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AI-Based Plant Disease Detection and Treatment Recommendation Using Mobile Application

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ABSTRACT

Agriculture is an important part in sustaining the global population and its food security. Nevertheless, the problem of plant diseases is a significant provision, and it has led to massive losses and losses to farmers. Plant diseases are difficult to detect, and their timely and correct detection is necessary to minimize the damage to crops and apply efficient treatment strategies. Conventional disease identification is based on human visual inspection by the farmers/agricultural expert which may be time consuming, subjective and inaccessible in the rural regions. In the environment where artificial intelligence and deep learning technologies develop, automated detection of plant diseases through the analysis of images has become one of the solutions. This study presents a proposal of an AI system which detects and recommends treatments of diseases in plants based on images of plant leaves using deep learning models. The training of the system is carried out with the use of a labeled dataset of several plant species, as well as diseases, categories. MobileNet-V2 and EfficientNet-B7 are two of the pretrained convolutional neural networks employed in the process of model training and assessment as they exhibit high performance in image classification challenges. The trained model becomes a part of a mobile application based on Flutter, where the user can upload or capture an image of the leaf to be diagnosed in real-time. The system then offers treatment suggestions based on a structured knowledge base in the form of a JSON file after detection of a disease. Also, the Google Gemini API offers elaborated explanations and directions to enable the user get a clearer picture of the disease and how it can be treated, and so the system can be utilized in real time agricultural purposes.

Keyword: - Plant Disease Detection, Deep Learning, MobileNetV2, EfficientNet-B7, Flutter Mobile Application, Agriculture AI, Crop Disease Classification.

1. INTODUCTION

Agriculture is very vital in global food security and sustenance of livelihood of millions of individuals. Nevertheless, plant diseases continue to be a significant problem to farmers since they cause a significant decrease in crop yield and quality. Bacteria, fungi, viruses, or other adverse environmental factors can cause these diseases. In case of late detection, the plant diseases can spread within the fields and cause significant agricultural losses. Conventional methods of disease detection are centered on the manual examination of the plant leaves by farmers or the agricultural experts which could be time consuming, need specialized skills and also inaccurately diagnose the disease. The development of the technologies of artificial intelligence and deep learning made image-based automated detection of plant diseases an efficient solution.

Convolutional Neural Network (CNNs) are extensively applied in image classification and have demonstrated great capability with regard to disease detection in plants based on leaf images. The proposed research is an AI-powered plant disease detection and treatment recommendation system that classifies the plant disease with the help of pretrained deep learning models like MobileNetV2 and EfficientNet-B7 based on leaf images. The trained model is provided as a part of a mobile application, which allows farmers to capture or upload plant leaf images in real-time to diagnose the disease in real-time. Treatment suggestions and preventive actions are also offered by the system based on structured database and generates elaborate explanations via the Google Gemini API which assists farmers to identify the diseases at an early stage and enhance the crop controlling measures.

The key contributions of the research are:

- Creation of a deep learning-based model of classifying plant diseases.
- Training of CNN architectures to better accuracy.
- Application of the trained model to a mobile application to be used in real-time.
- Treatment recommendation of identified diseases.

- Cognitive support of better user explanation by AI-assisted system of explanation.
- The solution that is proposed will equip farmers with a convenient, effective, and smart device to detect diseases in crops and manage them early on.

1.1 Problem Statement

The number of plant diseases has a high influence on the productivity of agriculture and food security of the world. Lack of accessibility to agricultural experts and absence of appropriate diagnostic tools are some of the challenges that farmers usually encounter in early detection of diseases. The conventional methods of detecting have been based on manual visual inspection which is time consuming and is subject to errors. The existence of machine learning approaches does not imply that they are all applicable to the practice of their treatment, and many do not provide guidance. Thus, a solution of an artificial intelligence-based system that identifies diseases in plants and offers treatment options via a mobile app to aid farmers in real-time is suggested.

1.2 Objectives

The main goal of the research is to create a plant disease detection and treatment recommendation system based on the AI which will help the farmer to detect and treat the disease of the plant as fast and as precise as possible with the help of the mobile technology.

The project objectives will be as follows:

- To sample and tabulate a collection of healthy and diseased plant leaf images of the Plant-Village dataset[13] to be used to train deep learning models.
- To pre-process and enhance the data set in order to enhance the strength and generalization capability of the machine learning programs.
- To train and test pretrained convolutional neural network models which can classify plant diseases and they include MobileNetV2 and Efficient-Net -B7.
- To incorporate the trained deep learning model into a mobile application with the Flutter framework in real-time disease detection.
- To create a treatment recommendation module to offer disease management recommendations through a structured knowledge database.
- To improve the user experience by creating clear explanations and recommendations with the help of the Google Gemini API.

The aim was to create a system that can deliver quick and reliable disease detection that can be used in a real-life agricultural setting.

