Plants disease

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Problem statement

The agricultural industry faces significant challenges in effectively detecting and diagnosing crop diseases. Early identification and accurate diagnosis of crop diseases are crucial for preventing yield losses and ensuring food security. However, farmers often lack the necessary expertise and resources to detect and manage diseases promptly. Therefore, there is a need for an AI-based solution that can assist farmers in detecting and diagnosing crop diseases accurately and in a timely manner.

Market/Customer/Business Need Assessment:

The target market for this AI product/service is small and medium-sized farmers, agricultural cooperatives, and local food chains. These businesses often struggle with limited resources and access to specialized agricultural expertise. By providing an AI-based solution for crop disease detection and diagnosis, we aim to address the following market needs:

1. Timely and accurate identification of crop diseases to prevent yield losses.
2. Reduction in the use of pesticides by targeting treatments only when necessary.
3. Accessible and user-friendly technology that does not require extensive technical expertise.
4. Cost-effective solution compared to traditional manual methods or hiring specialized consultants.

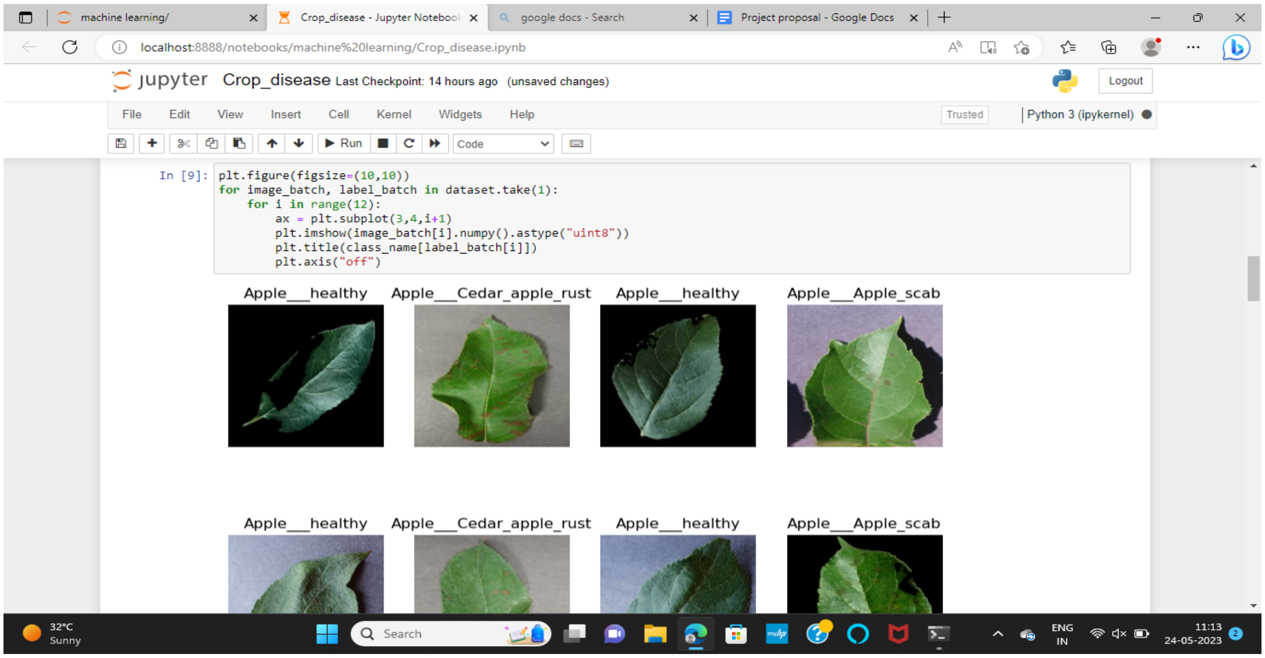
Target Specifications and Characterization

The target customers for this product/service are small and medium-sized farmers who cultivate various crops. These farmers typically have basic computer literacy and access to smartphones or computers. The AI solution should be designed to be user-friendly, intuitive, and accessible to individuals with limited technical knowledge.

