Image – Based Disease Detection App for Agriculture

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1. *Abstract:*

Machine learning (ML) is an emerging field that is being increasingly applied to the agricultural sector to improve crop yields, optimize resource use, and enhance overall agricultural efficiency. ML algorithms use statistical and computational techniques to learn from data and identify patterns, allowing for better predictions and decision-making.

Disease detection in agriculture by image is an important application of machine learning (ML) that can help farmers identify and diagnose plant diseases early on, allowing for targeted treatment and prevention of crop losses. Image-based disease detection in agriculture is an effective application of machine learning that can help farmers detect and diagnose plant diseases early, leading to better crop management and reduced crop losses. Also, an image-based disease detection app for agriculture can be a profitable business idea with the potential to create value for both farmers and agricultural technology companies.

2. *Problem Statement:*

FAO estimates that annually between **20 to 40 percent** of global crop production are lost to pests. The presence of plant diseases on an agricultural farm costs farmers a lot of money. Crop losses owing to animals, diseases, pests, and weeds account for 20 to 40 percent of the overall global agricultural productivity, according to IRJET research. The traditional method of physically analysing aspects of leaves, such as texture, colour, and form, to identify infections is not always efficient. As a result, most farmers throughout the world engage professional agriculturists to diagnose diseases in their crops on large farms. It is, however, a time-consuming and costly process.

3. Market/ Customer/ Business need Assessment:

Every year, agriculture sector face ton of loss due plant disease. To reduce this, it is required that every farmer must be available with correct recommendations and advice to help them crop which is impossible in a way. Also, even if is there, it would cost lot of money as well as time to the yielders. Plant diseases can significantly impact the profitability and sustainability of farming operations, highlighting the need for effective disease management strategies and tools, such as image-based disease detection apps that can help farmers identify and diagnose diseases early on, and take appropriate measures to prevent or control them.

All these problems can be solved to an extend by Image based Disease Detection app. There is a significant market and customer need for image-based disease detection apps in agriculture. Here are some reasons why:

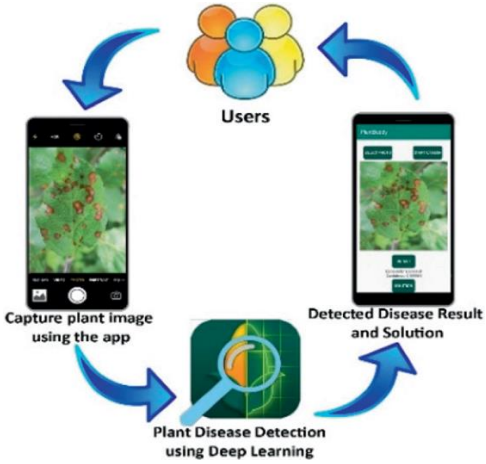
1. Rising Demand for Sustainable Agriculture: There is an increasing demand for sustainable agriculture practices that minimize the use of pesticides and other chemicals. Image-based disease detection apps can help farmers to identify and diagnose diseases early on, reducing the need for chemical treatments and promoting sustainable farming practices.

2. Need for Cost-effective Solutions: Many small and medium-sized farmers have limited resources and cannot afford expensive equipment or specialized services. Image-based disease detection apps can provide a cost-effective solution for disease management, reducing the need for expensive hardware or expert consultation.

3. Increasing Adoption of Precision Agriculture: Precision agriculture technologies, such as drones, sensors, and GPS, are becoming more common in agriculture. Image-based disease detection apps can be integrated with these technologies to provide farmers with a comprehensive solution for crop management.

4. Growing Market for Agricultural Technology: The agricultural technology market is growing rapidly, driven by increasing demand for sustainable and efficient farming practices. Image-based disease detection apps can help agricultural technology companies to differentiate themselves and create value for their customers.

Overall, an image-based disease detection app can provide significant value to farmers and the agricultural industry, creating potential revenue streams for agricultural technology companies. By developing innovative business models and partnering with stakeholders in the agriculture sector, an image-based disease detection app can be a successful and profitable business venture.



4. Target Specifications:

The targets to be achieved with their solution are:

A. To change traditional method of checking into disease of plants into a faster and accurate process by involving ML.

B. Reducing loss of crops and loss of farmers and increase profit in agriculture sector.

C. Dataset of diseased plants is collected so that the prediction and recommendation is correct.

D. The system should be able to analyse images and provide a diagnosis in real-time, allowing farmers to quickly take action to prevent or control disease outbreaks. This can be achieved through machine learning algorithms that are trained on a large dataset of plant images and disease information.