2. SYSTEM ARCHITECTURE AND DESIGN

The Proposed system architecture demonstrates the entire workflow of the AI-based Plant Disease Detection and Treatment Recommendation System, which is aimed at helping farmers to detect plant illnesses and receive appropriate treatment recommendations. The system combines the acquisition and preprocessing of images, the use of deep learning to detect the disease, and recommend treatment to enhance accuracy and use of the system in the actual farm setting.

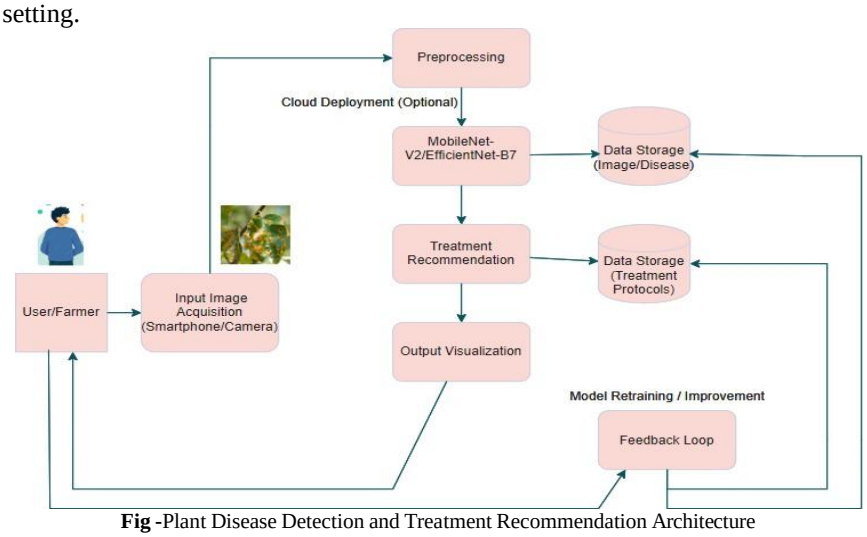

Fig -Plant Disease Detection and Treatment Recommendation Architecture

2.1 User / Farmer Interaction

The system starts by connecting with the mobile application in which the user or farmer interacts with the application. The smartphone camera also allows farmers to take pictures of plant leaves directly within their farms or to use the images that they have already taken, but stored in their phone gallery. This is a mobile based

strategy that will make the system readily available to the farmers and be applicable in the agricultural setting without the need to purchase any specific equipment.

2.2 Image Acquisition

The image taking module captures images of plants leaves using the smartphone camera. Such images can hold healthy or diseased leaves of varieties of plants. The image quality of the captured image is also significant in proper detection of the disease since the model studies the visual characteristics of color changes, texture, and spots in the leaf.

2.3 Image Preprocessing

Image preprocessing is done prior to the analysis of the images with the deep learning model in order to enhance the quality and compatibility of the input data. The operations involved in this step include image resizing, image normalization, image noise reduction, and conversion of the images into different formats. Preprocessing makes it possible to have all images in the same format that the convolutional neural network needs and enhances the accuracy of the results obtained.

2.4 Detection of diseases with CNN Models.

The preprocessing stage is followed by the disease detection module, which relies on deep learning models with the use of Convolutional Neural Networks (CNNs). Plant disease classification has been carried out with pre-trained models that include MobileNetV2 and EfficientNet-B7 in this system. These models examine the picture of the leaf and obtain valuable information in terms of colour, texture and structural patterns, which are considered to determine the type of disease that the plant is infected with. The model then makes a forecast on the most probable disease category and a score of confidence.

2.5 Image and Disease Database Data (Image and Disease Database).

The processed images together with predicted disease information are stored in the data storage module of the system. This database is used to store the information about the images of plants, disease classifications, and system outputs. This information can be stored to assist in disease trend tracking, enhanced system analysis, as well as assisting future model improvement.

2.6 The Treatment Recommendation Module.

Upon the identification of the disease, the treatment recommendation module is launched. This module retrieves the correct treatment information in a structured treatment protocol database that is provided in JSON format. The recommendations can consist of the description of the disease, recommendations on pesticides or organic treatments and prevention strategies to prevent the further development of the disease. Giving treatment advice makes farmers adopt corrective measures instantly.

2.7 Output Visualization

The user interface is presented with the final results using the mobile application interface. The visualization of the output also includes the name of the detected disease, the level of the confidence, the recommendations of the treatment and the preventive recommendations. The information is presented in easy and easy-to-follow format hence allowing farmers to be in a position to comprehend the diagnosis and implement appropriate solution.

2.8 Feedback Loop

The architecture also involves a feedback system which may enable the users to give feedback on the diagnosis or treatment recommendations. This feedback allows identifying the errors and enhancing the system performance in the long term.