External Search

During the development process, we will conduct extensive research on crop diseases, their symptoms, and the existing methods for disease detection and diagnosis. We will refer to agricultural databases, and online resources to gather relevant information. I use the online shopper dataset for this project, dataset can be found here: kaggle link

Let's view our dataset:



See some more information about our dataset:

CNN algorithms analyze an image and extract its features. Convolutional neural networks are deep learning algorithms that can process large datasets containing millions of parameters, modeled on 2D images, and connect the resulting representations to the corresponding outputs. A CNN is a supervised multilayer network that can dynamically learn new features from datasets. In nearly all significant classification challenges, CNNs have achieved state-of-the-art results recently. In the same architecture, they are also able to systematically isolate features and categorize them.

A. Flow Chart

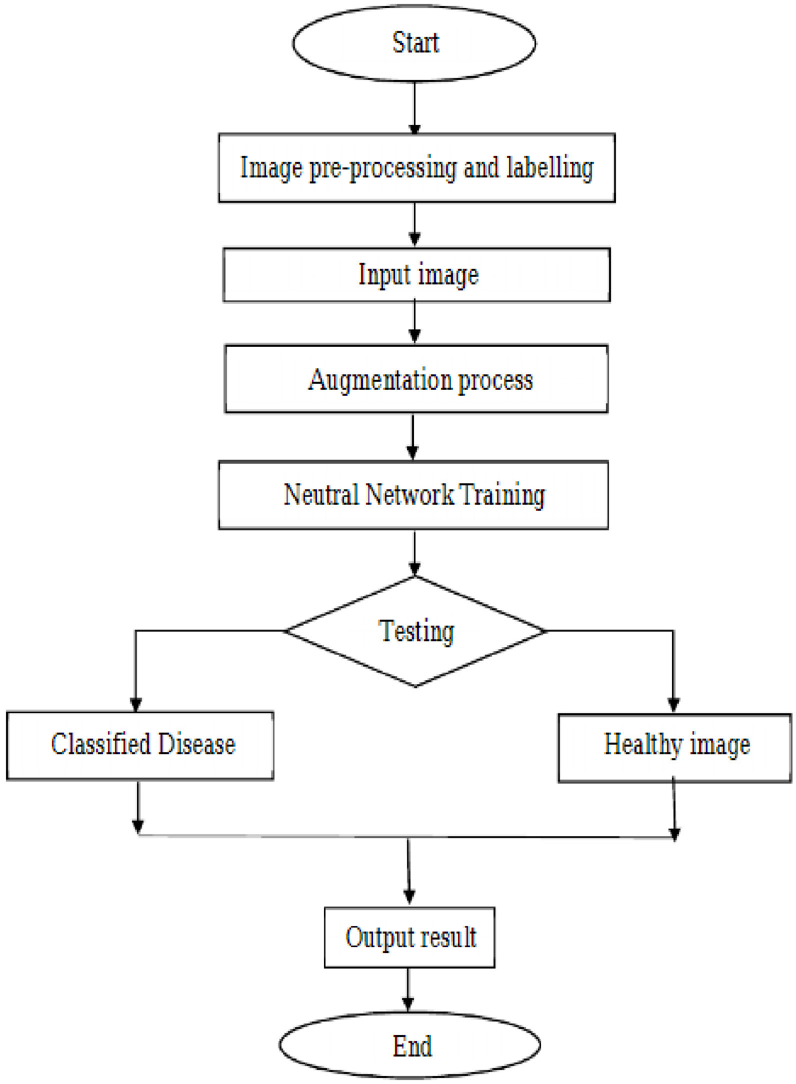


Fig. 1: System Design

Dataset Description:

This dataset consists of 6,342 images of diseased and healthy plant leaves, which were classified into 4 classes to train a deep learning and convolutional neural network which can identify the diseases

Clas s	Plant name	Healthy or Diseased	Disease name	Image number
1	Apple	Diseased	Apple_scab	1260
2	Apple	Diseased	Black_rot	1242
3	Apple	Diseased	Cedar_apple_rust	550
4	Apple	Healthy	Healthy	3290

Data Preprocessing:

The dataset included images that were resized to minimize training time, which was calculated automatically by a Python script that uses the OpenCV framework. The input data is pre-processed by scaling the data points from [0, 255] (the minimum and maximum

The dataset is divided into two parts, one for training and one for testing. 80% of the

dataset is

for training, and 20% for testing. A training dataset consists of 5,074 images and testing is

made of 1,268 images. The training

dataset is used to train the model while the testing dataset is kept unseen so that accuracy of the model can be tested.