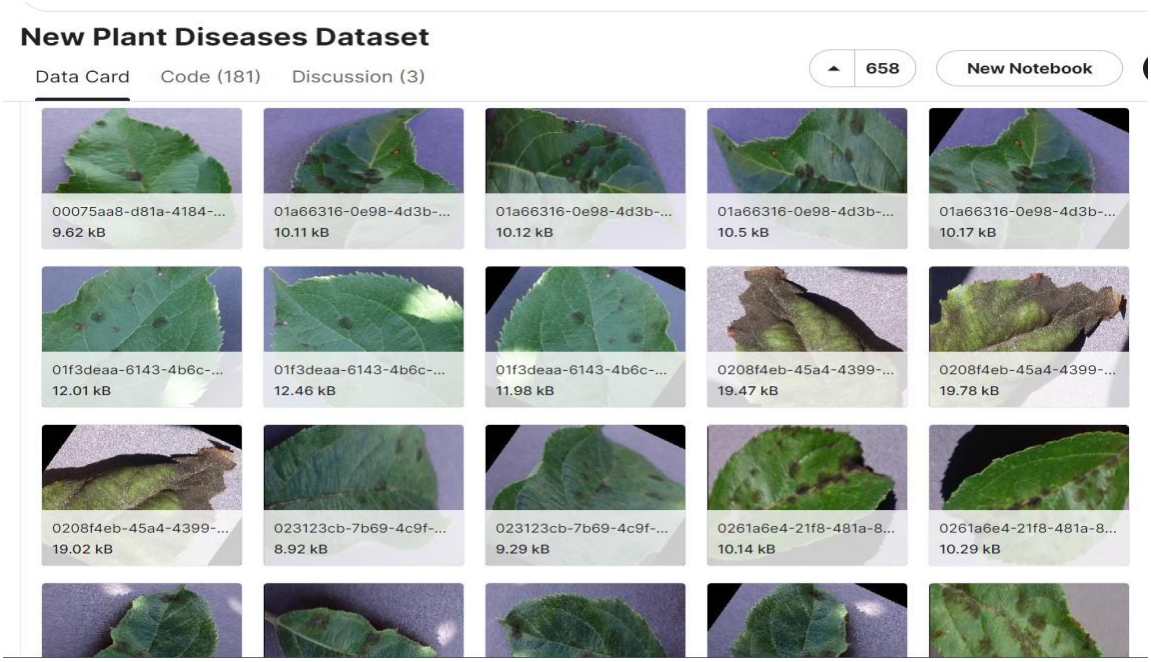
E. The system should be able to handle large volumes of data and support multiple crops and disease types. his can be achieved through cloud-based infrastructure and distributed computing techniques.

F. The system should be able to accurately identify and diagnose plant diseases, with a high degree of precision and low false-positive rate. This can be achieved through a well- designed user interface and a simple workflow.

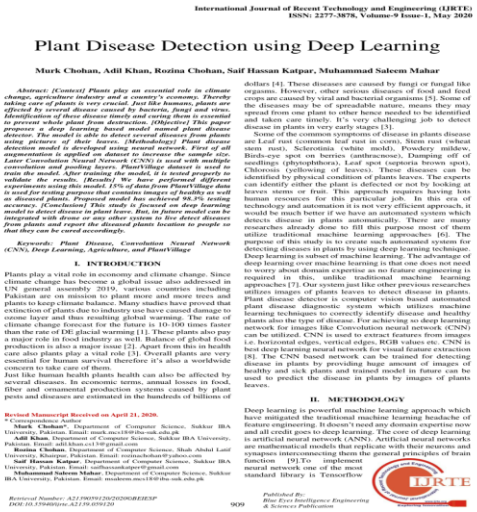
5. External Searches:

The dataset for the application can be found on Kaggle naming ‘Plant Disease Dataset.’ The dataset consists about the diseases picked up by plants in form of images.