3. PROPOSED SYSTEM

The proposed system is an AI-powered plant disease detection and treatment recommendation system capable of helping farmers and other agricultural professionals to recognize plant diseases by sharing images of leaves with a mobile device. The system utilizes the deep-learning methods and mobile app technology to deliver an efficient, quick, and cost-effective solution to monitor the health of crops. The setup will be to automatically process the images of leaf's of the plants and categorize them as healthy or diseased based on pretrained convolutional neural network (CNN) models, like MobileNetV2 and EfficientNet-B7. These models are trained on the plant-village dataset[13] that includes diverse crops and disease classes of labeled leaf images of plants.

The models are trained to detect valuable visual features like color patterns, leaf texture and spots of the disease with the help of transfer learning along with image preprocessing techniques. After identifying the disease, the system obtains relevant treatment recommendations based on the structured body of knowledge that is stored in a form of a JSON. This database will store data on the disease, which is recommended in treatment and preventive measures. Google Gemini API is also incorporated in the system as it will create detailed explanations and instructions in relation to the detected disease and treatment. This makes users have a better understanding of the disease and put relevant management practices into use

The trained deep learning model is embedded in a mobile application based on Flutter allowing its users to capture or upload leaf images received and get real-time predictions. This will make the solution to be very accessible, user- friendly, and practical in the field. In general, the suggested system should offer an intelligent decision-support system to farmers, which allows them to detect diseases in the early stages, receive

recommendations on timely treatment, and better manage crops.

The key functional components of the proposed system are described below:

3.1 Mobile Application Landing Page Interface

Mobile application offers a easy and convenient interface towards the plant disease detection system. The sign-in screen is a secure access point in which the users can create an account or log in with Google, Apple, or email authentication. Following the successful connection, users are able to find such features as the diagnostics of plant diseases, identification of plants, and the recommendations on their treatment. The software is built on the Flutter technology.

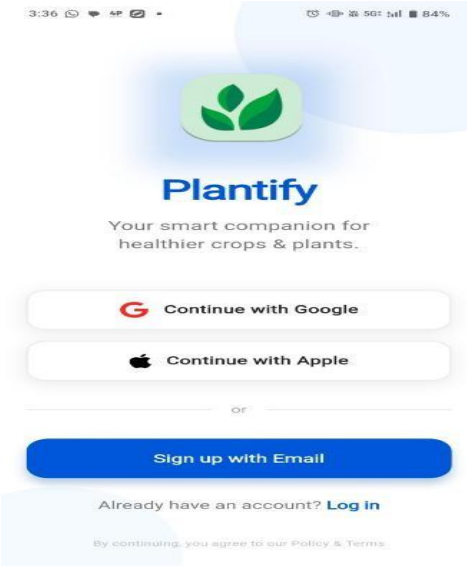

Fig -3.1 Mobile Application Landing Page Interface

3.2 Home Interface of Mobile Application

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Fig -3.2 Home Interface of Mobile Application

3.3 Disease Detection Result Interface

Disease Detection Result interface contains the diagnosis made upon analysing the uploaded image of a plant leaf. As illustrated in Fig. X, the system recognizes the disease as Potato Early Blight and with a high confidence level of 99. Environmental information like the level of humidity and temperature is also displayed on the screen, with the option of consulting the AI assistant with additional descriptions and instructions on how

to treat a specific ailment.

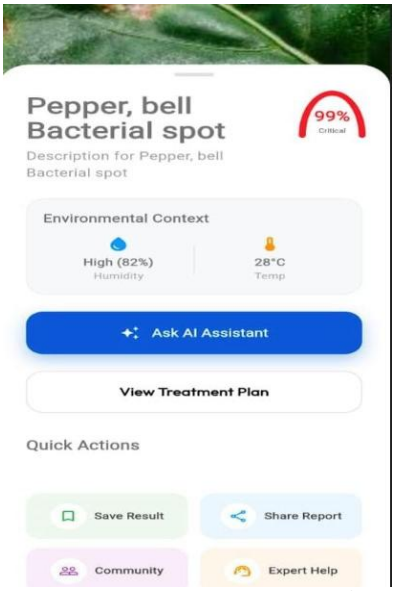

Fig -3.3 Disease Detection Result Interface

3.4 Treatment Recommendation Interface

Treatment Recommendation Interface allows the user appropriate treatment recommendations once a plant disease has been identified by the model. After detection of the disease by the system, it obtains the relevant treatment information of the disease in a structured knowledge database in the form of a JSON. The interface presents the necessary information including the name of the disease, description, treatments to be undertaken and preventive measures in an easy to read format. Also, it has been incorporated with Google Gemini API to provide comprehensive descriptions and instructions on the disease and its management. The module allows farmers to find out the problem fast and implement the necessary treatment procedures, which allow taking decisions and ensure correct control of crop health in time.

