several machine learning algorithms such as weighted k-Nearest Neighbor (k-NN), Bagged Trees, and Gaussian kernel-based Support Vector Machines (SVM) were used.

[8] Apurva Save, et al.[10] proposed Plant Disease Detection and Fertilizer Suggestion in 2022. This paper suggested a deep learning-based model, which was trained using a dataset of images of healthy and diseased crop leaves. The model was made to categorize the images of leaves into diseased classes based on the pattern of defect.

[9] In 2021, S. Nandhini, et al.[11] presented Analysis on Prediction of Plant Leaf Diseases using Deep Learning. In this paper, the system was capable of processing images of plants and detecting common diseases. The training set comprised 11,942 images, and the validation set was 35% of the training set, with a total of 6,421 images.

[10] In 2020, Garima Shrestha, et al.[1] suggested a Convolutional Neural Network (CNN) technique for detecting plant disease using a machine learning algorithm. In the research done, The model was trained on a dataset consisting of 15 cases, 12 of which were of diseased plant leaves. The test accuracy was obtained as 88.80%, and different performance metrics were derived for the same. The total computational time was approximately 30 minutes, including 3 minutes of pre-processing the data. Therefore, the model was limited to finding out the disease.

[11] In 2019, Devdatta A. Bondre, et al.[6] presented a prediction of Crop Yield and Fertilizer Recommendation using Machine Learning algorithms. In the research done, A brief analysis of crop yield prediction using machine learning techniques was presented. The SVM algorithm proved to be 99.47% accurate compared to the Random Forest algorithm. However, most of the data was inputted manually, so there was no option available for automation.

[12] Melike Sardogan, et al.[3] proposed Plant Leaf Disease Detection and Classification based on CNN with LVQ Algorithm in 2018. In this study, the dataset had 500 images of tomato leaves with four signs of diseases. The experimental results confirmed that the suggested method effectively identified four different kinds of tomato leaf diseases.

[13] Nikita Goel, et al.[13] proposed a Prediction Model for Automated Leaf Disease Detection & Analysis in 2020. In this paper, The test set was used to check if an image entered into the system had a disease. If yes, the disease was estimated and prevention of plant disease was suggested automatically. The accuracy of the results generated using different cluster sizes was improved experimentally with image segmentation.

[14] In 2021, Rubini PE, et al.[14] presented a Deep Learning model for early prediction of plant disease. In this paper, A deep learning model was proposed in this study, which accurately classified any leaf image as having a disease or not and provided the type of disease. The images of tomato plants were drawn from the Plant Village dataset, and pre-trained models like VGG16 and Dense Net were used for training the model through transfer learning.

[15] In 2018, B.K. Singh, et al.[15] presented Disease Manifestation Prediction from Weather Data Using Extreme Learning Machine In this paper, the late blight disease in potatoes was predicted in this study with the help of weather parameters using a new approach. Experiments were carried out on the AICR potato database, with different activation functions being tested. Satisfactory accuracy of 91.5% was achieved with the radial basis function.

III. PROPOSED METHODOLOGY

Plant Pathology Treatment System is a system where the disease of a plant is being analyzed, validated and identified by applying Image Classification and Conventional Neural Network (CNN) Algorithm. In addition to identification of diseases, it also suggests its solution by recommending the suitable crops and fertilizers to grow according to the condition of the soil. These both recommenders are supported by training and testing models using Random Forest, KNN Algorithm and SVM Algorithm respectively. It widely helps for the farmers in rural areas that face problems while growing crops and have to bear losses.