Data Augmentation:

Data augmentation is a technique for increasing the number of images in a database. Various operations such as shifting, rotating,

zooming, and flipping are applied to image datasets to diversify our dataset. By augmenting the dataset and adding distortion to the

images, overfitting can be reduced during the training period. The Keras ImageDataGenerator class implements in-place data

augmentation or on-the-fly data augmentation. Through this type of augmentation of data, we can make sure that our network, when trained, sees new variations every time epoch. It allows us to come up with high results utilizing a smaller dataset.

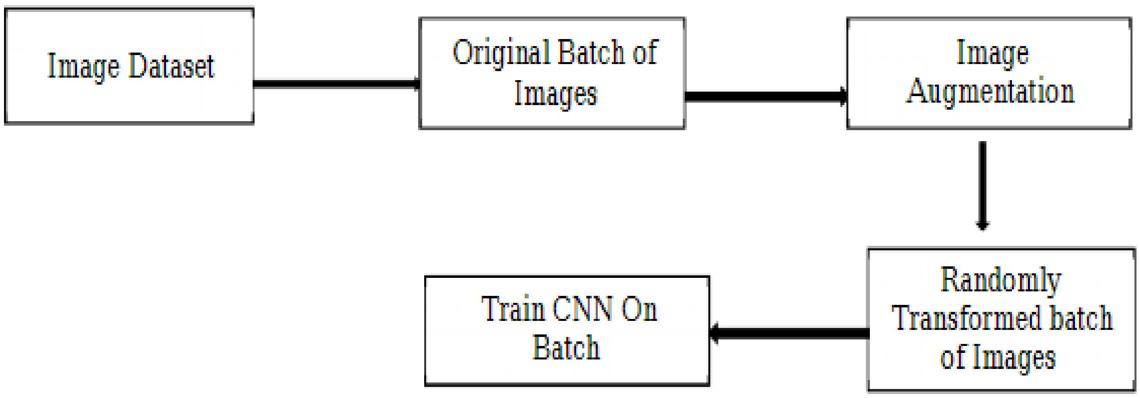


Fig. 2. In-place Data Augmentation

demonstrates the process of applying in-place data augmentation:

1) Step 1: The ImageData Generator is presented with an input batch of images.

2) Step 2: Next, the ImageDataGenerator transforms each image into a random series of rotations, flipping , cropping etc.

3) Step 3: The randomly transformed batch is trained by using CNN. E. Architecture of Convolutional Neural Network CNN architecture is divided into two main parts :

1) A convolution tool that separates and categorizes the various features of images for analysis in what is called Feature Extraction.

2) Convolution is applied to the output of the fully connected layer and predicts the class of image based on the features extracted before.

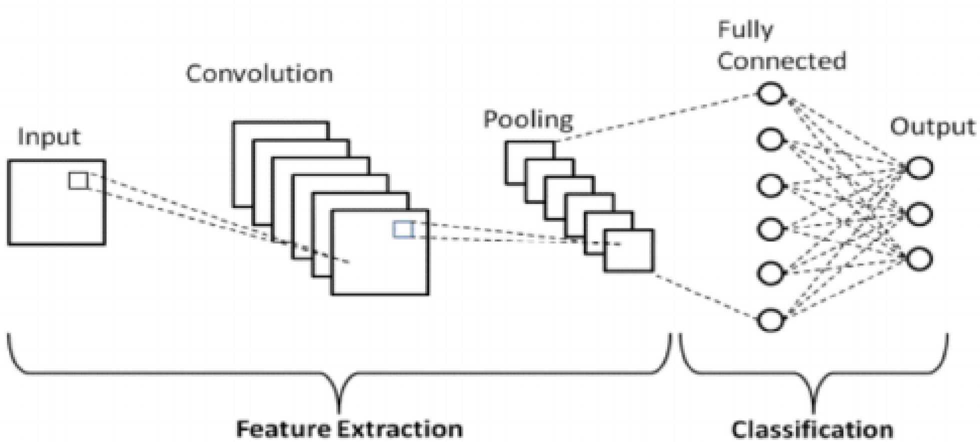


Fig. 3: CNN Architecture

Benchmarking Alternate Products

We will conduct a thorough analysis of existing products and services in the market that offer crop disease detection and diagnosis solutions. This analysis will help us identify the strengths and weaknesses of these products and highlight the unique value proposition of our AI-based solution.