The Treatment Recommendation Interface has certain characteristics such as:

- Shows the identified name of the disease and its data.
- Offers suggested therapy procedures of dealing with the illness.
- Recommends preventive actions that should be taken to curb further infection.
- Fetches the treatment information of a JSON recommendation database.
- It uses Google Gemini API to come up with more detailed explanations regarding the disease and how it can be treated.
- Presents is an interactive mobile application interface with a simple interface.
- Farmers use assistance to manage their crops at the right time to safeguard and enhance the well-being of their plants.

In general, this interface is a decision-support instrument that helps users to cope with the plant diseases.

Fig -3.4 Treatment Recommendation Interface

4. RESULT AND EVALUATION

Comparative Analysis of Performance Metrics

Based on the comparison, EfficientNet-B7 has better accuracy, recall, and F1-score, which implies that it can classify the disease better because of having a more elaborate architecture. Nevertheless, it has more computational needs, which means it has more latency and model size. MobileNet-V2, conversely, has a higher inference speed, reduced model size, and throughput hence is more appropriate in the deployment of a mobile based application like the Flutter application that was built in this project. Therefore, MobileNet-V2 is a more efficient network to apply to real-time mobile deployment, whereas EfficientNet-B7 is more effective to use in cases when there are sufficient computational resources.MobileNetV2 and EfficientNet-B7 were compared and analyzed based on a number of evaluation parameters such as accuracy, latency, throughput, model size, scalability, recall, and F1-score. The findings are devised in a horizontal tabular form as shown below.

Table -4.2.1: Performance Metric Comparison

Model	Accuracy (%)	Model Size (MB)	Recall	F1-Score	Scalability
MobileNet-V2	93.4	14	0.91	0.92	9/10
EfficientNet-B7	97.54	256	0.95	0.96	7/10

Accuracy Comparison Between MobileNet-V2 and EfficientNet-B7

The bar graph compares the classification accuracy of MobileNetV2 and EfficientNet-B7 for plant disease detection. MobileNetV2 achieved 93.7% accuracy, while EfficientNet-B7 achieved 97%, demonstrating better performance and improved feature extraction capability for accurate disease classification.

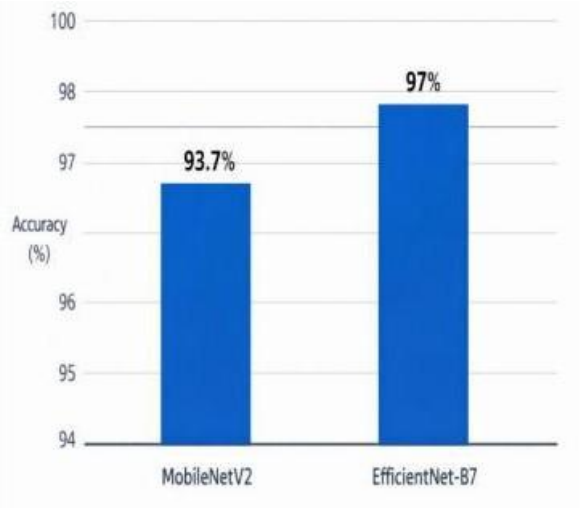

Chart -4.2.2: Performance Comparison: MobileNetV2 vs EfficientNet-B7

5. CONCLUSIONS

This study introduced an AI-informed system of plant disease detection and treatment recommendations that will help farmers recognize plant diseases in a short time and with high accuracy with the help of leaf pictures. The given system provides the means to classify plant diseases on the basis of visual patterns occurring on plant leaves through the application of deep learning methods. MovableNetV2 and EfficientNet-B7 are the pretrained convolutional neural network models that were used to enhance the accuracy and efficiency of the disease detection process. The models have been trained with the help of the Plant-Village Dataset[13] that includes the labelled images of leaf of various plant species that are healthy and diseased.

The experimental findings show that the deep learning models had greater classification accuracy to identify plant diseases. The efficacy of the EfficientNet-B7 model was slightly better since it could identify more complicated visual characteristics, and MobileNetV2 could achieve faster inference and reduced computational intensity, which is appropriate to use in mobile-based applications. Combining these models into a mobile application will allow the users to take pictures of plant leaves and post them online to receive an immediate diagnosis. Besides disease detection, the system offers treatment suggestions and explanatory advice by use of Google Gemini, which guides the users to comprehend the disease identified and implement the right management practices. The proposed system uses deep learning, computer vision, and mobile technology to make a useful and affordable tool that will assist farmers in managing crop disease.

In general, the created system shows the possibilities of artificial intelligence to enhance the agricultural decision- making process and minimize the losses of crops due to plant diseases. The suggested solution helps to optimize the development of intelligent farming because it allows identifying disease early and giving a

recommendation on how one can treat the problem with the goal of improving the health status of crops.

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