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Plant Life: An Intelligent Mobile Plant Disease Diagnostic System using Deep Learning

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Abstract: *Agriculture is an important sector that considerably enhances a nation's economic development. Farmers encounter several obstacles every year in order to produce high-quality crops. Plant diseases are a significant factor in the failure of the harvest. Additionally, pests, specialized illnesses, or natural disasters cause massive crop losses every year. It raises serious concerns about the application of sustainable advanced technologies to agricultural problems. The proposed intelligent system's main job is to detect plant disease using an image captured in the mobile application. It employs the region-based convolution neural network (fast-RCNN) and pre-trained model generation for the set of datasets and captured images. To ensure long-term viability, the mobile app is integrated with cloud services. The proposed system also includes recommendations to help farmers determine whether plant conditions are healthy or unhealthy, as well asthe recommendations to cure disease.*

Keywords: fast R-CNN, plant disease, CNN, Android App

I. INTRODUCTION

India is a major agricultural-producing country that is heavily reliant on food production. Agriculture is also the main industry and source of wealth in India. Agriculture is also the primary source of employment, food, and income for many Indians. Good agricultural production is influenced by a variety of things. A few of the variables are the application of fertilizers, the quantity and distribution of rain, the fertility and condition of the soil, and others. Crop diseases are the main problem that people encounter. Farmers can lack a thorough understanding of the diseases, which can result in incorrect disease diagnoses and poor problem-solving techniques. An intelligent mobile plant disease diagnostic system, on the other hand, has become valuable because of its utility in the early diagnosis and detection of plant diseases using leaf images, whether healthy or unhealthy. Mobile apps that use artificial intelligence to assist farmers in identifying plant-affected diseases are one such tool being investigated. In this mobile application, we use deep learning technology to accurately determine the disease. The region-based convolution neural network model is being used (fast R-CNN). It is made up of three simple steps: Take a photograph with your camera first. The second step is to generate a diagnosis report, which will inform the user about the disease and whether the leaf is healthy or unhealthy. The third step suggests treating the disease with fertilizer.

1.1 Existing System

In previous work, The user application takes a picture of a leaf with the phone's camera. The trained model included in the "Plant Buddy" app is then used to process the taken image. Based on the precision of the image, the programme then decides if the plant is healthy or unhealthy. The suggested model performs 10–20% worse when photographs are taken outside. An image dataset that was taken in a real-world environment can be used to get around this restriction.

II. LITERATURE WORK

A.Uzhinskiyet al [1] To provide a new level of service to the farmers' community, plant disease detection was designed using modern organisation and deep learning technologies. A mobile application that allows users to send sick plants photos and text descriptions.

Adedamola O. Adedoja et al [2] The system is powered by a web service that performs diagnostics using the CNN model. The web service is used to provide photographs of plant leaves taken with the developed mobile app, and the NASNet-Mobile CNN model is used to identify plant diseases.

Sophia Sanga et al [3] The system is powered by a web service that performs diagnostics using the CNN model. The web service is used to provide photographs of plant leaves taken with the developed mobile app, and the NASNet-Mobile CNN model is used to identify plant diseases.

Ayesha Siddiqua et al [4]Weston Three raters evaluated the chosen apps using the system we developed for app evaluation. Inter-rater reliability is computed with intra-rater reliability to check rater agreements on the ratings and ensure rating consistency.

ZarreenNaowal Reza et al [5] Using the colour co-occurrence methodology, the resultant feature values from the segmented area will be gathered for texture analysis. To recognise and categorise the disease, sample values from the pre-defined database will be compared to the extracted values using a multi-SVM classifier.

Nikos Petrellis et al [6]The user's processing of plant images captured using visible, infrared, and other wavelengths of light. It is common to utilise lesions or spots in different sections of a plant to determine a disease. The colour, size, and number of these spots can all aid in determining which disease has killed a plant.

N. Petrellis et al [7] A software for smartphones that can identify plant illnesses. It is based on identifying the disease signature, which is expressed as a set of guidelines for the colour, shape, and placement of spots, as well as information about previous weather patterns. The collection of plant diseases supported can be expanded or altered by an agriculturist using the built programme as an end user thanks to the disease signature format.