The sources of subsequent information are provided below as:



Also, International Journal of Recent Technology and Engineering (IJRTE) have published a publication regarding the process and concept of Plant disease detection by machine learning.
The following link for the same is:
'https://www.researchgate.net/publication/341025012_Plant_Disease_Detection_using_Deep_Learning'



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Plant Disease Detection using Deep Learning

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Abstract: [Context] Plants play an essential role in climate change, agriculture industry and a country's economy. Thereby taking care of plants is very crucial. Just like humans, plants are affected by several disease caused by bacteria, fungi and virus. Identification of these disease timely and curing them is essential to prevent whole plant from destruction. [Objective] This paper proposes a deep learning based model named plant disease detector. The model is able to detect several diseases from plants using pictures of their leaves. [Methodology] Plant disease detection model is developed using neural network. First of all augmentation is applied on dataset to increase the sample size. Later Convolution Neural Network (CNN) is used with multiple convolution and pooling layers. PlantVillage dataset is used to train and test the model. Cross validation is also applied to validate the results. [Results] We have performed different experiments using this model. 15% of data from PlantVillage data is used for testing purpose that contains images of healthy as well as diseased plants. Proposed model has achieved 98.3% testing accuracy. [Conclusion] This study is focused on deep learning model to detect disease in plant leave. But, in future model can be integrated with drone or any other system to live detect diseases from plants and report the diseased plants location to people so that they can be cured accordingly.

Keywords: Plant Disease, Convolution Neural Network (CNN), Deep Learning, Agriculture, and PlantVillage

I. INTRODUCTION

Plants play a vital role in economy and climate change. Since climate change has become a global issue also addressed in UN general assembly 2019, various countries including Pakistan are on mission to plant more and more trees and plants to keep climate balance. Many studies have proved that extinction of plants due to industry use have caused damage to ozone layer and thus resulting global warming. The rate of climate change forecast for the future is 10-100 times faster than the rate of DE glacial warming [1]. These plants also pay a major role in food industry as well. Balance of global food production is also a major issue [2]. Apart from this in health care also plants play a vital role [3]. Overall plants are very essential for human survival therefore it's also a worldwide concern to take care of them.
Just like human health plants health can also be affected by several diseases. In economic terms, annual losses in food, fiber and ornamental production systems caused by plant pests and diseases are estimated in the hundreds of billions of dollars [4]. These diseases are caused by fungi or fungal like organs. However, other serious diseases of food and feed crops are caused by viral and bacterial organisms [5]. Some of the diseases may be of spreadable nature, means they may spread from one plant to other hence needed to be identified and taken care timely. It's very challenging job to detect disease in plants in very early stages [3].
Some of the common symptoms of disease in plants disease are Leaf rust (common leaf rust in corn), Stem rust (wheat stem rust), Sclerotinia (white mold), Powdery mildew, Birds-eye spot on berries (anthracnose), Damping off of seedlings (phytophthora), Leaf spot (septoria brown spot), Chlorosis (yellowing of leaves). These diseases can be identified by physical condition of plants leaves. The experts can identify either the plant is defected or not by looking at leaves stems or fruit. This approach requires having lots human resources for this particular job. In this era of technology and automation it is not very efficient approach, it would be much better if we have an automated system which detects disease in plants automatically. There are many researches already done to fill this purpose most of them utilize traditional machine learning approaches [6]. The purpose of this study is to create such automated system for detecting diseases in plants by using deep learning technique. Deep learning is subset of machine learning. The advantage of deep learning over machine learning is that one does not need to worry about domain expertise as no feature engineering is required in this, unlike traditional machine learning approaches [7]. Our system just like other previous researches utilizes images of plants leaves to detect disease in plants. Plant disease detector is computer vision based automated plant disease diagnostic system which utilizes machine learning techniques to correctly identify disease and healthy plants also the type of disease. For achieving so deep learning network for images like Convolution neural network (CNN) can be utilized. CNN is used to extract features from images i.e. horizontal edges, vertical edges, RGB values etc. CNN is best deep learning neural network for visual feature extraction [8]. The CNN based network can be trained for detecting disease in plants by providing huge amount of images of healthy and sick plants and trained model in future can be used to predict the disease in plants by images of plants leaves.

