Plant Disease Detection Using CNN Model

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Abstract- **A major problem in the agriculture industry is the identification and management of plant diseases. Identification of plant diseases is the key to prevent losses in the yield and quantity of agricultural products. Preventing losses in agricultural product production and quantity requires the identification of plant diseases. Detecting plant diseases quickly and accurately is essential to raising agricultural output in a sustainable manner. This article analyses the application of deep learning techniques for plant disease identification through a CNN model incorporated in a mobile application developed in Flutter. The system provides farmers with instant classification and suggested treatments for images taken of infected part of plants. The model is trained using a dataset of plant leaf images captured in both infected and healthy conditions and converted to TensorFlow Lite (TFLite) format for rapid inference on mobile devices. Experimental results show that the model achieves a training accuracy of 96.56% and testing accuracy of 96.20%, demonstrating its reliability in real-world applications. This research illustrates the contribution of AI-enabled mobile apps in agricultural development.**

Index Terms- **CNN, Deep learning, mobile application, plant disease detection, TensorFlow Lite.**

I. INTRODUCTION

Global farming continues to face challenges due to losses from plant diseases, which further threaten economic stability and access to food. Handlers often find it difficult to monitor plant infections accurately and in a timely manner, leading to wasteful expenditure on treatments and lower production levels. Traditional approaches relies on expert's opinion of the disease, which in itself costs a lot of time and money. For small farmers, it can be quite unattainable. For farmers, incorrectly diagnosing or failing to detect a problem in a timely manner can lead to significant yield losses and damages.

Automated processes like plant disease detection have been made easier through recent advances in artificial intelligence, especially deep learning technologies based on Convolutional Neural Networks (CNNs). CNNs have the capability to analyze images of the leaves of a plant and automatically identify whether it is healthy or diseased. The use of mobile apps simplifies the earlier complicated procedures because farmers using smartphones can now diagnose and treat diseases in a timely manner.

This study combines a deep learning system and a mobile application developed in Flutter to create a simple tool for plant disease identification. The application classifies various plant diseases and uses AI in the form of GPT to recommend treatment suggestions for disease management. This innovation provides a straightforward and inexpensive solution which, in turn, improves agricultural productivity and assists farmers globally.

II. LITRATURE REVIEW

a. Chittabarni Sarkar, Deepak Gupta, Umesh Gupta, Barenya Bikash Hazarika proposed a detailed review in their paper titled *"Leaf disease detection using machine learning and deep learning: Review and challenges"* published in *Applied Soft Computing, Volume 145, 2023*, where they analyzed existing methods, highlighted current challenges, and suggested future directions for improvement in plant disease detection.

b. W. Shafik, A. Tufail, A. Namoun, L. C. De Silva and R. A. A. H. M. Apong conducted a *Systematic Literature Review* in their paper titled *"A Systematic Literature Review on Plant Disease Detection: Motivations, Classification Techniques, Datasets, Challenges, and Future Trends"* published in *IEEE Access, 2023*. They discuss the motivations for using AI in agriculture and summarize the various machine learning and deep learning techniques.
DOI: 10.1109/ACCESS.2023.3284760

c. V. Balafas, E. Karantoumanis, M. Louta, and N. Ploskas published a paper titled *"Machine Learning and Deep Learning for Plant Disease Classification and Detection"* in *IEEE Access, 2023*, which provides an overview of various object detection and classification algorithms used in smart agriculture.
DOI: 10.1109/ACCESS.2023.3324722

d. Nigar, Natasha; Faisal, Hafiz; Umer, Muhammad; Oki, Olukayode; Lukose, Jose (2024) proposed a method for improving plant disease classification using deep learning enhanced with *Explainable Artificial Intelligence (XAI)* in their paper *"Improving Plant Disease Classification With Deep-Learning-Based Prediction Model Using Explainable Artificial Intelligence"* published in *IEEE Access*.
DOI: 10.1109/ACCESS.2024.3428553

e. X.E. Pantazi, D. Moshou, A. Tamouridou from Aristotle University proposed an approach in *"Automated leaf disease detection in different crop species through image features analysis and One Class Classifiers"*, where they used one-class classifiers to detect anomalies in leaves based on image features.