Applicable Patents

We will investigate any relevant patents related to AI techniques, image processing algorithms, or disease detection systems. This research will ensure that our product/service does not infringe on existing patents and allows us to incorporate any patented technology in a legally compliant manner.

Applicable Regulations

We will review the government regulations and environmental standards imposed on the agricultural industry. Compliance with regulations related to data privacy, pesticide usage, and environmental protection will be essential in the development and deployment of our AI product/service.

Applicable Constraints

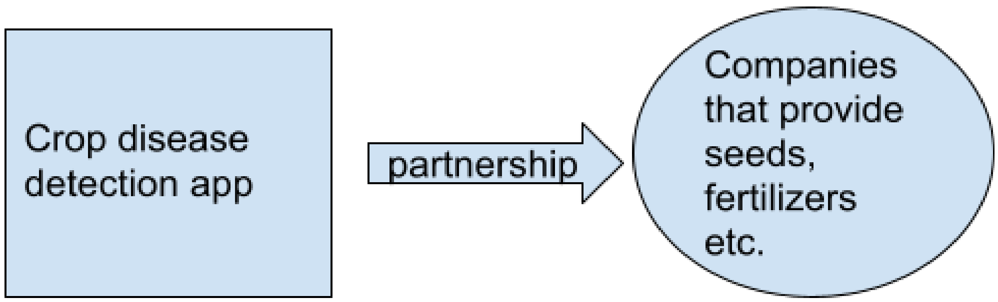
We will consider various constraints, such as budget limitations, hardware and software requirements, and the need for domain expertise in agriculture and AI. The product/service should be scalable, cost-effective, and suitable for deployment in resource-constrained environments.

Business Model

Our proposed business model involves offering a subscription-based service for crop disease detection and diagnosis. Farmers can subscribe to our platform and access the AI-powered system through a web or mobile interface. We will also explore partnerships with agricultural cooperatives and local food chains to provide additional value-added services.

Customer Segments: Small-scale farmers: Targeting farmers who cultivate a variety of crops and face challenges in detecting and managing crop diseases.

Agricultural input suppliers: Partnering with companies that provide seeds, fertilizers, and pesticides to offer the crop disease detection service as an add-on.



Value Proposition: Accurate and timely disease detection: Provide farmers with an AI-enabled system that can accurately identify crop diseases at an early stage, enabling timely intervention to minimize crop losses.

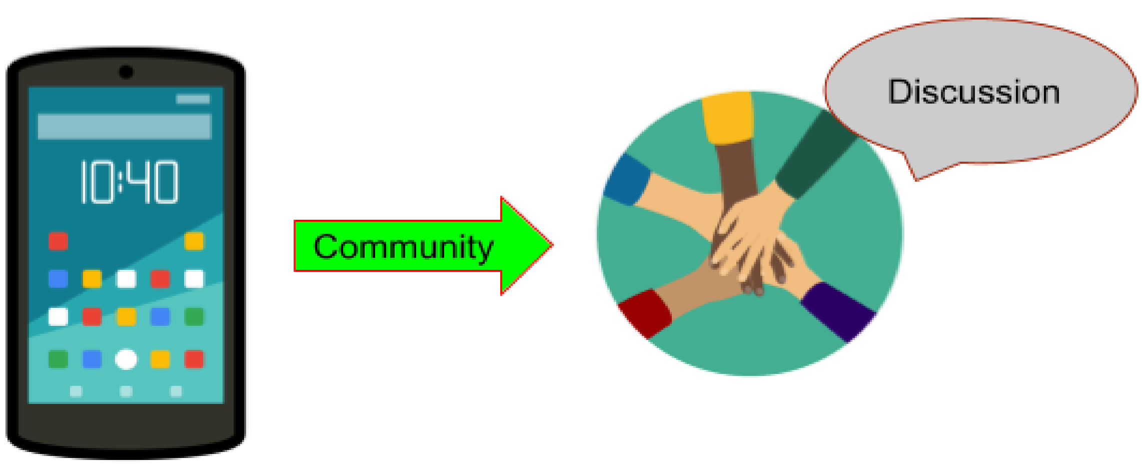
Cost-effective solution: Offer an affordable and accessible tool that eliminates the need for expert knowledge or expensive laboratory tests, making it suitable for small-scale farmers.