II. METHODOLOGY

Deep learning is powerful machine learning approach which have mitigated the traditional machine learning headache of feature engineering. It doesn't need any domain expertise now and all credit goes to deep learning. The core of deep learning is artificial neural network (ANN). Artificial neural networks are mathematical models that replicate with their neurons and synapses interconnecting them the general principles of brain function [9].To implement neural network one of the most standard library is Tensorflow

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6. *Benchmarking alternate products*:

Benchmarking alternate products for an image-based disease detection app for agriculture involves comparing your product against existing solutions in the market. An existing

App is ‘AGRIO’ based on artificial intelligence.

Serial no.	Services	Existing App	Our App
1.	Features	Provide suggestions For crop disease	Provide suggestion for crop disease as well as provide the needful medication by exports.
2.	Dataset	Dataset is limited to some species and crops	Large dataset covering almost every present species of plants.
3.	Accuracy	Accurate within the training set but fails to identify out of set diseases.	Accuracy to be high with large training and testing dataset.
4.	User-friendly	Interface easy to handle.	Interface easy to handle by any type of user.
5.	Areas of improvement	Speed and accuracy.	Day by day updation of dataset.
6.	Market Reach	Has good reach among users.	Require terms for market reach

7. *Applicable Regulations (Government and Environmental*):

a. Regulation of environmental damage and use of chemicals in general.
b. Regulations on Use of fertilisers.
c. Any app that collects, stores, or processes personal or sensitive data must comply with data privacy laws and regulations
d. App and any associated algorithms, models, or data should be compliant with intellectual property laws and regulations
e. Antitrust Regulations

8. Applicable Constraints:

a. Data Collection from fields and agriculture areas.
b. Continuous data update and maintenance
c. Lack of technical knowledge for the user(farmers)
d. Correct working of neural network algorithm
e. Make the app in reach of the users.

9. *Business Model*:

An image-based disease detection app for agriculture can be a profitable business idea with the potential to create value for both farmers and agricultural technology companies. Here are some potential business profits for an image-based disease detection app:

1. Subscription-based Model: A subscription-based model charges farmers a monthly or annual fee for access to the app's disease detection and identification capabilities. This model is beneficial for farmers who have limited resources and cannot afford expensive hardware or equipment.

2. Partnership with Agricultural Technology Companies: An image-based disease detection app can partner with agricultural technology companies to integrate its capabilities into their hardware or software platforms. This model can create value for both parties by providing farmers with a comprehensive solution for crop management.

3. Government or NGO Partnership: The government or non-governmental organizations can partner with an image-based disease detection app to provide farmers with free or subsidized access to the app's capabilities. This model can create social impact and promote sustainable agricultural practices.

Overall, an image-based disease detection app can provide significant value to farmers and the agricultural industry, creating potential revenue streams for agricultural technology companies. By developing innovative business models and partnering with stakeholders in the agriculture sector, an image-based disease detection app can be a successful and profitable business venture.

