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Plant pesticide recommender application for remote villages using convolution neural network

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Abstract

One of the primary issues with inside the agricultural region is crop sicknesses and automated detection is crucial for crop monitoring. Plant leaves generally display the maximum ailment symptoms, however professional laboratory leaf analysis is high priced and time-consuming. According to the Food and Agriculture Organization (FAO), agricultural pests lessen crop yields international via way of means of 20 to 40% according to year. Smart farming is good solution for farmers is to apply artificial intelligence techniques along with modern statistics and communication technologies to get rid of those dangerous insect infestations. Farmers can substantially lessen financial losses via way of means of treating plants directly and detecting sicknesses and pests in apple, mango and graphs leaves appropriately and timely. Image type accuracy has progressed notably because of latest advances in deep studying-primarily based totally convolutional neural networks (CNN). This article evolved strategies primarily based totally on deep studying to hit upon sicknesses and pests in apples, mango, and grape leaves. These strategies have been influenced via way of means of the achievement of CNNs in photograph type.

Keywords: Artificial Intelligence; Deep Convolutional Neural Networks; Leaf diseases identification Machine learning Machine learning; Image processing; Pest Detection

1. Introduction

India is an agricultural kingdom with greater than 50% of the populace depending on agriculture. Since this agriculture is taken into consideration to be the spine of the Indian economy, the significance of the rural enterprise to authorities sales is probable to be extra in India. Whether consciously or not, maximum Indians rely on agriculture. Others engage with those goods, even as a few are without delay associated with agriculture (Liu, Jun, and Xuewei Wang 2021). Plant infections are then because of a number of pathogens consisting of viruses, bacteria, fungi, and molds, and on occasion environmental situations consisting of precipitation, temperature, and humidity, which function a vector for the unfold of viruses, plagues, and different diseases (Yang and Guo 2017). Manually comparing bushes for analysis is a time-consuming, costly, and complicated process. To clear up those problems, there's a developing call for for an powerful and green automatic ailment detection machine to locate infections at an early level and defend plants from manufacturing downtime and excellent degradation. (Chuanlei et al., 2017). In Turkey, apples may be grown and saved for a totally long term in lots of special cities, particularly Kayseri and Isparta. After bananas and watermelons, it's far the fruit this is produced the maximum withinside the international in 2018. There have been greater than 86 million tonnes produced. (Sottocornola et al., 2021). This leaf species' statistics set became supplied, and withinside the first step, we focused on apple, mango, and grapes leaves, which can be vital plants in phrases of nutrition. The truth that the supplied statistics set enclosed a couple of ailment sorts became taken into consideration. Because of this, it became determined to apply the "apple, mango, and grapes-leaf ailment" statistics set, that is present day and suitable for the study's subject (Metlek 2021)

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2. Related work

Plant diseases were identified by the analysis of previous studies in the literature using characteristics including color, texture, form, and shape of plant infections (Prashar et al., 2017) These study provided the basis for the pre-processing of several leaf images used as deep learning algorithm input.

The deep-neural-networks, Convolution-Neural Network (CNN) widely used for a variety of image-based object recognition tasks. For the purpose of identifying the types of diseases mentioned on apple, mango and grapes leaves, the suggested work uses the CNN model. Some of the photographs come from an existing data set, while others were taken in the actual

3. Methodology

3.1. Convolutional Neural Network For Pest Detection

Deep neural network models that have standardized multilayer perception include convolutional Neural Networks (CNNs). Data overfitting results from an entirely connected network. It facilitates problem-solving and outperforms hierarchical structures. A great place to start is by using basic patterns to construct more complex patterns. The arrangement of neurons in a neural network is referred to as neuronal connectivity. The convolution neural network and biological process are related (Ozguven et al.,2019).

Fig.1 The three primary building blocks of CNNs are convolutional, pooling, and fully connected layers. Of these layers, the convolutional layer is the most significant element as it is responsible for detecting features in the input image. The convolutional layer applies a set of filters to the input image, which helps extract relevant features. The pooling layer reduces the spatial size of the image, while the one by one connected layer combines the extracted features to classify the image into its respective category. The architecture of CNNs is designed in a way that allows for effective feature extraction and classification, making them a popular choice for image recognition and object detection tasks.