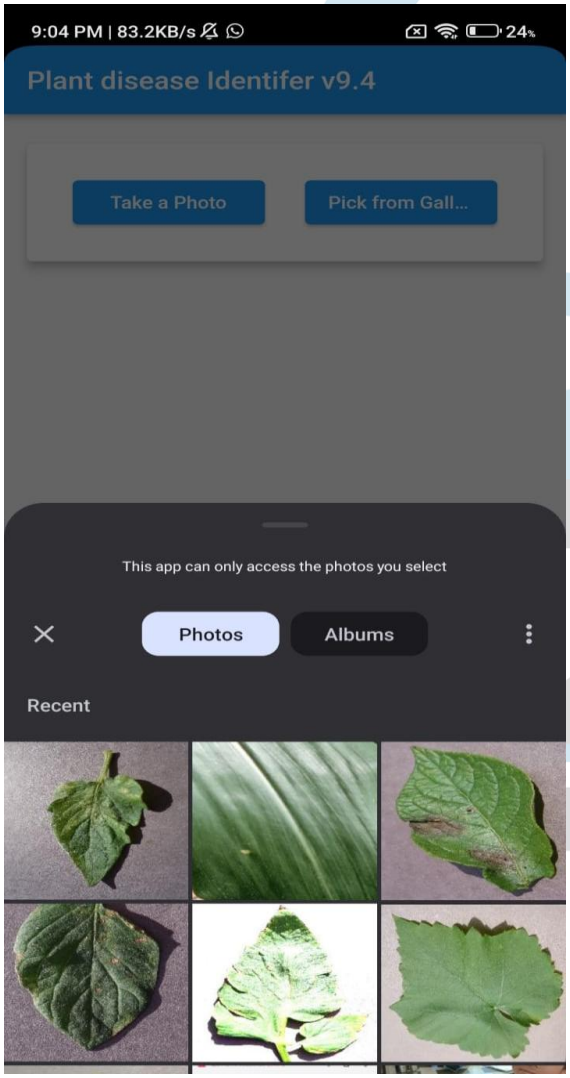
f. Murk Chohan et al. published a paper *"Plant disease detection using deep learning"* in the *International Journal of*

Recent Technology and Engineering, 2020, discussing the application of CNN-based deep learning approaches for early disease identification in crops.

III. PROPOSED SYSTEM

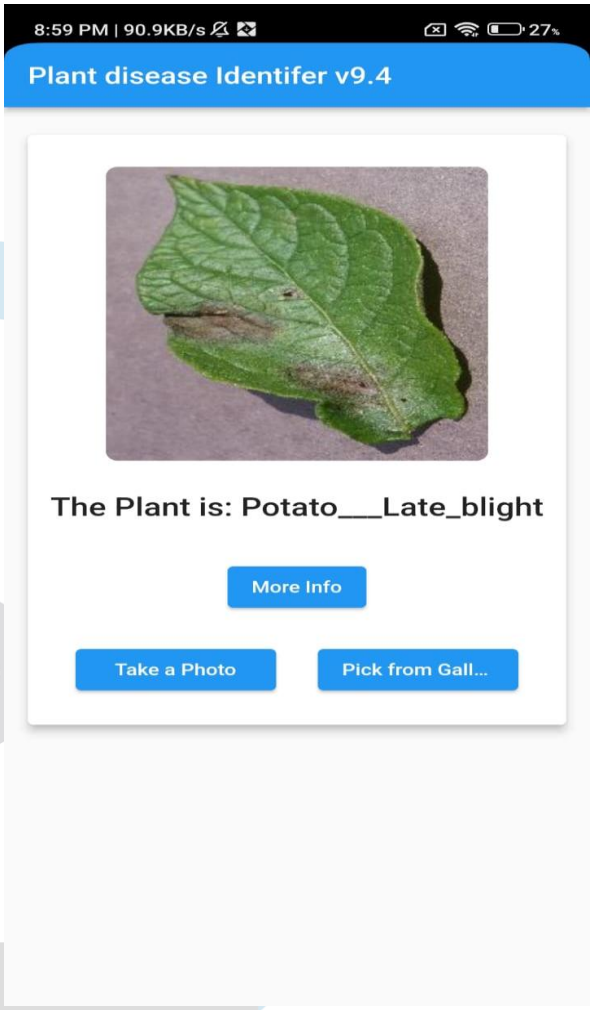
The suggested system is a mobile application for the detection of plant diseases based on a custom Convolutional Neural Network (CNN) model for real-time disease classification. The aim is to offer farmers an easy, efficient, and affordable diagnosis of plant diseases and suggestions of treatments through integration with GPT-based AI.
The system has the following components:

A. Image Acquisition:
The user can take a picture of a plant leaf with the camera of their mobile phone or upload a saved image from the gallery.



B. Preprocessing & Feature Extraction:
The taken image is preprocessed (resized, normalized, and augmented).The system identifies important features based on a specially designed CNN model that has been trained to distinguish healthy and diseased leaves.

C. Disease Classification:
The CNN model classifies the leaf as healthy or infested with a certain disease.



D. Treatment Suggestion:
The app includes GPT API integration to suggest detailed treatment in accordance with the predicted disease.

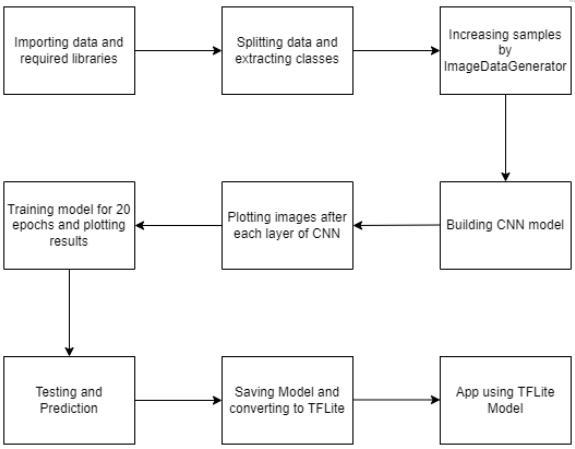
E. Offline Inference:
The model is converted to TensorFlow Lite (TFLite) for effective, real-time detection of the disease directly on mobile devices without internet connectivity.

IV. DATASET

The model is trained on the Plant Leaves dataset and real-world images consisting of 38 different classes and over 87000 RGB images of healthy and diseased crop leaves, with augmentation and normalization for robustness. An 80-20 train-test split ensures accuracy. Deployed with TFLite in a Flutter app, it enables real-time plant disease detection and treatment suggestions.

