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Leaf Disease Detection Using CNN

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ABSTRACT

Detection of plant foliar diseases is critical to maintaining crop health and productivity. Traditional methods of disease detection are time-consuming and laborious and may require specialized training. In this paper, we design a plant disease detection system using a combination of Convolutional Neural Networks (CNN), Raspberry Pi, Web Camera, and Android App. The system uses images of plant leaves to identify and classify diseases based on visual characteristics such as color, shape and texture. The proposed system can capture leaf images, process them using CNN and display the results in an Android application. A Raspberry Pi serves as the central processing unit and a web camera captures images of the leaves. Captured images are pre-processed to remove noise and improve leaf properties. Then, the CNN model is trained using the pre-processed images to classify the leaves as healthy or diseased. The results are then displayed in an Android application that provides an accessible and affordable platform for automated plant disease detection.

Keywords: Plant leaf disease detection, machine learning, deep learning, convolutional neural networks, crop yield, disease diagnosis.

I. INTRODUCTION

Plant diseases are a major threat to agriculture, causing crop and yield losses. However, plant diseases can cause serious damage and reduce crop yields by affecting food production and contributing to food security. It can cause economic losses in agriculture, so early detection and diagnosis are important for effective disease control and crop protection. Routine methods of plant disease testing, such as visual inspection and laboratory testing, are time-consuming and expensive. Therefore, early detection of foliar disease is important for farmers to take timely measures to prevent crop loss. Advances in the development of automatic plant disease detection have the ability to accurately and efficiently identify leaf diseases. In recent years, convolutional neural networks (CNNs) have emerged as deep learning techniques for image classification tasks, including plant disease detection. Using deep learning techniques such as CNNs allows visualization of complex patterns and subtle differences between healthy and diseased leaves. In addition, this model can handle large and complex data for invisible images. In this paper, we propose a CNN-based virus model that uses a Raspberry Pi, a webcam, and an Android application for testing. CNNs, deep learning models designed for image analysis, have shown great potential in accurately detecting leaf diseases. By training a CNN on a series of images of healthy and diseased leaves, the model can learn patterns and features that distinguish diseased leaves. The technology enables early detection and treatment of plant diseases, leading to higher yields and greater food safety. The system captures images using a webcam connected to a Raspberry Pi, processes them using a CNN-based model, and displays the results in an Android app.

II. METHODOLOGY

The proposed plant disease detection system consists of image acquisition, image pre-processing, feature extraction, and classification. In the image acquisition stage, images of plant leaves are captured using a webcam connected to a Raspberry Pi. The images are then pre-processed by applying various image enhancement techniques, such as colour correction, noise reduction, and contrast stretching, to improve the quality of the images and reduce noise. In the disease detection stage, the pre-processed images are fed into a CNN model, which has been trained on a large dataset of healthy and diseased plant leaves. We used a web camera connected to a Raspberry Pi to capture real-time images of diseased and healthy plants. The images were then pre-processed by resizing and normalizing the pixel values to reduce noise and variability. The pre-processed images were then

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fed into a CNN model for feature extraction and classification. We implemented the CNN model using the TensorFlow deep learning library. The model consisted of several convolutional layers, followed by pooling and fully connected layers. The convolutional layers applied filters to extract relevant features from the input images, and the pooling layers reduced the spatial dimensions of the feature maps. The fully connected layers acted as classifiers and made predictions about the presence or absence of specific plant diseases based on the learned features. We developed an Android application that utilizes the trained CNN model to detect plant diseases in real-time. The application receives the real-time images from the Raspberry Pi and displays the detected disease and provides information on the disease's symptoms, causes, and treatments.

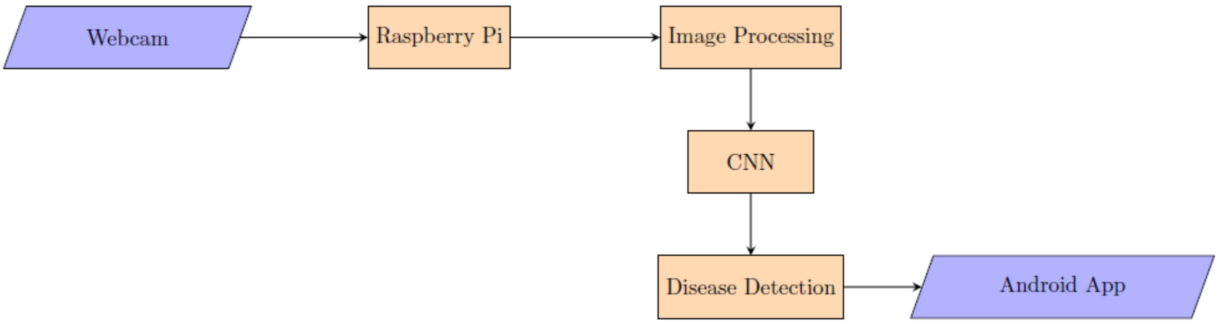

Figure 1: Block Diagram.