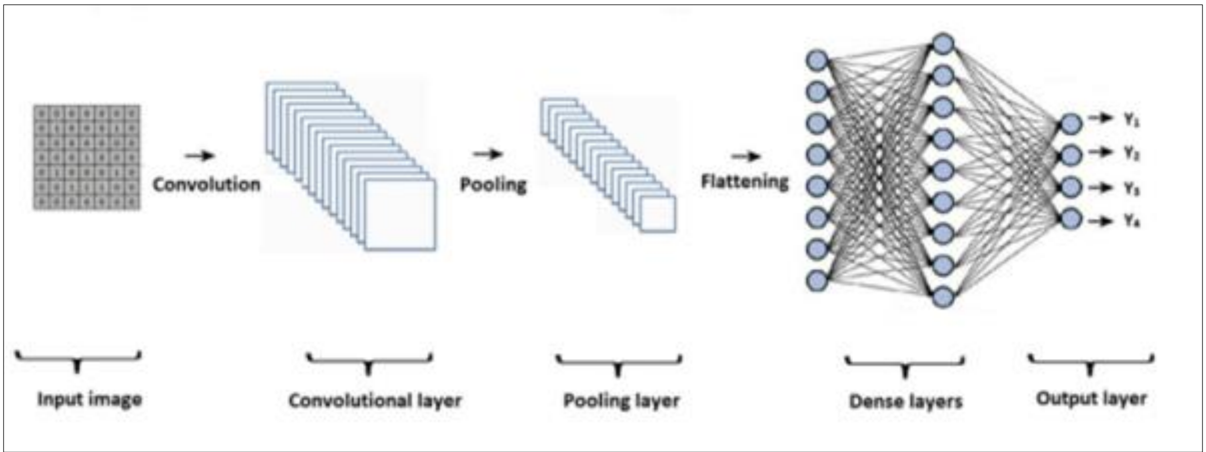

Figure 1 Convolutional neural network architecture for plant leaf disease detection

Fig.2.The process you described is known as the convolution operation, which is a fundamental operation in CNNs. The size of the kernel and the stride of the convolutional operation can be adjusted to control the spatial size of the output feature map. The values in the kernel are typically learned during training using backpropagation, allowing the CNN to learn relevant features from the input data.

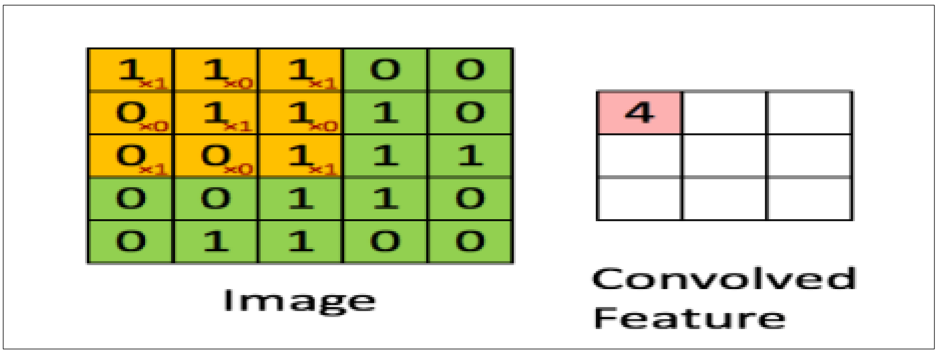

Figure 2 Developing a 3x3x1 image by mixing a 5x5x1 image with a 3x3x1 kernel

Max Pooling and Average Pooling is the two different varieties of pooling shown in Fig.3. In a CNN, Max Pooling is often applied after the convolutional layer to reduce the spatial dimensions of the feature map and extract the most significant features. Reducing the spatial size of the feature maps, Max Pooling also helps to reduce the computational complexity of the network, making it more efficient and faster to train. Overall, Max Pooling is a powerful technique for feature extraction and noise reduction in image processing tasks, and it is commonly used in combination with other techniques to achieve optimal results in CNNs.