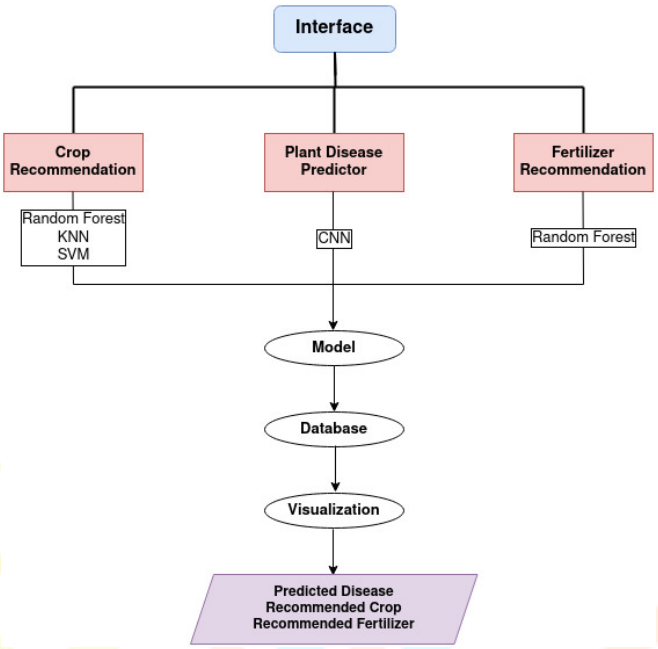

Fig 1. Block Diagram of Proposed System

As shown in the above Figure 1, the Proposed System has an Interface which is developed using the Streamlit library of Python. This interface is linked with the trained and tested models of Disease Detection, Crop Recommender and Fertilizer Recommender. The Data is acquired by compilation of various diseased plant leaves pictures as well as the data regarding Soil, Crops and Fertilizers which is stored in MySQL Database. The output of those models are stored, the data is compared and visualized and finally the result is shown in the form of Predictions and Recommendations.

Following are the main modules of the Plant Pathology Treatment System:
1. Crop Recommendation
2. Plant Disease Prediction
3. Fertilizer Recommendation

[A] Crop Recommendation:
Crop Recommender is used for identifying suitable crops according to the inputs given in the following parameters for the soil which are Nitrogen (N), Phosphorous (P), Potassium (K), Temperature, Humidity, pH Levels and Rainfall. For this module, there are 3 different algorithms applied which are Random Forest, KNN and SVM Algorithms which provide separate sets of output.

[B] Plant Disease Prediction:
Plant Disease Predictor is used for identifying and determining crop disease by analysing the plant leaf image using Image Classification and Convolutional Neural Network (CNN) Algorithm. It also visualizes the comparison of 3 crops by the number of identified diseases.

Fig. 2 depicts a block diagram that illustrates the Input Dataset, Image Acquisition, Image pre-processing, and Classification.

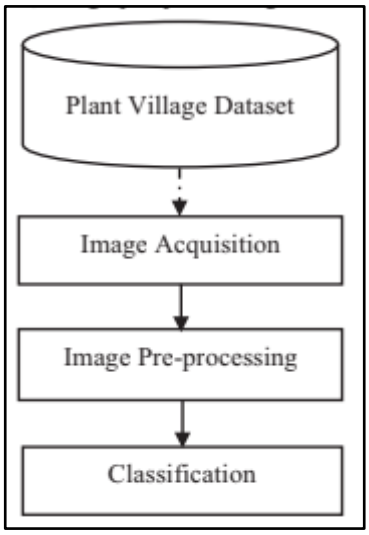

Fig 2. Plant Leaf Detection and Disease Recognition Process

a] Data Acquisition:
An Image dataset sourced from the Plant Village repository was utilized to train the model. The plant disease images were acquired by downloading a zip file from the repository, extracting it and subsequently loading it into the system dataset. The dataset consists of approximately 20,000 images belonging to 15 different plant disease classes, spread across 3 plant varieties.

b] Image Pre-Processing:
The pre-processing of images involves reducing their size and cropping them to a predetermined input. Additionally, it enhances the images to meet the desired color scale. For this study, the images were resized and converted to a 96x96 resolution after color processing.

c] Classification:
In the feature extraction process, convolutional and pooling layers are used for feature extraction, while fully connected layers are used for classification. The classification process involves identifying the presence of plant disease on the leaf, categorizing the specific type of disease, and recognizing the plant variety.

[C] Fertilizer Recommendation:
Fertilizer Recommendation is used to get cure for the disease predicted from the Plant Disease Predictor. This module is further divided in 2 types:
1] Diseased Based - It takes input from prediction of CNN Algorithm having parameters Crop Select and Disease Select respectively.
2] Overall Based - It takes input manually having parameters Temperature, Humidity, Moisture, Soil Type, Crop Type, Nitrogen (N), Phosphorous (P) and Potassium (K) levels.

Libraries used:
Streamlit, pandas, pickle, sklearn, Tensorflow, Keras, Numpy, etc.