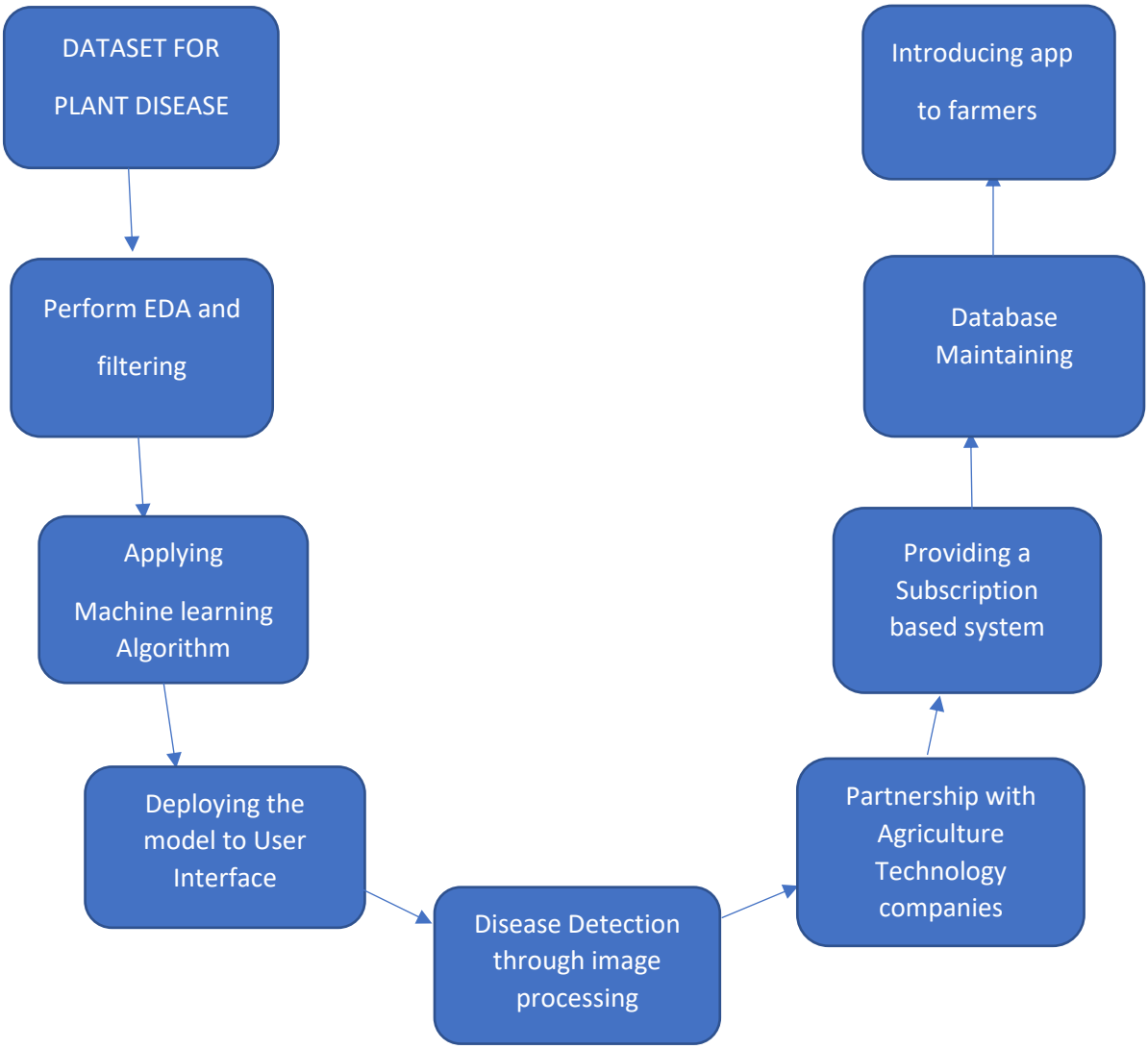
10. *Concept Generation*:

As agriculture struggles to support the rapidly growing global population, plant disease reduces the production and quality of food, fibre and biofuel crops. Losses may be catastrophic or chronic, but on average account for 42% of the production of the six most important food crops. Farmers spend billions of dollars are on disease management, often without adequate technical support, resulting in poor disease control, pollution, and harmful results. In addition, plant disease can devastate natural ecosystems, compounding environmental problems caused by habitat loss and poor land management.

To reduce this problem, many technical experts are there who advice the farmers for betterment of their crop. But not every farmer is in direct contact with these experts. Even if the expert is present, it would cost a high amount to farmer with loss of time in addition.

An image based disease detection app is a way to help farmers . This can provide a immediate and cost friendly solution to them. Also, to make the app, updated with the diseases and trends, machine learning is used. Machine learning provide the ability to the app to learn daily and be updated.

11. *Final Product prototype*:



12. Product details:

This is an app which takes in the image of a plant and compare it with the dataset consisted in the system and gives out the outcome as the disease name along with its cure recommendations. The system is based on machine learning which will update itself with every use. This app is a help to many of farmers who need immediate help for their crop disease detection within the minimal cost. The app also can provide a one to one

interaction with agriculture experts as have the partnership with Agriculture Technology Companies.
Crop diseases are an important problem, as they cause serious reduction in quantity as well as quality of agriculture products. An automatic plant-disease detection system provides clear benefit in monitoring of large fields, as this is the only approach that provides a chance to discover diseases at an early stage. With very less computational efforts the optimum results were obtained, which also shows the efficiency of the proposed algorithm in recognition and classification of the leaf diseases.

12.1 Algorithm:

Deep learning algorithms can be very effective for image-based disease detection in agriculture. One commonly used deep learning algorithm for image classification is Convolutional Neural Networks (CNNs). Here is a high-level overview of how CNNs work for image-based disease detection:

1. Input layer: The input layer receives the image data and prepares it for processing.

2. Convolutional layer: The convolutional layer applies filters to the image to extract important features such as edges, curves, and textures.