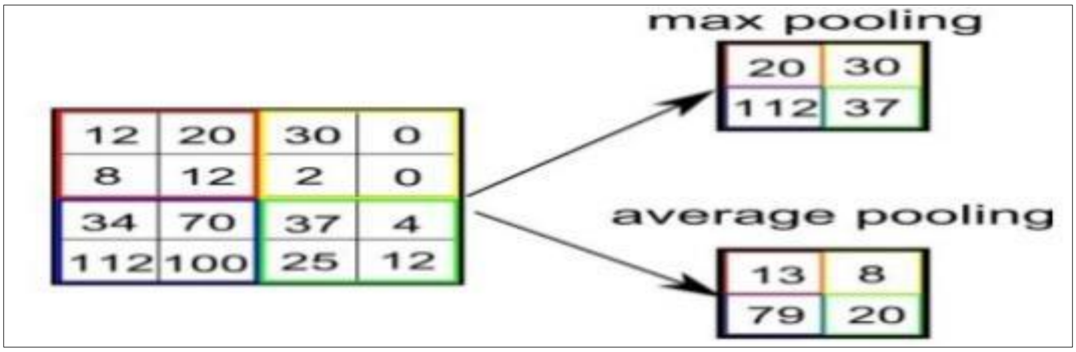

Figure 3 Pooling layer

Convolutional neural networks (CNNs) are composed of multiple layers, with the 2 main types of layers being convolutional layers and pooling layers. Convolutional layers apply a set of filters to the input data, producing a set of feature maps that represent the presence of different features at different locations in the input data. Pooling layers then down sample these feature maps, reducing their spatial resolution and extracting the most salient features. This helps to reduce the computational complexity of the network, while retaining the most important information for classification or prediction.

3.2. Proposed Method

An Android mobile application is a potential solution for identifying leaf diseases in agriculture. The app enables users to capture a photo of the plant and upload it for analysis. This technology can be easily integrated with smartphones, making it an accessible and cost-effective solution for improving agricultural productivity.

The process of identifying leaf diseases comprises steps: capture of images, image pre-processing, segmentation of images, object recognition, and grading. Image pre-processing is a critical stage in image processing, which includes enhancing the image quality, identifying infected and unaffected areas, removing markers that indicate the location of the infection, and classifying the diseases present in the image.

3.3. Dataset

The plant village dataset was used to download pictures of both healthy and damaged plant leaves. Using a dataset comprising 954 images of three distinct plant leaves, the suggested a deep learning model (CNN) put to test. Using illness image labels, each of the 15 classes in the database is classified as either a sick or healthy plant. Fig. 4 displays the sample photographs from the random classes.