III. SYSTEM ARCHITECTURE

In this Proposed system design and development of a mobile application-based plant leaf disease detection and fertilizer recommended system. In the nutrients model, yield prediction and fertilizer observation are critical for farmers to assess fertiliser nutrient loss from rain, cyclones, and yieldand other natural disasters. An R-CNN-based deep learning approach is used to train the model for plant leaf disease.

Project's goal is to develop a mobile application that uses deep learning to diagnose plant diseases. And it’s consisting of three stages of the layer. User layers are used to upload or capture the image of the plant leaf, algorithm layer is used to identify whether the plant leaf is healthy or unhealthy. In the android application layer, the final layer displays the leaf status using the deep learning algorithm of the fast R-CNN technique.

1. This project can help farmers by detecting diseases at earlier stages.
2. Better quality crops can be harvested as the diseases are found easily by the farmers.
3. It gives recommendations on how the affected leaf can be prevented and cured.
4. It is easy to maintain and user-friendly.

The overall goal of the project is to predict diseases on the leaf. The images are divided into 80:20 training and testing phases. During the training period, the leaf is subjected to the fast RCNN algorithm, which is used to determine the plant's labels. During the testing phase, we can determine the diseases of a plant using an Android application by capturing a real-time image or uploading images from the dataset.

The above image depicts the layers available in the system architecture such as Mobile App Layer, Pre-processing Layer, Deep Learning Model Layer, Database Layer.

Mobile App Layer: This layer is responsible for capturing images of the plant leaves through the mobile camera and sending them to the pre-processing component for further processing.

Pre-processing Layer: This layer is responsible for cropping, resizing, and enhancing the images to improve the performance of the deep learning model. It then sends the pre-processed images to the deep learning model component.

Deep Learning Model Layer: This layer is responsible for analysing the pre-processed images using convolutional neural networks (CNNs) to identify the plant disease.

Database Layer: This layer stores information about various plant diseases, including their symptoms, causes, and treatments.

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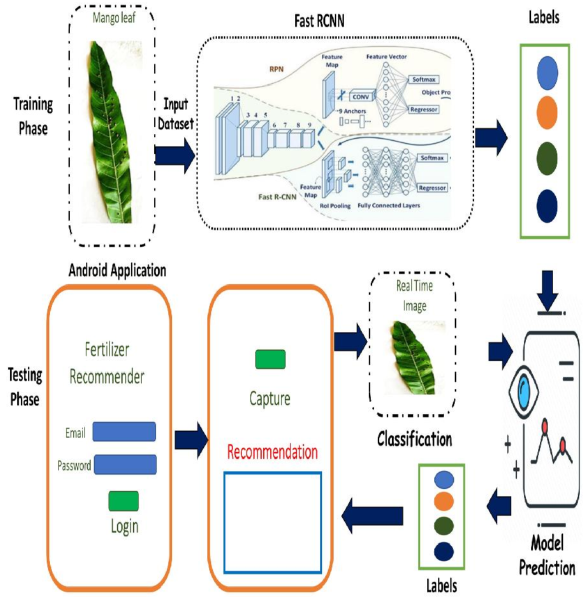
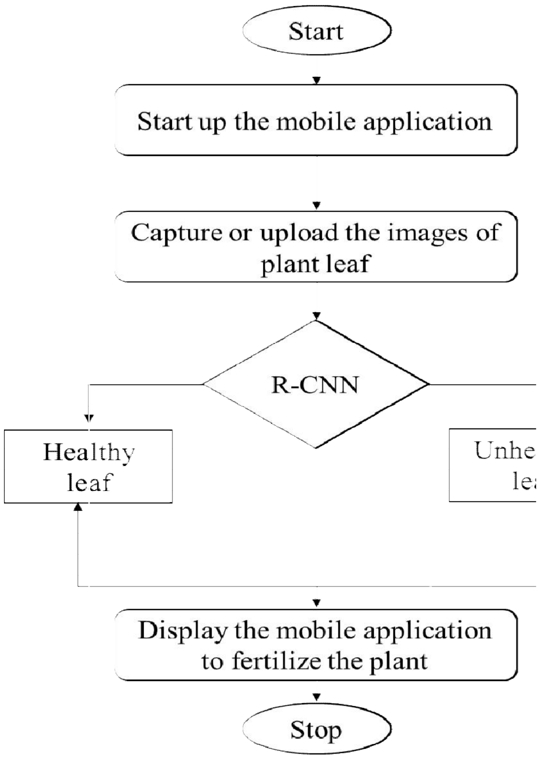


Fig 1. Overall system architecture

Flowchart shows whether the leaf is healthy leaf or unhealthy leaf.



