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Plant Disease Detection and Cure Recommendation Using Machine Learning

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Abstract: Plant Health Monitoring and Disease Detection are the two main types of factors responsible for sustainable growth of agriculture. Effective plant disease detection technique can be used to reduce the use of toxic chemicals by leading to a better environment. In this paper we have used automated plant disease detection approach to identify the images of plant leaf as diseased or healthy and providing the accurate recommendation cure. Our paper mainly focuses on machine learning and deep learning approaches such as Convolutional Neural Networks to identify the diseases associated with the particular plant and recommending possible for the diseased plants. Our system performs image processing and the processes the images of plant leaf and extract features such as shape, size of the plants and the CNN model identifies the plants as healthy or diseased. If our system identifies the plant as diseased then it will give the pesticide to be used for disease cure in plants and it will also give the direction or action to be used to reduce the disease associated with the plants. Our system mainly uses the automated plant disease detection approach which will help the farmers for timely and accurate intervention of disease detection to improve crop health and the growth of sustainable agriculture.

***KeyWords* - Plant Health Monitoring, Plant Disease, Image Processing, Deep Learning, CNN**

I. INTRODUCTION:

Agriculture plays is very important factor for sustaining and ensuring food security and crop productivity and driving the economic growth and also enable the farmers to use automated plant disease detection techniques to improve the crop health and also to ensure food security. Machine learning-based software has been developed to detect plant diseases and suggest appropriate pesticides. Early detection of plant diseases reduces reliance on harmful chemicals, thereby promoting safer plant growth practices. Deep learning techniques, particularly convolutional neural networks (CNNs), are employed to identify and classify plant diseases, providing actionable recommendations for treatment.

Our project aims to leverage advanced machine learning and deep learning strategies, specifically CNNs, to precisely identify and classify diseases in plants, facilitating prompt intervention to minimize the impact of harmful chemicals and enhance overall agricultural productivity. Improved detection and identification of plant diseases are particularly beneficial in complex and dynamic agricultural environments.

By implementing recommendation systems for treatment based on accurate disease identification and classification, farmers are equipped with actionable insights to mitigate the impact of diseases on crops and improve agricultural output. Furthermore, our project integrates deep transfer learning techniques to enhance accuracy in predicting disease outcomes, particularly in the early stages of infection.

The project aims to develop robust solution that will help the farmers to identify the diseases in plants in early stages and it will help the farmers for timely disease management and reduce and mitigate the use of harmful chemicals. Our project aims to use machine learning based techniques and methods to accurately classify and identify diseased and healthy plants and also to recommend the appropriate pesticides to be used for the disease cure in plants.

II. RELATED WORK :

This literature review serves as a foundational exploration of methodologies, technologies, and best practices relevant to the development of desktop applications for Plant Disease Detection and Cure Recommendation using Machine Learning. It is imperative to delve deeper into each area through academic papers, case studies, and documentation to gain more specific insights and guidance for your project.

In [1] the paper provides an overview of machine learning techniques, including deep learning, CNN, and other approaches for processing image data. [2] Introduces Convolutional Neural Network (CNN) and Local Binary Pattern (LBP) algorithms for extracting and classifying plant leaves. [3] Conducts experiments to evaluate the performance of classification and object detection models, suggesting model ensembling and image segmentation as promising approaches. [4] Surveys CNN based disease detection systems for various crops, investigating lightweight and transfer learning algorithms, CNNs, GANs, attention mechanisms, and autoencoders. [5] Proposes a deep CNN model for identifying diseases in apple crops, achieving 98% accuracy on the Plat Village dataset. [6] Introduces deep learning neural networks for image classification and disease detection. [7] Develops a system to extract affected areas from complex background images, utilizing detailed feature extraction techniques. [8] Compares and evaluates machine learning based disease detection, identification, and classification methods using digital images of plant leaf signs and symptoms. [9] Highlights the need for deep learning models to adapt to diverse disease datasets for improved detection. [10] Develops leaf and fruit disease detection and classification using MATLAB, employing fuzzy c-means, histogram-based equalization, and artificial neural networks. [11] Explores supervised learning scenarios for CNN architectures using different datasets and benchmarks via Matlab/Python scripting. [12] Utilizes deep convolutional neural networks for detecting and classifying healthy and unhealthy coffee plants. [13] Develops deep learning models through transfer learning techniques, enhancing pre-trained machine models such as VGG16, MobileNet, and AlexNet. [14] Uses HSV and Lab color models for segmenting healthy and diseased parts of grape plant leaves. [15] Demonstrates that CNN classifiers detect a higher number of diseases with high accuracy, with SVM classifiers being commonly used for disease classification by many authors. [16] Achieves the goal of detecting and recognizing 32 different plant varieties and diseases using convolutional neural networks. [17] Study of CNN algorithm due to its proficient accuracy in image classification.