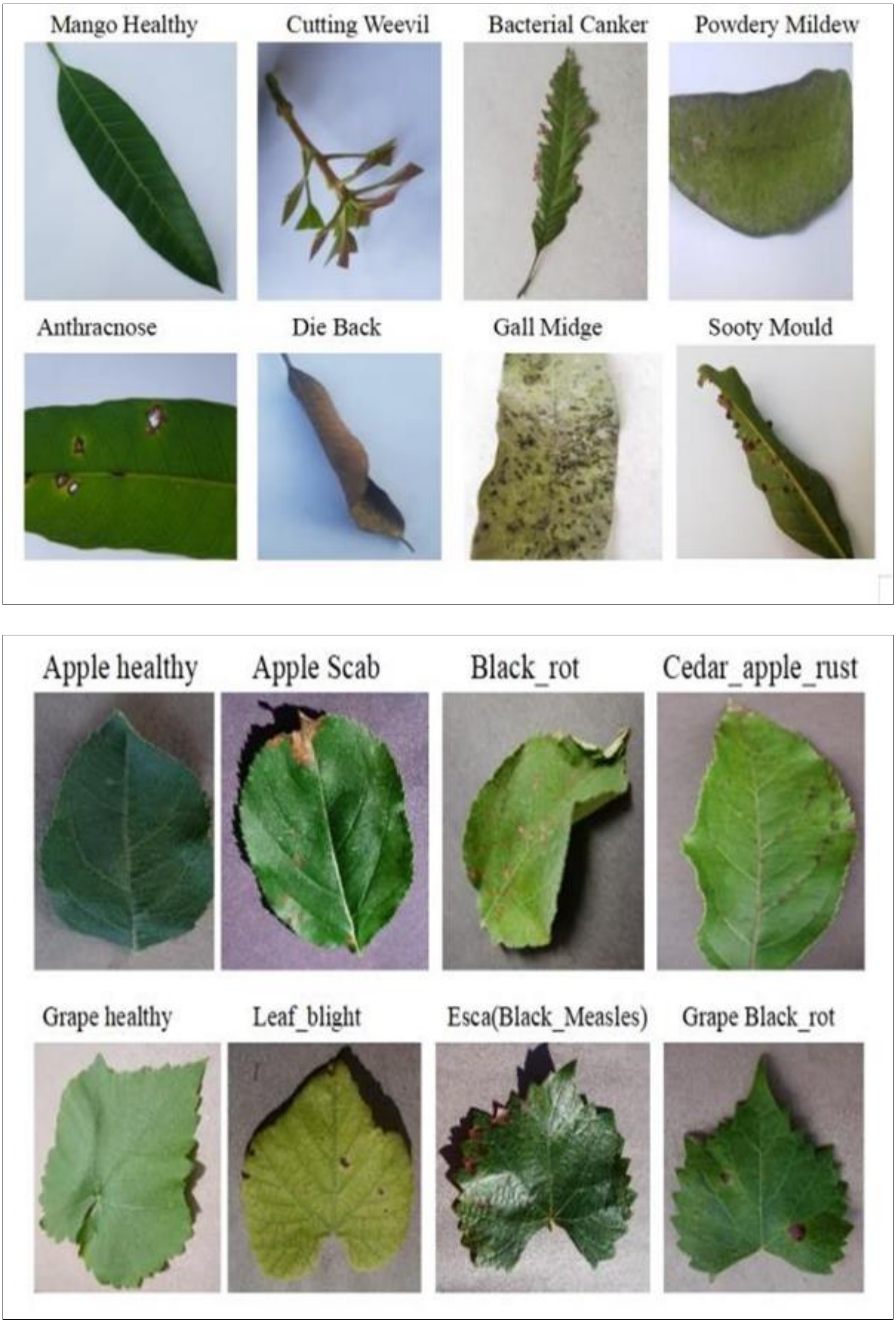

Figure 4 Sample images from leaf disease

3.4. The Pest Detection Module

3.4.1. Image Acquisition

Gathering photographs of both beneficial and ill plant leaves is the process in image acquisition. Picture categories used after training have a significant impact on the system's accuracy. With a camera phone, pictures are taken or gathered on the farm. (Lu, Jinzhu 2021).

Fig.5.The resolution refers to the number of pixels in an image, with higher resolutions generally resulting in higher image quality. Color depth refers to the number of colors that can be represented in an image, with higher color depths generally resulting in more accurate and realistic color representation. Additionally, image processing techniques such as resizing, cropping, and filtering can also impact image quality. It is important to consider these factors when selecting and preparing images for use in computational tasks.