Improved productivity: Enable farmers to make informed decisions regarding crop management practices, leading to increased yields and improved overall farming practices.

Channels: Online platform: Provide a user-friendly online platform or mobile application where farmers can access the AI-enabled crop disease detection system.

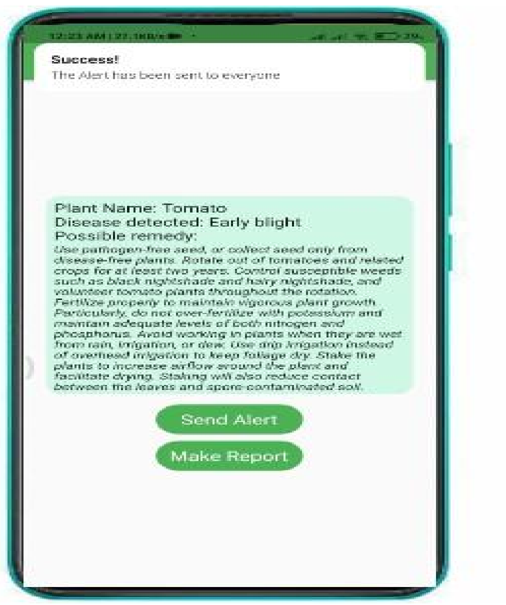
Agricultural extension services: Collaborate with agricultural extension services and local farming communities to raise awareness and distribute information about the service.

Partnerships with agricultural input suppliers: Collaborate with companies that provide agricultural inputs to bundle the crop disease detection service with their products.



Customer Relationships: Self-service platform: Design a user-friendly platform that allows farmers to access the crop disease detection system and receive automated disease reports.

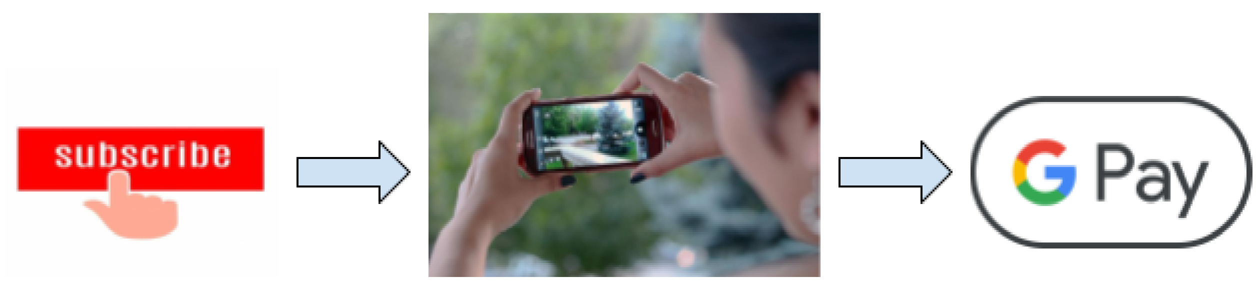
Customer support: Provide customer support channels, such as email or chat, to address any technical issues or inquiries from farmers.



Revenue Streams: Subscription-based model: Offer different subscription tiers based on the number of crops and frequency of disease detection required by farmers.

Pay-per-scan: Provide an option for farmers to pay a fee for each crop disease detection scan they perform.

Partnerships: Generate revenue through partnerships with agricultural input suppliers by receiving a percentage of the sales of bundled products.



Key Resources: AI technology and infrastructure: Develop and maintain the AI algorithms and infrastructure required for image recognition and disease classification.

Crop disease image database: Build a comprehensive database of labeled crop disease images to train and improve the accuracy of the AI models.

Technical expertise: Employ a team of data scientists, software engineers, and agricultural experts to develop and continuously improve the system.

Key Activities: System development: Continuously enhance the AI models and algorithms for accurate disease detection and classification.