This literature survey encompasses various researchers' exploration of different algorithms for plant disease detection techniques. It reviews relevant literature, methodologies, technologies, and best practices for developing desktop applications for plant disease detection and cure recommendation using machine learning.

III. PROBLEM STATEMENT:

To develop a machine learning based system for detection and diagnosis of plant diseases. The system should be capable of processing the images of plant leaves and identifying and classifying them as healthy or diseased, and if diseased specifying the disease type and recommend the related cure.

IV. PROPOSED METHODOLOGY:

1. SYSTEM ARCHITECTURE:

The block diagram in Fig 1. gives an overview of the approach towards building a basic version of the intended features for Plant Disease Detection.

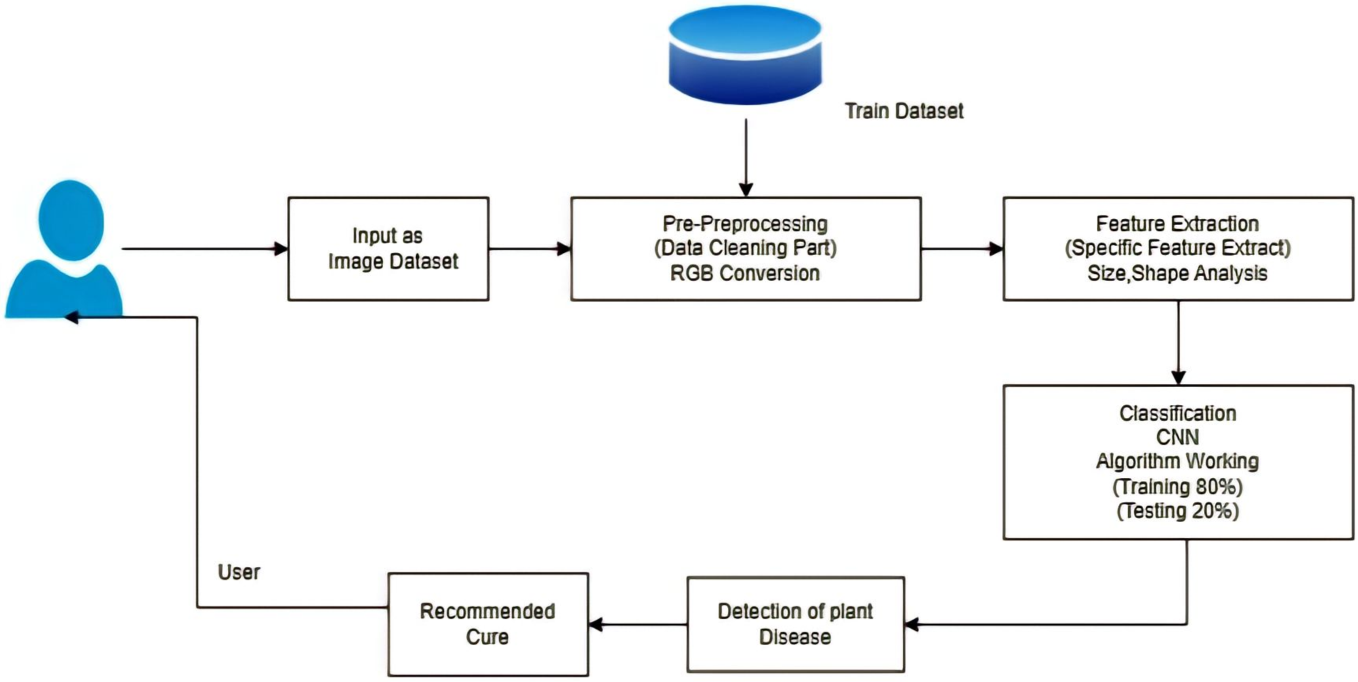

Fig 1. System Architecture

The figure 1. shows the system architecture for plant disease detection and cure recommendation. In the system architecture the user first has to login and register into the system with his username and password. The user has given the access to work with the system if he enters correct username and password. If the user enters incorrect username and password then the system redirects the user again to the login and register page for entering the correct username and password. After performing the login and registering tasks, now the system takes the input dataset of plant leaf to identify the plant leaf images as healthy or diseased. The system performs preprocessing process which involves removing null, missing, redundant values from the dataset and also involves cleaning process to convert the raw image data into the clean data which will allow for better prediction of the plant leaf as healthy or diseased. Data preprocessing step also involves RGB to binary conversion which involves converting the uploaded image firstly into grayscale values and finally to binary values.

After the data preprocessing step the system performs feature extraction process which involves extracting the correct, accurate and relevant features from the dataset addressing the problem domain and omitting the irrelevant features that would reduce the performance of the predicting the plant leaf images as healthy or diseased. After the feature extraction process the system uses the CNN model which is deep learning algorithm which is used to extract features from the input image and also to identify the images of plant as healthy or diseased. Our system makes the use of CNN model which is trained on the images of plant leaf and the model identifies the plant leaf images and predicts the plants as healthy or diseased plants. If it predicts the plant as diseased then it will provide the pesticide to be used for the cure of the diseased plants. The system will also provide the direction or action to be used to reduce the diseased cure associated with the plants.