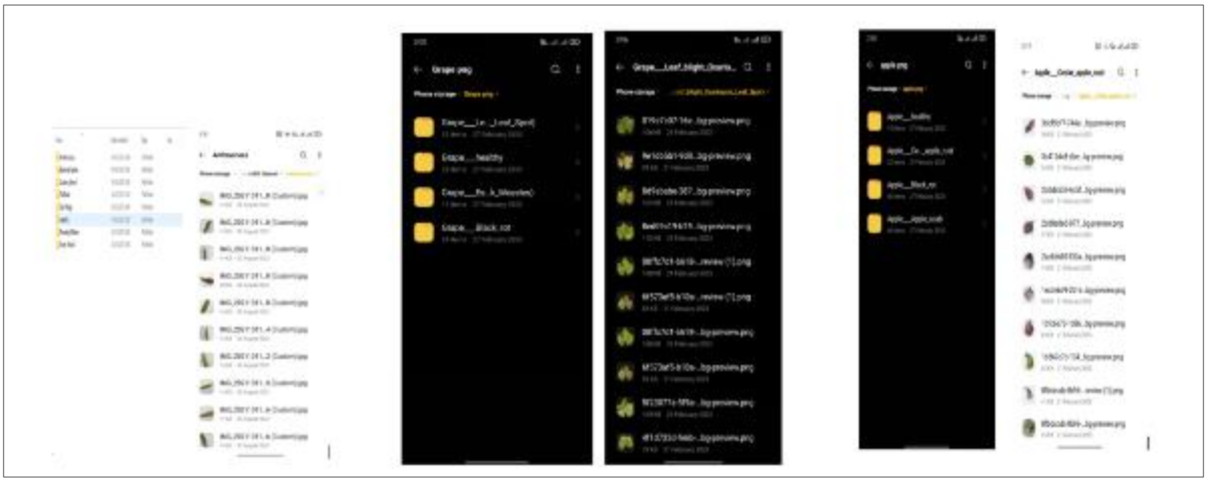

Figure 5 Image acquisition process

3.4.2. Image Pre-processing

Figure 6 Pre-processing of leaf images

Fig. 6. Pre-processing is a crucial step in image processing, which involves preparing the image for analysis or further processing. It can involve various operations such as removing noise, enhancing image quality, resizing the image, trimming, changing the color space, smoothing, and more. If the image has low contrast, procedures for boosting contrast are required to improve the image quality. In some cases, pre-processing may involve isolating specific areas of the image that are of interest for further analysis, such as in object detection or character recognition. Pre-processing can also involve normalization, which is the process of scaling the pixel values of the image to a common range. This can

help improve the accuracy of machine learning models that are trained on the image data. Overall, pre-processing plays a critical role in ensuring the accuracy and reliability of image analysis and machine learning tasks.

3.4.3. Image Segmentation

When pre-processed pictures are obtained from the region of interest, image segmentation is crucial for the identification of leaf disorders. The split is necessary to divide the image into several portions connected to leaves. A number of techniques, including Otsu, k-means, thresholding, region, edge, etc., can be used to segment data. (Shruthi, 2019).

Fig.7. This is an illustration of edge detection in segmentation via deformation, which separates pictures based on intensity values. Infectious leaves exhibit colour changes, and these leaf pictures are removed utilising the clustering process to get rid of the sick parts of the leaves.

Figure 7 Segmentation of leaf images

3.4.4. Feature Extraction

Intrinsic characteristics, also known as descriptive picture features of the illness, are found and gathered throughout the extraction process. Usually, characteristics like colour, texture, and form are recorded. Color features are the primary colour components of the histogram and moments, which use colour to distinguish between various illnesses (Ngugi 2021). Textures are extracted to demonstrate the distribution of picture textures for illness categorization. Entropy, uniformity, and contrast are a few examples of textural characteristics.