Dataset:
The dataset extracted from PlantVillage repository contains over 20000 images which comprises Healthy and Diseased plant leaves. These pictures are obtained from 3 crop species that are Potato, Tomato and Bell Pepper.

Below is the classification of the dataset according to the number of leaf images:

Table 1. Classification of Dataset [16]

Sr. No.	Plant Disease	Number of Images
1.	Bell Pepper - Bacterial Spot	997
2.	Bell Pepper - Healthy	1478
3.	Potato - Early Blight	1000
4.	Potato - Healthy	152
5.	Potato - Late Blight	1000
6.	Tomato - Target Spot	1404
7.	Tomato - Mosaic	373

	Virus	
8.	Tomato - Yellow Leaf Curl Virus	3209
9.	Tomato - Bacterial Spot	2127
10.	Tomato - Early Blight	1000
11.	Tomato - Healthy	1591
12.	Tomato - Late Blight	1909
13.	Tomato - Leaf Mold	952

Fig 3. Dataset of Leaf Images [16]

IV. RESULTS AND DISCUSSION

We introduced a Machine Learning based Plant Pathology Treatment System in this paper. Using various algorithms such as Convolutional Neural Network, Random Forest, KNN and SVM, the system was developed to identify the disease, analyze its solution and recommend suitable fertilizers to cure such diseases. The dataset used in this study consisted of approx 20000 images of plant leaves which consists of 3 different crops species having Healthy and Diseases leaves. The high accuracy achieved by the proposed system demonstrates the effectiveness of Deep Learning in recognizing and classifying plant diseases. The system is capable of accurately identifying and classifying the health status of the crop as well as recommending the cure for the identified disease. This makes it very useful and beneficial for the improvement of farming efficiency.

Table 2. Accuracy Comparison of every block with its algorithms

	Crop Recommendation	**Disease Prediction**	**Fertilizer Recommendation**
CNN	NA	94%	NA
RF	100%	NA	95%
KNN	98%	NA	NA
SVM	99%	NA	NA

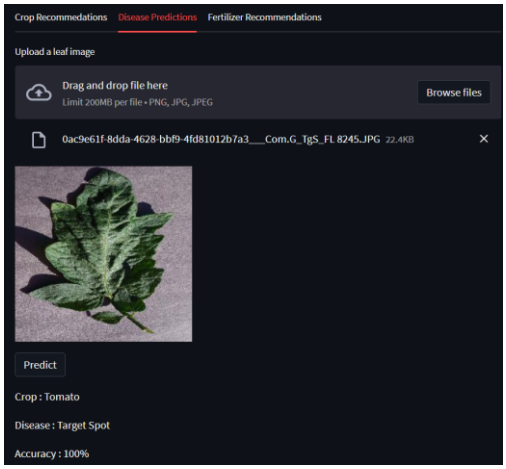

Fig 4. GUI of Plant Disease Prediction System

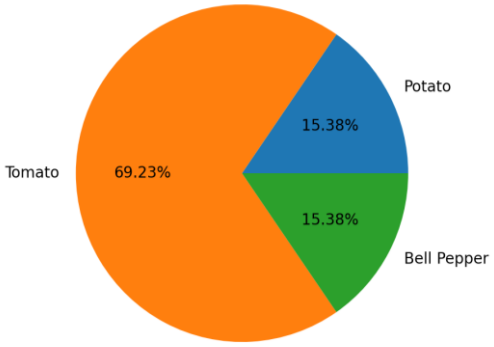

Fig 5. Plot of number of diseases detected in each plant

V. CONCLUSION AND FUTURE SCOPE

In this study, the proposed system has achieved desirable and promising results in each provided module. This system has attained 94% accuracy on the dataset containing three different crops. This system accurately distinguishes between 15 diseases. It also provides crop recommendations based on soil characteristics with the help for three different algorithms gaining variation in the recommendations and fertilizer recommendations on the same as well as the for the diseased crops that are predicted by the system.

The main focus of this study was to utilize the CNN model to predict the pattern of plant diseases by analyzing images from both the given dataset and historical datasets. The predictions are categorized into three types: healthy, early blight, and late blight. As this system covers various types of plant leaves, it enables farmers to discover and identify new plants, aiding them in deciding which crop to cultivate. Additionally, the system considers past production data, providing the farmer with valuable insights into the demand and cost of various plants in the market.