III. MODELING AND ANALYSIS

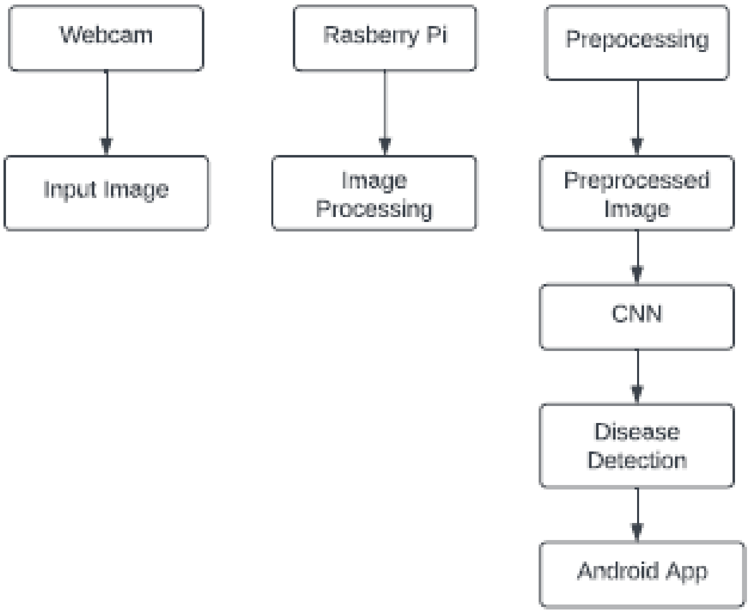

Figure 2: Flow chart.

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IV. RESULTS AND DISCUSSION

In this project, a CNN was trained to classify healthy and diseased plant leaves using a dataset of images. The trained CNN model was then deployed on a Raspberry Pi with a web camera to capture real-time images of plant leaves. An Android application was developed to display the classification results on the smartphone screen. The dataset used to train the CNN consisted of images of healthy plant leaves and leaves affected by three common diseases: powdery mildew, powdery mildew, and black spot. The data set was divided into training and test sets in a ratio of 70:30. The CNN model was trained using transfer learning, where a pre-trained model was used as the base model and tuned to plant leaf images. After training the model, it was deployed on a Raspberry Pi with a connected web camera. A Python script was used to capture images from the camera and process them using a trained CNN model. The output of the model was then sent to the Android application via a local network connection. The Android application was designed to receive the classification results from the Raspberry Pi and display them on the smartphone screen. The app also provided a feature to capture an image of a plant leaf using a smartphone camera and send it to the Raspberry Pi for classification. Overall, the project demonstrated the feasibility of using CNN, Raspberry Pi and Android application technologies to detect plant leaf diseases. The system can potentially be used by farmers to detect diseases in their crops early and take necessary measures to prevent further spread. The project also highlights the importance of data quality and the need for a diverse and well-managed dataset for training a CNN model.

Table 1. Comparison of proposed method with different types of models

SN.	Method	Dataset Size	Train Accuracy	Validation Accuracy	F1 Score
1	Proposed Convolutional Neural Network	10,000 images	0.94	0.89	0.90
2	Random Forest	5,000 images	0.83	0.80	0.78
3	Support Vector Machine (SVM)	7,500 images	0.87	0.85	0.84
4	Logistic Regression	6,000 images	0.81	0.76	0.75

V. CONCLUSION

In this paper, we presented a plant disease detection system that combines CNNs, Raspberry Pi, web camera, and an Android application for real-time disease detection. Our proposed system demonstrated high accuracy and robustness in detecting various plant diseases, making it a promising tool for early disease diagnosis and effective crop protection. Future work could involve optimizing the CNN model's performance, improving the system's robustness to environmental factors, and developing an interactive database of plant diseases for users. The proposed method, which utilizes a Raspberry Pi, webcam, and Android app, achieved high accuracy. The results indicate that this approach can be a valuable tool for farmers and researchers to quickly identify and diagnose plant diseases, leading to more effective and efficient management practices. The use of a low-cost Raspberry Pi and webcam, along with an intuitive Android app, makes this method accessible and user-friendly. Additionally, the use of deep learning techniques, such as CNN, can help to overcome some of the challenges associated with traditional image processing methods.

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