Data collection and analysis: Collect and analyze crop images, weather data, and other relevant information to improve disease prediction and detection.

Customer support and maintenance: Provide technical support to farmers, maintain the system, and ensure smooth operation.

Key Partnerships: Agricultural input suppliers: Collaborate with companies that provide seeds, fertilizers, and pesticides to bundle the crop disease detection service with their products.

Agricultural extension services: Partner with agricultural extension services and local farming communities to promote and distribute the service.

Cost Structure: Research and development: Allocate resources for ongoing research and development to improve the accuracy and capabilities of the AI-enabled system.

Infrastructure and hosting: Invest in the necessary hardware and software infrastructure to support the platform and ensure its reliability.

Team and expertise: Budget for a team of data scientists, software engineers, and agricultural experts to develop and maintain the system.

Marketing and promotion: Allocate funds for marketing activities, including online advertising, partnerships, and awareness campaigns.

Final Product Prototype/ Product Details

By providing farmers with an efficient, accurate, and accessible crop disease detection and analytics platform, this product aims to enhance agricultural productivity, minimize yield losses, and contribute to sustainable farming practices. The integration of historical data analysis and advisory services makes it a valuable tool for decision-making and crop management strategies.

Some dynamics of the Apriori Algorithm used in this model and their meaning.

1.Support: Support is the probability that a given itemset appears in a transaction (crop sample). For an itemset X, support is calculated as the ratio of the number of transactions containing X to the total number of transactions in the dataset.

Formula for Support of itemset X:

$$\text{Support}(X) = \frac{(\text{Number of Transactions containing } X)}{(\text{Total Number of Transactions})}$$

2. Confidence: Confidence measures the conditional probability of finding a second itemset Y given the occurrence of the first itemset X. It quantifies how often the items in Y appear in transactions that also contain X.

Formula for Confidence of itemset X => Y:

$$\text{Confidence}(X \Rightarrow Y) = \frac{(\text{Support}(X \cup Y))}{(\text{Support}(X))}$$

3. Lift: Lift indicates the ratio of the observed support of the itemset X and Y occurring together to the support that would be expected if X and Y were statistically independent.

Formula for Lift of itemset X => Y:

$$\text{Lift}(X \Rightarrow Y) = \frac{(\text{Support}(X \cup Y))}{(\text{Support}(X) * \text{Support}(Y))}$$

4. Leverage: Leverage measures the difference between the observed frequency of the co-occurrence of itemset X and Y and the frequency that would be expected if X and Y were statistically independent

Formula for Leverage of itemset X => Y:

$$\text{Leverage}(X \Rightarrow Y) = (\text{Support}(X \cup Y)) - (\text{Support}(X) * \text{Support}(Y))$$

A) Feasibility The platform is feasible for development and deployment as a Software as a Service (SaaS) within a reasonable timeframe. Advances in machine learning, computer vision, and cloud-based infrastructure support efficient disease detection and real-time analytics.

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B) Viability The platform's viability is bolstered by the growing agricultural sector's demand for innovative solutions. As the importance of crop health monitoring and sustainable farming practices increases, the need for AI-powered disease detection and analytics solutions will persist in the long term.

C) Monetization The platform is directly monetizable as a service offered to farmers, agricultural institutions, and stakeholders in the agriculture industry. Subscription-based pricing models and partnerships with agritech companies and government agencies offer revenue opportunities. Personalized advisory services can be offered as premium add-ons.

By adopting a Subscription-Based Business Model with a free-tier offering and customer engagement strategies, the Crop Disease Detection and Analytics Platform aims to convert users into paid subscribers, ensuring sustainable revenue generation and long-term growth.

Financial Modeling for the Crop Disease Detection and Analytics Platform:

Assumptions:

1. The initial price of the product (subscription fee) is $250 per user per month.
2. The projected growth rate of the customer base is 3.2% per month.
3. Time intervals (t) are measured in months.