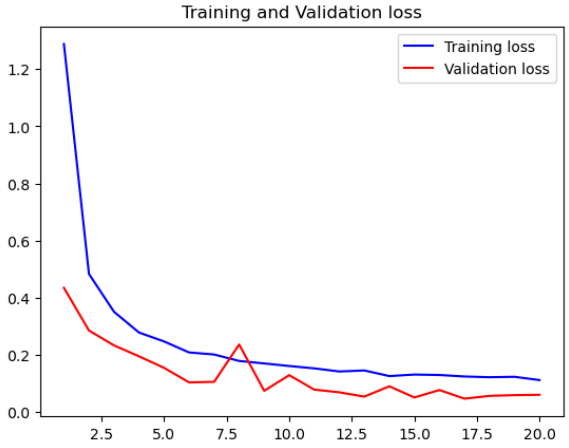
V. METHODOLOGY

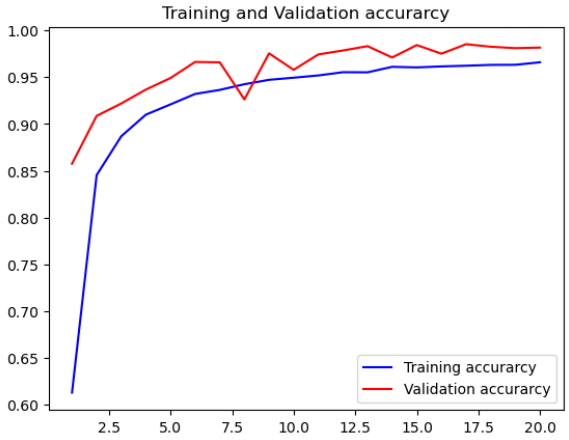
The system under consideration adopts a systematic approach for plant disease identification through a custom Convolutional Neural Network (CNN) model. The system starts with importing necessary libraries and dataset. The dataset is preprocessed and divided into training and testing sets, with class labels separated for classification. For enhancing the performance of the model, data augmentation techniques like rotation, flipping, and brightness adjustments are performed. A custom CNN model is created and trained, made up of convolutional layers for feature extraction, activation functions for non-linearity, and pooling layers for reducing dimensions. To evaluate effectiveness of feature extraction, feature map visualization is done following the application of every CNN layer. The model is then trained for 20 epochs, with accuracy and loss tracked throughout. After training, the model is tested and evaluated with the test dataset to determine its classification accuracy. After validation, the trained model is converted into TensorFlow Lite (TFLite) format for mobile optimization. Lastly, the TFLite model is embedded into a Flutter-based mobile app, enabling users to upload plant leaf images for real-time disease detection and treatment advice.



VI. RESULTS

The CNN model yielded an accuracy of 98.16% for the validation set. The mobile application gave near real-time disease classification with minimal latency. Comparison with other available models showed that detection speed and accuracy were better. Integration with GPT-based APIs allowed patients to receive treatment recommendations immediately.





VII. CONCLUSION

This study successfully demonstrates the effectiveness of a deep learning-powered mobile application for plant disease detection. The proposed CNN model achieved a high validation accuracy of 98.16%, indicating strong performance in classifying plant diseases. The integration of TensorFlow Lite (TFLite) ensures real-time, on-device inference, making the application accessible to farmers even in remote areas with limited internet connectivity. Additionally, the incorporation of GPT-based AI for treatment recommendations enhances its usability.

Model	Dataset Used	Accuracy (%)	Inference Time	Notes
LeNet	PlantVillage	85.42%	3.5 sec/image	Basic model, low complexity
VGG16	PlantVillage	91.23%	4.2 sec/image	Deeper, but more resource-intensive
ResNet50	PlantVillage	93.88%	2.9 sec/image	Good balance of depth and speed
Custom CNN (Ours)	PlantVillage	98.16%	1.2 sec/image	Lightweight, optimized for mobile

Table A: Accuracy Comparison with Other CNN Models

VIII. FUTURE SCOPE

Future enhancements include expanding the dataset with more diverse plant species, optimizing the model for better efficiency on mobile devices, and integrating cloud-based solutions for large-scale implementation. This research highlights the potential of AI-driven mobile applications in revolutionizing agricultural disease management and promoting sustainable farming practices.

ACKNOWLEDGMENT

It is our pleasure to acknowledge sense of gratitude to all those who helped us in making this project. We thank our Project Guide Prof. Manisha Desai helping us and providing all necessary information regarding our project. We are also thankful to Dr. Deepali Newaskar (Head of Department of Computer Engineering) for providing us the required facilities and helping us while carrying out this work. Finally, we wish to thank all our teachers and friends for their constructive comments, suggestions and criticism and all those directly or indirectly helped us in completing this project.

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