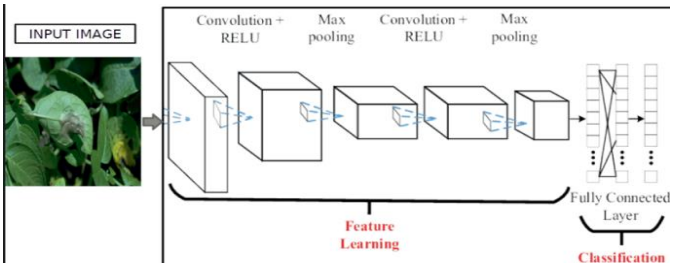
3. Pooling layer: The pooling layer reduces the size of the feature maps to simplify the model and reduce overfitting.

4. Fully connected layer: The fully connected layer connects all the neurons from the previous layer to every neuron in the next layer.

5. Output layer: The output layer provides the classification results, indicating whether the image contains a particular disease or not.

   To train a CNN model for image-based disease detection, a large dataset of labeled images is needed. The images are divided into training and validation sets, and the model is trained on the training set using backpropagation to adjust the weights of the neurons to minimize the error. The validation set is used to evaluate the model's performance and adjust hyperparameters such as learning rate, number of layers, and filter size.

   Once the model is trained, it can be deployed as part of the image-based disease detection app. The app takes in an image, processes it through the CNN model, and provides the classification results to the user.



12.2 Working:

The working of an image-based disease detection app involves several steps, which can be summarized as follows:

1. Image Acquisition: The user captures or uploads an image of the plant or crop they suspect is affected by a disease. This image serves as the input to the disease detection app.

2. Image Processing: The image is pre-processed to enhance the quality and extract relevant features. This step involves tasks such as image resizing, noise reduction, and segmentation, which prepare the image for analysis.

3. Disease Detection: The pre-processed image is then analysed using computer vision and machine learning algorithms to detect any signs of disease. The algorithms may use a variety of techniques such as convolutional neural networks (CNNs).

4. Diagnosis and Recommendation: Once the disease is identified, the app provides a diagnosis and recommends appropriate steps to manage or treat the disease. This information can include suggestions for spraying pesticides, removing the infected plant, or taking other measures to prevent the spread of the disease.

5. User Feedback: The user may provide feedback on the accuracy of the app's diagnosis or the efficacy of the recommended measures. This feedback can be used to improve the app's performance and accuracy over time.

6. Database Management: The app may store the analyzed images and their corresponding diagnosis and recommendations in a database for future reference and analysis. This data can be used to improve the accuracy of the algorithms and to track the spread of diseases over time.

12.3 Team required to develop:

1. Machine learning engineering
2. Business analyst
3. Software developer

4. Data Analyst

5. Database Engineer

13. Code Implementation:

This code implementation part will show some small-scale validation with the dataset.

a. **LIBRARIES TO BE IMPORTED**:

```
In [2]: import numpy as np
        import pandas as pd
        import matplotlib.pyplot as plt

        import keras
        from keras.preprocessing.image import ImageDataGenerator
```

```
In [ ]:
```

```
[5]: import tensorflow as tf
```

```
[6]: from tensorflow.keras import models, layers
```

b. **DATA SETUP**:

```
def convert_image_to_array(image_dir):
    try:
        image = cv2.imread(image_dir)
        if image is not None :
            image = cv2.resize(image, default_image_size)
            return img_to_array(image)
        else :
            return np.array([])
        except exception as e:
            print(f"Error : (e)")
            return None
```

14. *Conclusion*:

Food is a basic need of human beings that is now satisfied through farming. Machine learning in agriculture can optimize the way food gets to our table and revolutionize one of the most critical sectors of the economy. It can help us increase efficiency and accuracy in decision-making while simultaneously minimizing risks and costs associated with agricultural operations.

The detection of plant disease is of vital importance in practical agricultural production. It scrutinizes the plant's growth and health condition and guarantees the regular operation and harvest of the agricultural planting to proceed successfully.

Machine Learning based disease detection app can be a boon for farmers. It is a simple application which not only save the cost but also helps in cutting time. Just by a click of plant, farmers can cure their crop. Machine learning has came a long way and the time is not far when it will came out as an essential part of human life and works for benefit of whole humankind.