The future scope is this system can be training the model with a dataset containing more crops and diseases. Gathering and creating custom datasets favouring local crops which may provide variations in the diseases according to the local climate and conditions. Increasing the number of epochs specified in the current system to increase the overall accuracy of the trained model. Developing a mobile based application for real time uses this proposed system which will provide more efficiency.

REFERENCES

[1] Plant Disease Detection using CNN - Garima Shrestha, Deepshikha, Majolica Das, Naiwrita Dey. Applied Signal Processing Conference (ASPCON) [Issue-2020], IEEE.

[2] Plant Disease Detection Using Machine Learning - Shima Ramesh, Mr. Ramachandra Hebbar, Niveditha M, Pooja R, Prasad Bhat N, Shashank N, Mr. P V Vinod. 2018 International Conference on Design Innovations for 3Cs Compute Communicate Control, IEEE.

[3] Plant Leaf Disease Detection and Classification based on CNN with LVQ Algorithm - Melike Sardogan, Adem Tuncer, Yunus Ozen. (UMBK'18) 3rd International Conference on Computer Science and Engineering, IEEE.

[4] Plant Disease Detection and Classification by Deep Learning - Lili Li, Shujuan Zhang, Bin Wang. IEEE Access (Vol 9 – Issue 2021), IEEE.

[5] Plant Leaf Detection and Disease Recognition using Deep Learning - Sammy V. Militante, Bobby D. Gerardo, Nanette V. Dionisio. 2019 IEEE Eurasia Conference on IOT, Communication and Engineering, IEEE.

[6] Prediction of Crop Yield and Fertilizer Recommendation using Machine Learning Algorithms - Devdatta A. Bondre, Mr. Santosh Mahagaonkar. International Journal of Engineering Applied Sciences and Technology (IJEAST), 2019, Vol. 4, Issue 5, ISSN No. 2455-2143, Pages 371-376.

[7] Soil Classification using Machine Learning Methods and Crop Suggestion Based on Soil Series - Sk Al Zaminur Rahman, Kaushik Chandra Mitra, S.M. Mohidul Islam. 2018 21st International Conference of Computer and Information Technology (ICCIT), IEEE.

[8] Crop Recommendation System for Precision Agriculture - S. Pudumalar, E. Ramanujam, R. Harine Rajashree, C. Kavya, T. Kiruthika, J. Nisha. 2016 IEEE Eighth International Conference on Advanced Computing (ICoAC), IEEE.

[9] An IoT Based Smart Solution for Leaf Disease Detection - Apeksha Thorat, Sangeeta Kumari, Nandakishor D. Valakunde. 2017 International Conference on Big Data, IoT and Data Science (BID), IEEE.

[10] Plant Disease Detection and Fertilizer Suggestion - Apurva Save, Aksham Gupta, Sarthak Pruthi. Divyanjana Nikam, Prof. Dr. Shilpa Paygude. International Journal for Research in Applied Science & Engineering Technology (IJRASET), Volume 10, Issue 2, Feb 2022.

[11] Analysis on Prediction of Plant Leaf diseases using Deep Learning - S. Nandhini, Dr K. Ashokkumar. 2021 International Conference on Artificial Intelligence and Smart Systems (ICAIS-2021), IEEE.

[12] Analysis of Effectiveness of Augmentation in Plant Disease Prediction using Deep Learning - Jithy Lijo. Fifth International Conference on Computing Methodologies and Communication, 2021 (ICCMC 2021), IEEE.

[13] Prediction Model for Automated Leaf Disease Detection & Analysis - Nikita Goel, Dhruv Jain, Adwitiya Sinha. 8th International Advance Computing Conference, 2018 (IACC), IEEE.

[14] Deep Learning model for early prediction of plant disease - Rubini PE, Dr. Kavitha P. 3rd International Conference on Intelligent Communication Technologies and Virtual Mobile Networks, 2021 (ICICV 2021), IEEE.

[15] Disease Manifestation Prediction from Weather Data Using Extreme Learning Machine - B.K. Singh, R.P. Singh, Tejasvee Bisen, Shweta Kharayat. 8th International Advance Computing Conference, 2018 (IACC), IEEE.

[16] Plant Village Dataset from Kaggle - https://www.kaggle.com/datasets/emmarex/plantdisease