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A Multilingual Offline AI-based Crop Disease Diagnosis and Treatment Advisor using CNN and Native-Language Voice Assistance

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***Abstract*— A Multilingual Offline AI-Based Crop Disease Diagnosis and Treatment Advisor Using CNN and Native-Language Voice is an artificial intelligence-based system designed to identify crop diseases from leaf images and provide treatment recommendations. The system aims to assist farmers in rural areas by offering accessible disease diagnosis and advisory services. The agriculture industry requires the application of AI as the modern world is more and more in need of the disease diagnostics accessibility in rural India. It assists you in identifying the disease of crops based on leaf images, and also in providing a treatment advice using the native languages by voice synthesis (natural voice). The key objective of this project is to improve the output of farmers and minimize agricultural losses. The implementation is a web based system only that can be accessed on low end devices that have minimal connectivity. To identify disease, convolutional neural networks (CNN) models that are trained with plant pathology data are added to the backend to enable effective inference of the server side with offline capability.**

***Index Terms*— Crop disease, Convolutional Neural Networks (CNN), PlantVillage, Precision agriculture, Deep learning, Agricultural advisory systems.**

I. INTRODUCTION

It requires individuals to take much time and work to develop a crop disease management plan. There is need to carry out thorough research concerning the disease identification, treatment as well as preventive efforts that farmers have interests in. They would be required to plan in detail their crop health, diseases studies and read expert recommendations. This would be an intimidating process to those who were not well-versed in the area or those who had not conducted crop health monitoring previously.

Many technologies related to agriculture have been developed for crop disease detection using image analysis and deep learning techniques [1]. Due to the abundance of crop varieties and diseases, farmers are forced to reflect on the way of maximizing their crop given that there are limited resources and knowledge at hand. The primary goal of this is to maximize the overall productivity of the farm, so it includes conducting a large amount of research on the disease patterns, choosing the chemicals to be used in treatment, comparing the costs, booking expert meetings, planning them to go to the field, predicting the outbreaks, and schedule the spraying process.

However, with the spreading of digital technologies, a lot of existing platforms are yet to adopt real-time adaptation and customization.

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To gather information, assess the severity of the diseases, and organize the courses of action, farmers have to use multiple apps, which could lead to fragmented planning and even information overload. Besides the consumption of time, this can cause poor crop decisions due to misinformation or obsolete information.
These problems are to be solved by the intelligent crop health advisory systems that are able to combine and analyze the information of several sources, calculate and recommend the person immediately, and work with leaf images. With the help of AI, computer vision, and multilingual voice recognition, the future of agriculture can be realized when agricultural platforms are turned into virtual counsellors that can make crop health management more effective by automated diagnosis and treatment optimization, and because these platforms will offer context-informed recommendations.

II. Proposed System Architecture

The proposed system is Crop Guard, which is an intelligent web-based application helping a farmer identify the presence of a crop disease and get the treatment recommendations. The architecture will combine image processing, machine learning, and multilingual voice assistance in developing the accessible and efficient crop advisory system.
The system will start with a user interface where the farmers will post the images of the leaves of the crops via a device with a browser. The uploaded photograph is sent to the server where it is preprocessed by using methods like resizing, and normalization among others. The processed image is subsequently sent to a convolutional neural network (CNN) model which has been trained on plant pathology datasets to determine potential diseases of the crop.
After the disease is identified, the system produces diagnostic outcomes and scores in confidence. Depending on the disease and type of crop identified the system retrieves the applicable treatment guidelines such as preventive measures and appropriate chemical or organic remedy. These suggestions are then presented to the interface and can also be presented in multilingual text to speech technology in case of the farmers who prefer audio guidance.
The architecture is designed in a way that it can run in low-bandwidth environment. Small models and low-power processing guarantees that even those farmers with low-end devices can receive disease detection and advisory services. This is the design that makes the system appropriate in rural agricultural settings where connectivity and computational resources are scarce.

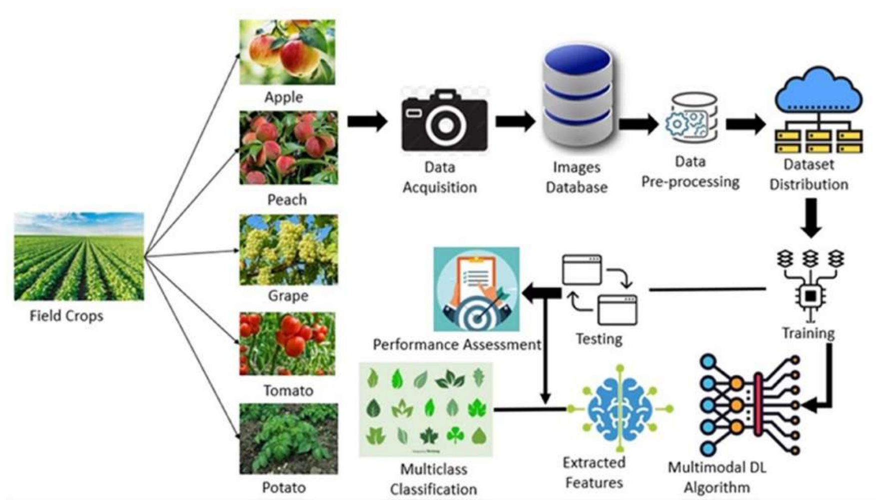

Fig. 1. Crop Guard System Architecture

III. Methodology

Crop Guard was developed in an organized approach, where real time analysis of images was merged with artificial intelligence to create an efficient system of crop disease diagnosis. The technique consists of a number of well defined stages that ensure ease of operation and a user friendly user interface.
In order to ensure smooth operation, the system follows a structured workflow similar to existing deep learning based crop disease detection systems