3.1. Modules

3.1.1 Image Acquisition

Selecting the diseased plant is the first step. Next, gather the damaged plant's leaves, take a photo of them, or load an existing image of them into the computer system. In order to make digital photos useful for the system, image acquisition is used to process the images using algorithms.

It eliminates visual distortion and noise. Images from the source folder are read by data producers. To process the photos, data augmentation is employed. This method improves dataset image quality such that Fast R-CNN models can be created with them.

3.1.2. Feature Generation

The autonomous learning of the features plays a significant role in feature development for plant disease diagnosis. In order to identify plant illnesses, shapes, textures, and colours of plant leaf photos are typically used. Using features Fast R-CNN algorithm, automatically extracting features and detecting plant leaf illness. A quick and effective way to utilise the features that a neural network that has already been trained has learned is through feature extraction. It defines the output feature by propagating the input image to a very specific layer of our own (completely linked).

3.1.3. Training the Model

The trained model created in the preceding steps can be used to test real-time images for plant disease detection and recognition. We train the model using fast R-CNN algorithm.

The RPN and Fast R- CNN are two separate networks that make up the Fast R-CNN architecture. They can all be trained independently. In contrast, it is possible to create a combined network for Faster R-CNN in which both the RPN and Fast R-CNN are trained simultaneously.

The fundamental concept is that the convolutional layers used by Fast R-CNN and RPN are identical. Although only existing once, these levels are utilised by the two networks. It is possible to refer to it as sharing of features or layer.

3.1.4. Testing the Model

The testing models are used to test the plant leaf images to detect and recognize the three pages. It's listed below, Admin page, Login page, Prediction page.

- **Admin Page:** When first opened, the application displays the admin page. Here, there are two buttons: Signup and Login. The Register button displays the user's name, email address, password, and contact number.
- **Login Page:** This button directs the user to the login page. Capture or upload the leaf image and Result are the two buttons present. A previously acquired image from the gallery can also be loaded, or a fresh image can be taken with the camera. The detected plant disease and the precision of the detection are then displayed after pressing the "Result" button.
- **Prediction Page:** Following the image's detection, the solution page is shown, where the disease's therapy is explained.
- **Recommendation Page:** It gives the recommendations to cure the disease after detecting the disease. After this the user can logout from the page.

IV. ALGORITHM

Approach 1: Plant Leaf Disease Diagnosis using Fast RCNN
Input: Infected or healthy leaf image **Output:** Class of leaf image
1. Read the input image. 2. Read the image into RGB image. 3. Resize the image. 4. Convert input image into the feature extraction. 5. Apply the Fast RCNN algorithm. 6. Diagnosis the input image. 7. Calculate the image is healthy or unhealthy. 8. Calculate the Evaluation metrics. 9. End