The system architecture consists of the following steps :

1. **Data Collection:** Data Collection process involves collecting different types of plant leaf images and fed them as input to the system to predict the correct output.
2. **Data Preprocessing:** Data Preprocessing involves converting the raw input data of plant leaf images into clean data which perform operations such as removing the irrelevant, inaccurate, redundant or missing values in the dataset to make it suitable for training models to learn from the image data and also help the system to predict the correct output.
3. **Feature Extraction:** Feature extraction process involves extracting the meaningful and relevant features from the data and omitting the redundant or irrelevant feature. Extraction process extracts specific features like size and shape of the images for the analysis.

4. **Classification :** In classification process Convolutional Neural Networks are used to identify and classify the plant leaf images to predict the plants as healthy and diseased plants and if the system predicts the plants as diseased then it will recommend the appropriate pesticides to be used for the cure of diseased plants.
5. **Training and Testing:** Training and Testing process involves dividing and splitting the dataset into training and testing datasets. Training dataset enables the machine learning model identify and extract features of the plant images and testing dataset is used for evaluating and checking the performance of the model.
6. **Detection of Plant Disease :** In this process the system will identify and classify the images of plant leaf and predict the plants as healthy and diseased.
7. **Recommendation Cure :** In this process if the system identifies the plants as diseased then it will recommend the possible pesticides for the cure of diseased plants.

2. MATHEMATICAL MODEL :

The mathematical model provides the clear understanding of the overview of the purpose, assumptions, mathematical equations and variables that the model aims to address. It is used for analyzing as well as summarizing the key findings or results that are obtained from the proposed problem under the project domain.

The set theory model for the proposed system is :
Let S be the whole system ,
S= I, P, O
Where
I= Input Image
P= Procedure
O= Output
Dataset= Plant Leaf Image Dataset
Procedure (P),
P= I Using I the system detects the disease and provides the recommended cure.

3. ALGORITHM DETAILS:

The figure 2. shows the convolutional neural network architecture diagram. It consists of the different layers such as input layer, convolutional layer, pooling layer, fully connected layer and the output layer. The cnn architecture is widely used for image recognition and classification tasks. The convolutional neural network is used for guiding the flow of information through the neural networks.