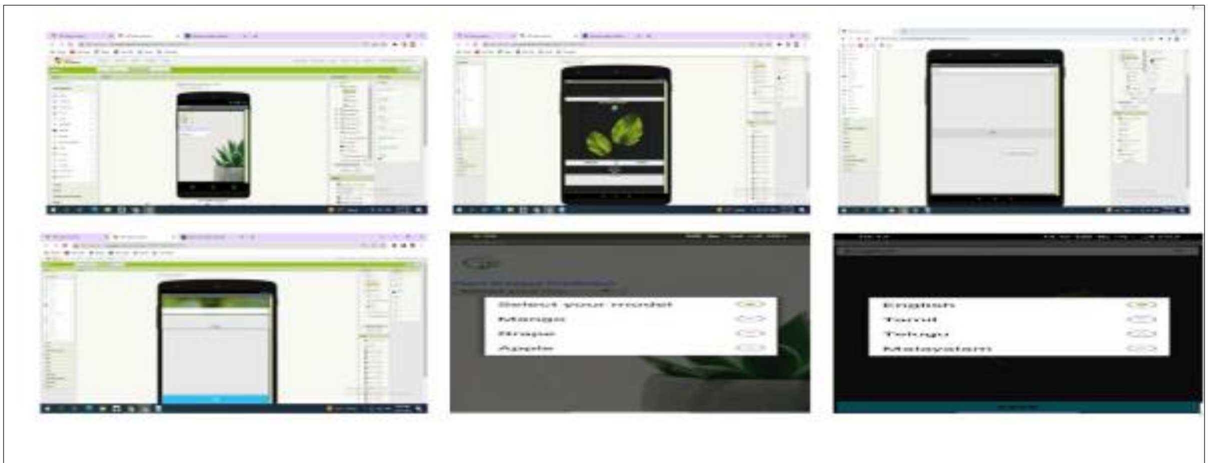

Figure 8 Feature extraction process

Fig.8.Identifying leaf diseases accurately is crucial for maintaining plant health and productivity. While color- and texture-based extraction methods have been commonly used for disease detection, they may not always be effective

since different diseases can have similar visual appearances. Structure-based extraction methods, on the other hand, can offer more distinct features for disease identification.

3.4.5. Disease Classification

Fig.9.Collected traits are used to classify leaf diseases. A supervised method of assigning picture of leaves to different disease classes is called classification. By learning from disease images, the classification technique created describes the preset set of disease classes. This learning phase is called training. Images are tested using the trained classifier, and the level of accuracy achieved depends on the trained classifier.