V. RESULTS

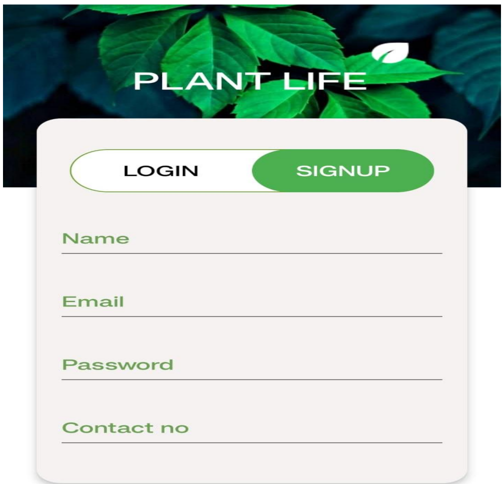


Fig 2.Signup page

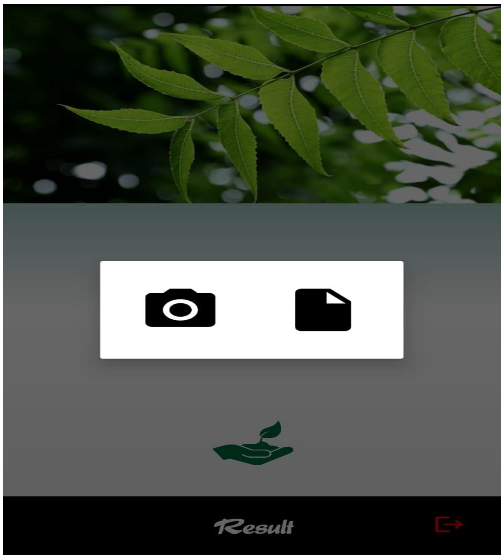


Fig 3.Upload/ Capture image

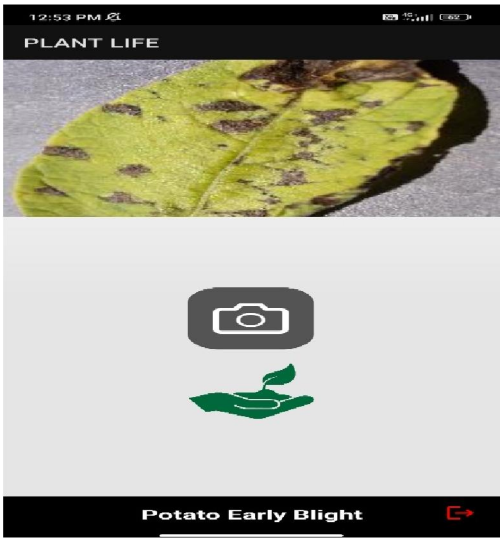


Fig 4.Disease prediction page

Fig 5. Recommendation page

Fig.2 describes the signup page. Where a farmer must provide his details for creating an account. the details include name, email address, and contact number. To create the account for the first time we need to sign up, then onwards we can log in to the app directly.

Fig.3 shows uploading or capturing the image, where a user may access both the real-time images and the dataset images. While capturing the images they have to be present in real, the uploading can be done with the already present dataset.

Fig.4 describes the disease prediction. after submitting the image, the user can able to notice the disease type and the fertilizer that needs to be used.

Fig.5 gives the recommendations to cure the disease when the disease is detected.

5.1. Evaluation Metrics

The following evaluation measures are used to evaluate the effectiveness of the FE algorithms and ML models:

- TP: True Positive is the quantity of attack samples that were accurately identified.

The number of benign samples that were appropriately identified as TN: True Negative.

- The number of attack samples that were incorrectly labelled as false positives.

The number of benign samples that were incorrectly labelled as false negatives.

Accuracy: Accuracy is calculated as the ratio of samples that were properly identified to all samples:

$$ACC = \frac{TP + TN}{TP + TN + FP + FN}$$

Recall: Also referred to as detection rate, is the ratio of attack samples that were correctly categorised to all of the attack samples:

$$DR = \frac{TP}{TP + FN}$$

False Alert Rate: The ratio of assault samples that were mistakenly classified to benign samples is known as the false alarm rate.

$$FAR = \frac{FP}{FP + FN}$$

F1-Score: F1 Score is the harmonic mean of precision and Detection Rate:

$$F1 = \frac{2\ x\ Precision\ x\ DR}{Precision\ x\ DR}$$

Area Under the Curve: The trade-off between the DR and FAR is shown by the area under the Receiver Operating Characteristics (ROC) curve, or area under the curve.