Financial Equation:

Y = X * (1 + r)^t

where,

Y = Total Revenue (Profit) over time

X = Price of the Product (Subscription Fee) = $250

r = Growth Rate per month = 3.2% = 0.032

t = Time Interval (measured in months)

Financial Projection:

Let's calculate the financial projection for the Crop Disease Detection and Analytics Platform over a period of 12 months:

1. For t = 0 (Initial Month):

Y = 250 * (1 + 0.032)^0 = $250 (Total Revenue in the initial month)

2. For t = 1 (After 1 month):

Y = 250 * (1 + 0.032)^1 = $258 (Total Revenue after 1 month)

3. For t = 2 (After 2 months):

Y = 250 * (1 + 0.032)^2 ≈ $266 (Total Revenue after 2 months)

4. Continuing this calculation for each month up to 12 months, we get the following financial projection:

Time (Months)	Total Revenue ($)
0	$250
1	$258
2	$266
3	$275
4	$284
5	$293
6	$303
7	$314
8	$324
9	$335
10	$347
11	$359
12	$371

Business Modeling

For this service, it is beneficial to use a Subscription Based Model, where initially some features will be provided for free to engage customer retention and increase our customer count. Later it will be charged a subscription fee to use the service further for their business.In the subscription business model, customers pay a fixed amount of money on fixed time intervals to get access to the service provided by the company. The major problem is user conversion; how to convert the users into paid users.

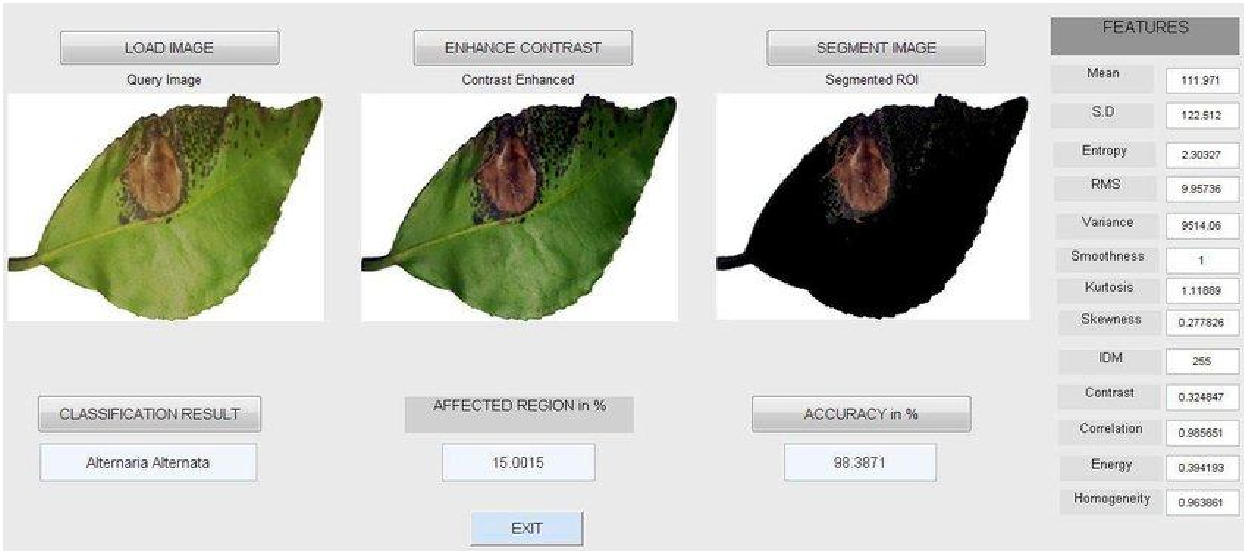
Conclusion:

The financial modeling projection demonstrates the potential revenue growth of the Crop Disease Detection and Analytics Platform over a period of 12 months. As more users subscribe to the platform and the customer base expands, the total revenue steadily increases.

The platform's direct launch into the agricultural market can capitalize on the increasing demand for advanced disease detection and analytics solutions. Small farmers, agricultural experts, and agribusinesses can benefit from the platform's services, enabling them to improve crop health, optimize agricultural practices, and achieve sustainable growth in their operations. By leveraging market basket analysis and hidden disease relationships, the platform can provide valuable insights, driving its adoption in the agricultural industry.