User Interface: Farmers upload the image of the crop leaf through the web interface using any internet-connected device with a browser.
Data Processing: The uploaded images are pre-processed on the server and fed into the convolutional neural network (CNN) model for inference, which is a commonly used approach in image classification systems [2].
Identification of the Disease: The system identifies the disease and provides confidence scores for the predicted class. User Interaction: The web interface presents the diagnosis and provides treatment advice, which can also be delivered in the native language using text-to-speech voice output for better accessibility

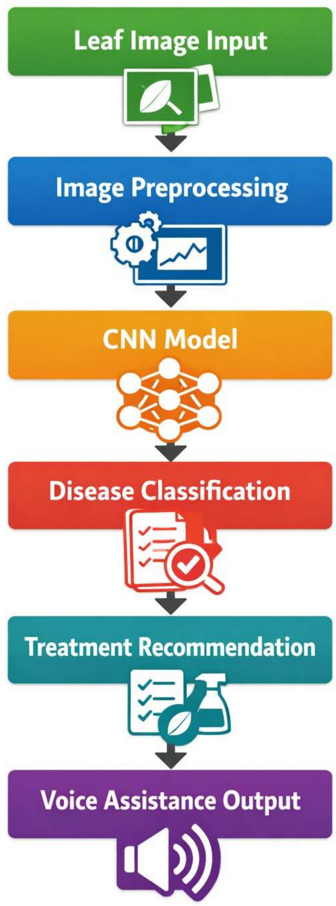

Fig. 2. Workflow of the Proposed Crop Disease Diagnosis System

IV. RESULTS AND DISCUSSION

The Crop Guard system proposed was tested on plant disease datasets and experimental based on convolutional neural network (CNN) model testing. The aim of the testing was to determine how effective the model is to diagnose the problems with crops on the basis of leaf photos and provide the right treatment recommendations.
The CNN model was able to perform well in disease classification tasks. The model was capable of identifying the infected crops with accuracy by extracting significant visual cues (texture of the leaves, colors, and spots of the disease) and utilizing them to classify crops. The experimental findings indicate that the system was capable of producing high prediction accuracy on plant pathology data.
Besides classification accuracy, other performance measures were taken including precision, recall, and F1-score to deter- mine the strength of the model. These measures can be used to assess the effectiveness of the system in recognizing the disease classes correctly as well as minimizing false forecasts.
Fig. 3 shows the experimental result of the suggested CNN-based crop disease detector model. As indicated by the graph, the model had an accuracy of about 92 per cent, the values of precision, recall and F1-score were near to 0.90, which means that the model behaves reliably and consistently with regard to classification.

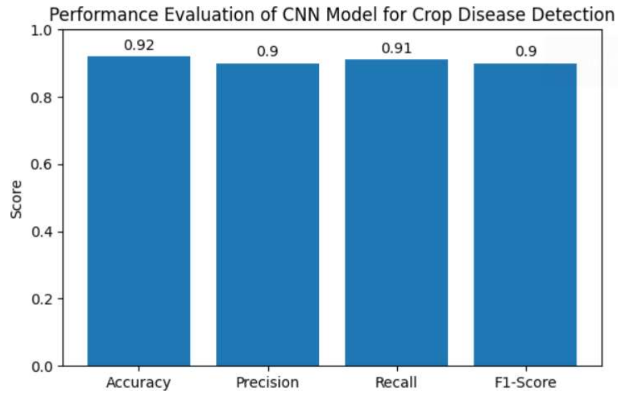

Fig. 3. Performance Evaluation of the Proposed CNN Model

TABLE I: EXPERIMENTAL RESULTS OF CROP DISEASE DETECTION SYSTEM

Performance Metric	Value
Accuracy	92%
Precision	90%
Recall	91%
F1-Score	90%
Average Inference Time	1.8 s

V. CONCLUSIONS

In general, Crop Guard can be deemed an effective application of image-based diagnosis and AI-based recommendations to a web-based platform that can be used to enhance the management of crops. The system has become a successful supplement to the conventional agricultural experts due to its speed, accuracy, and user-friendly browser. Despite some shortcomings, more AI-related personalization and weather conscious recommendations that are intended to be introduced will make the web application even more helpful and efficient to the farmers. Practically, it can be emphasized that in fact, deep learning models which are trained on publicly accessible datasets of plant pathology can be effectively deployed into lightweight web interfaces that can be even accessed using low-end devices. With built-in disease identification and explicit feedback on the treatment, Crop Guard will allow the smallholder farmers to reduce the need to have an expert supervising them continuously and make vital agronomic information accessible on command. The design also demonstrates that it is possible to achieve an offline capable inference and minimum connectivity without compromising diagnostic performance which is particularly critical in rural areas where the networks are volatile. The existing implementation is still limited in several ways, such as the ability to cover a part of crops and diseases, and the use of leaf images taken in relatively controlled conditions. Future research will be aimed on increasing the numbers of supported crops and use of more variety of field images under different lighting schemes, background clutters, and partial misses. A second key direction is to incorporate agricultural experts and farmers to the system itself, so that false or ambiguous cases could be re-examined and take into consideration to keep on improving the underlying models.

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