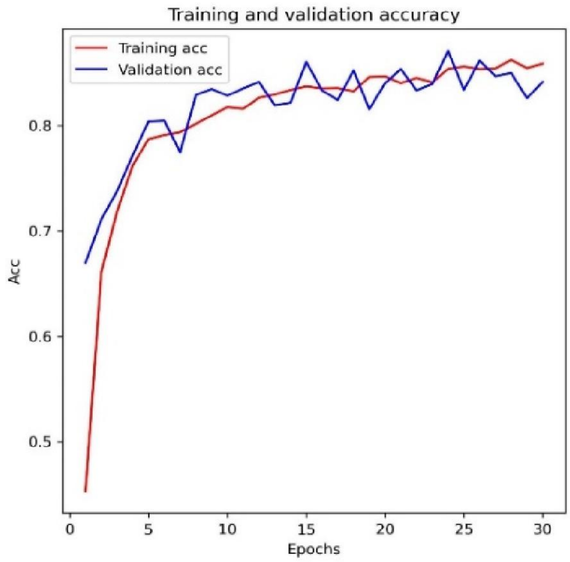


Fig 5.1 Fast RCNN Algorithm

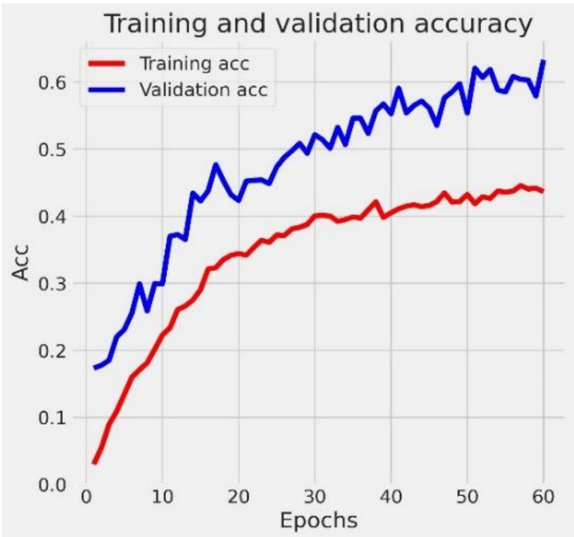


Fig 5.2 Inception Algorithm

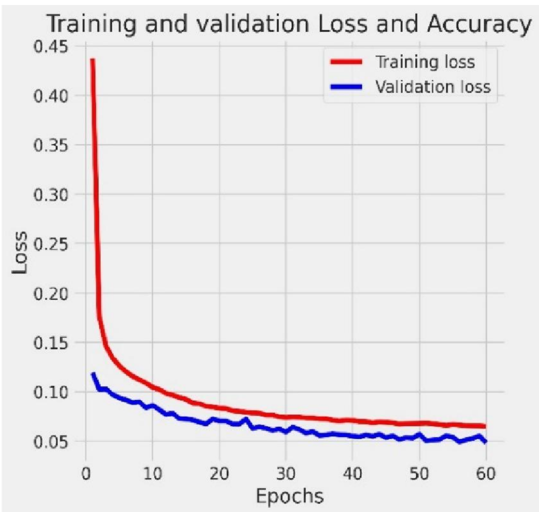


Fig 5.3 Inception Loss

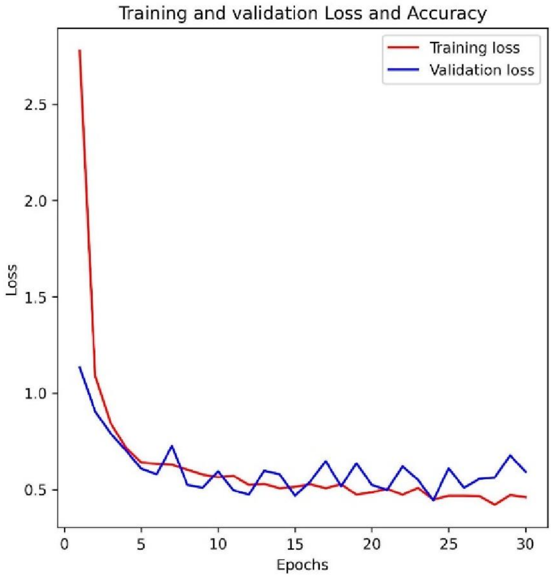


Fig 5.4 Fast R-CNN Loss

Algorithm	Accuracy
ResNet (Residual Networks)	98.8
LRA	92.3
Inception	85.3
CNN (Convolutional Neural Networks)	94.1

VI. CONCLUSION

In this study, a mobile application for Android has been created to quickly and accurately identify and detect plant illnesses. The model's high accuracy, which was reached using a huge public dataset of plant photos, demonstrates the model's acceptance. In this essay, it is suggested that an Android app be created to detect plant leaf disease. Using the Fast RCNN technique, the disease detection model in this approach analyses a plant leaf image as input before detecting and identifying the disease. With low-end hardware, this suggested way application also runs and performs well. The user interface for the application is likewise fairly simple. So, farmers may use the programme pretty well. It can be used by farmers in remote places to correctly identify plant illnesses and administer the required treatments.

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