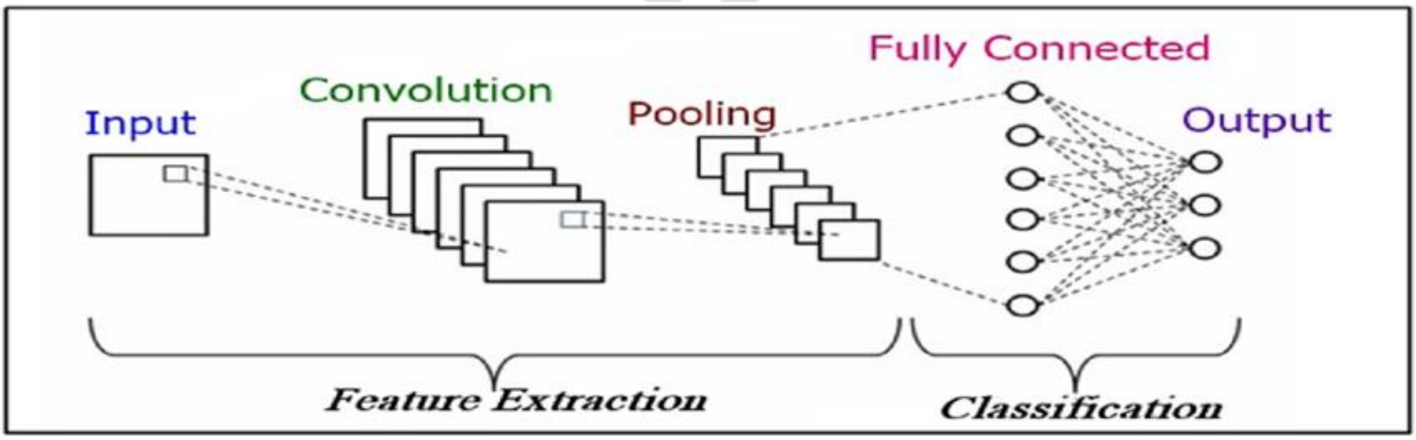

Fig 2. Convolutional Neural Network Architecture

Artificial Intelligence has been witnessing monumental growth in bridging the gap between the capabilities of humans and machines. Researchers and enthusiasts alike, work on numerous aspects of the field to make amazing things happen. The agenda for this field is to enable machines to view the world as humans do, perceive it in a similar manner, and even use the knowledge for a multitude of tasks such as Image Video recognition, Image Analysis Classification, Media Recreation, Recommendation Systems, Natural Language

Processing, etc. The advancements in Computer Vision with Deep Learning have been constructed and perfected with time, primarily over one particular algorithm, Convolutional Neural Network**.**

A Convolutional Neural Network (Covnet/CNN) is a Deep Learning algorithm that can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image, and be able to differentiate one from the other. The pre-processing required in a ConvNet is much lower as compared to other classification algorithms. While in primitive methods filters are hand-engineered, with enough training, ConvNets have the ability to learn these filters/characteristics. The architecture of a ConvNet is analogous to that of the connectivity pattern of Neurons in the Human Brain and was inspired by the organization of the Visual Cortex.

CNN is a deep neural network algorithm which is used visual image classification and recognition tasks. CNN algorithm architecture consists of input layer , convolutional layer , pooling layer , fully connected layer and the final output layer to make accurate predictions. Plant leaf disease images are trained using CNN algorithm and the algorithm will try to identify the type of disease associated with the specific plant and and it will recommend the appropriate pesticide for disease cure. CNN's are well suited for image classification tasks to identify and extract the relevant features from the input images. They also have wide applications in self driving cars, automatic image and video classification tasks.