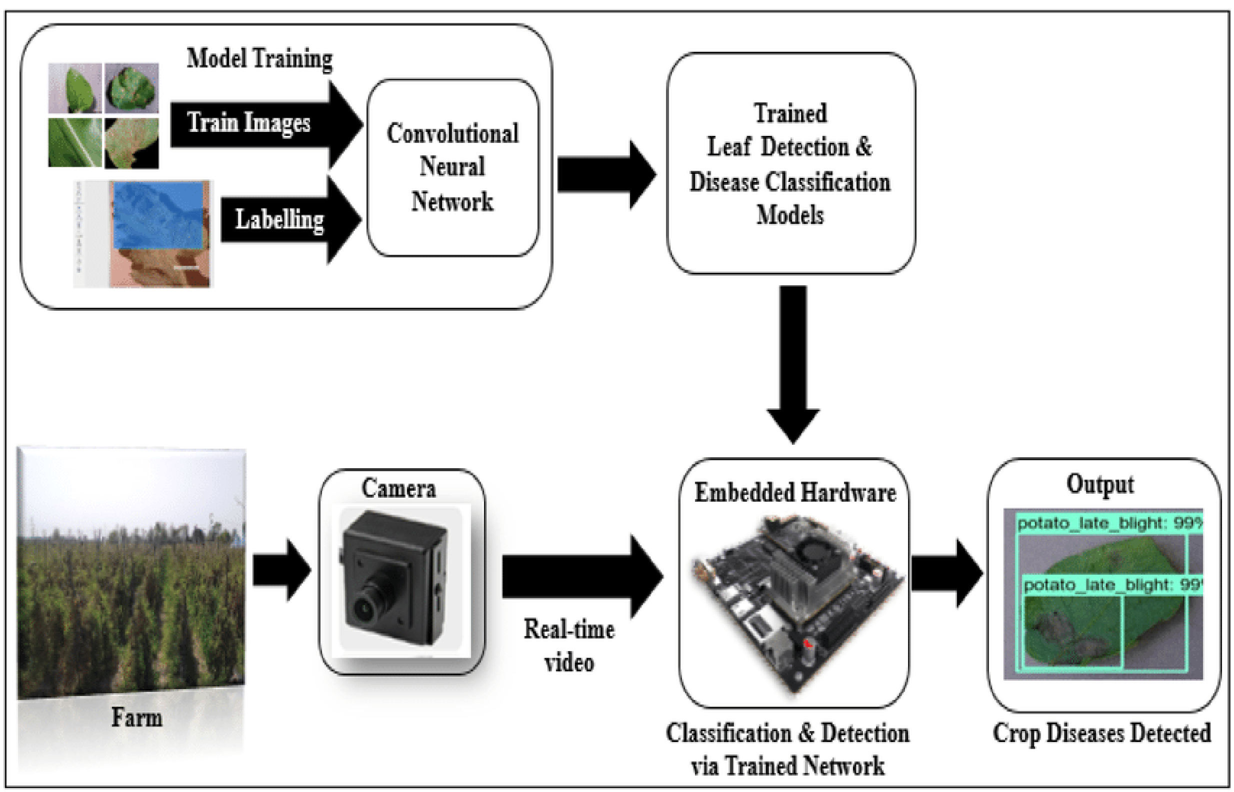
Concept Generation

We will leverage the power of AI and machine learning to develop a system that can analyze images of crops and detect disease symptoms accurately. The system will utilize deep learning algorithms and computer vision techniques to identify patterns and anomalies in the images, enabling the early detection of crop diseases.



Concept Development

The proposed product/service will consist of an AI-based platform that integrates with farmers' existing devices, such as smartphones or tablets. Farmers can capture images of their crops using the device's camera, and the platform will analyze these images to detect and diagnose potential diseases. The platform will provide real-time notifications and recommendations for.



Code Implementation

This is a jupyter notebook link : view

Conclusion

The AI-enabled crop disease detection system has the potential to revolutionize small-scale farming practices, protect crops, and empower farmers. By harnessing the power of artificial intelligence, we can make significant strides towards a more sustainable and productive agricultural sector, ultimately benefiting both farmers and society as a whole.

Crop diseases have a significant impact on agricultural productivity and the livelihoods of small-scale farmers. Traditional detection methods are time-consuming and often require expert knowledge, leading to substantial financial losses. However, with the implementation of the AI-enabled system, farmers can benefit from accurate disease identification, timely intervention, and improved overall farming practices.