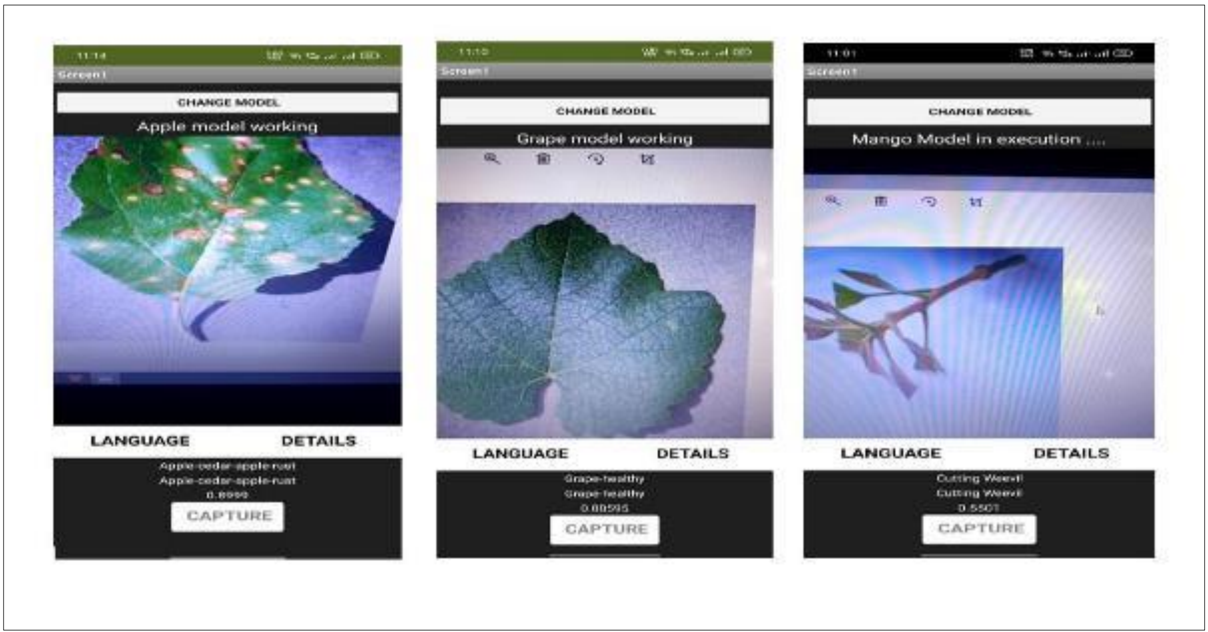

Figure 9 Identification of leaf disease

3.4.6. Outcome

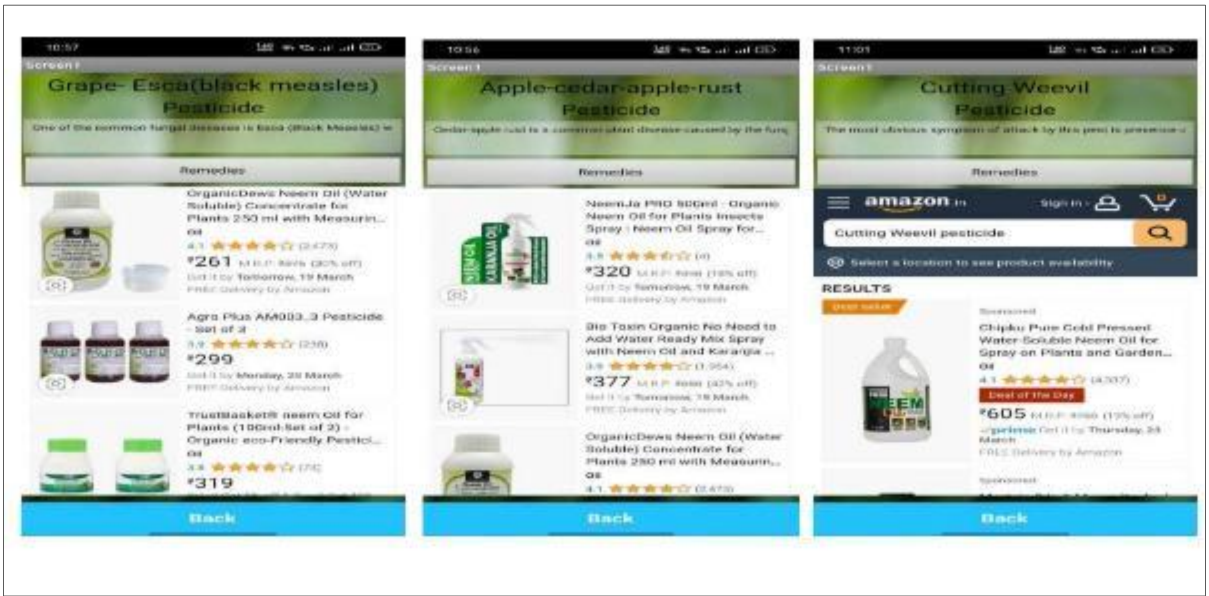

Figure 10 Outcome of the remedies in amazon app

Fig.10 In the developed mobile application, images of leaves are accurately predicted, and the fig 10 indicates leaf diseases and plant disease medicines the software include. Four languages “tamil, english, malayalam and telugu” are used in the, as useful for all farmers and college students. The Amazon application displays pictures and pictures and solutions for diseases.

4. Conclusion

There are lots of techniques for computer vision or automated plant disease detection and categorization, however this research field still needs improvement. There are also still no commercial solutions available on the market, with the exception of those that deal with identification of plant species using images of the leaves.

In our study, we have proposed an automated approach based on machine learning and computer vision techniques to identify diseases in apples, mango, and grape leaves. The model has been trained specifically for certain plant species with particular plant diseases. Identifying and classifying leaf diseases using digital images can be a challenging task. Therefore, rapid diagnosis of leaf diseases is crucial for farmers to take timely actions. Our proposed approach makes use of a total of three distinct types of plant leaf images for training the CNN model.

The future of the upcoming study is to create a comprehensive system with characteristics like displaying known diseases in fruits, vegetables, and other plants based on leaf images taken with a mobile phone's camera. Future study will also involve increasing the model's application by training it to recognise plant diseases over a larger range of geographical areas, merging drone-taken aerial images of leaf disease convolution neural networks for object detection, and more.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest.

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