The CNN architecture consists of the following layers:

1. **Input Layer/Input Image:** Input layer takes the plant leaf disease images as an input and the images will be trained with the help of CNN algorithm so that it will identify and classify the plant leaf images as healthy and diseased. If it classifies the diseased plant then it will specify the type of disease associated with the specific plant and recommend the pesticides for the disease cure
2. **Convolutional Layers:** Convolutional layer is used to extract and scan the input images with the help of learnable filters and passing the outputs to the subsequent layers in input.
3. **Pooling Layers**: After convolution operations the pooling layer is used to perform pooling operations such as max or average pooling to reduce the spatial dimensions or information associated with feature maps . The main task of pooling layer is to reduce the spatial dimensions of the input images while maintaining and preserving the important information .
4. **Fully Connected Layer:** Fully connected layer is also called as dense layer which is attached to the network after convolutional and pooling layers .The main task of fully connected layer is the map the extracted patterns and features from the input image to the desired output and is widely used for classification tasks.
5. **Output Layer:** Output layer is the layer which produces the final and accurate prediction outputs and it applies activation functions to give the output in terms of probabilities .

V. RESULT :

The uploaded image is processed by the application for disease detection.The application uses machine learning algorithms to analyze the image and identify the disease based on visual symptoms.The application displays detailed information about the identified disease, including symptoms, causes, and recommended treatments. Users can learn about the disease affecting their plants. Basic functionalities like image capture and offline disease identification are available.

1. Image Upload :

The figure 3. shows image upload diagram for the system. In this step the image uploading process is carried out in which we input the image of plant leaf image and we use the cnn model for identifying the images of plant leaf and predicting the diseased plants and also the cnn model will give the recommendation cure for the diseased plant.

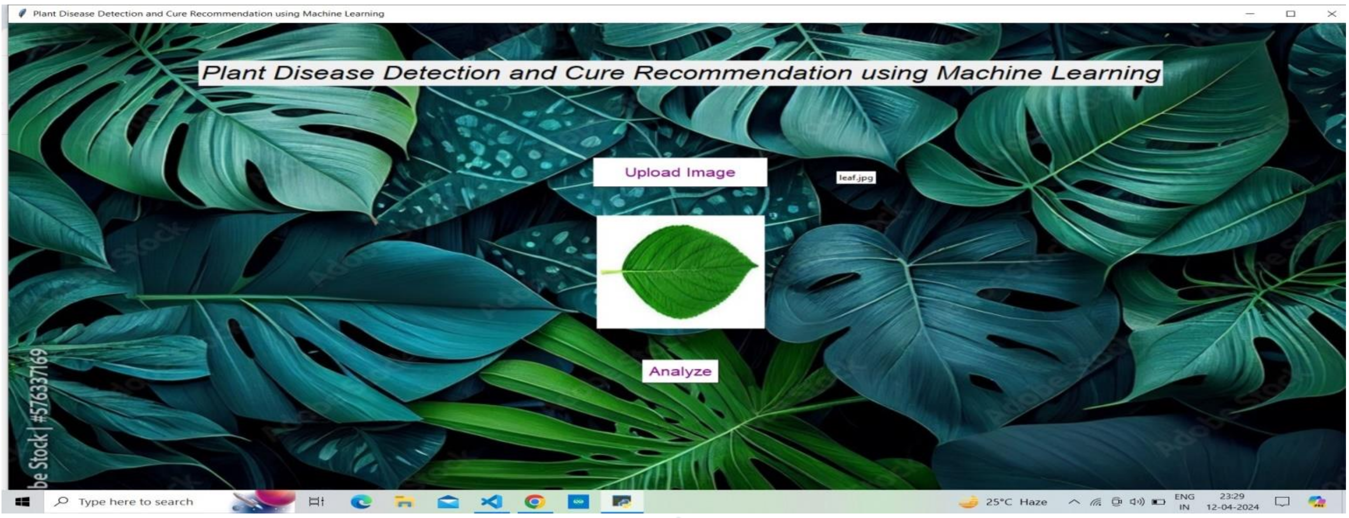

Fig 3. Image Upload

2. Original image to Gray scale to Binary Conversion :

The figure 4. shows the image conversion of original iamge to gray scale and then greyscale to binary conversion after the image uploading process. The uploaded image is converted into firstly the gray scale image which converts the image pixels into RGB values which are the 8 bit values in the colour values of red, green and blue. After the gray scale conversion the image is further converted into binary image conversion. The system performs this task after image uploading process and the image preprocessing operation will convert the image into gray scale and gray scale to binary.

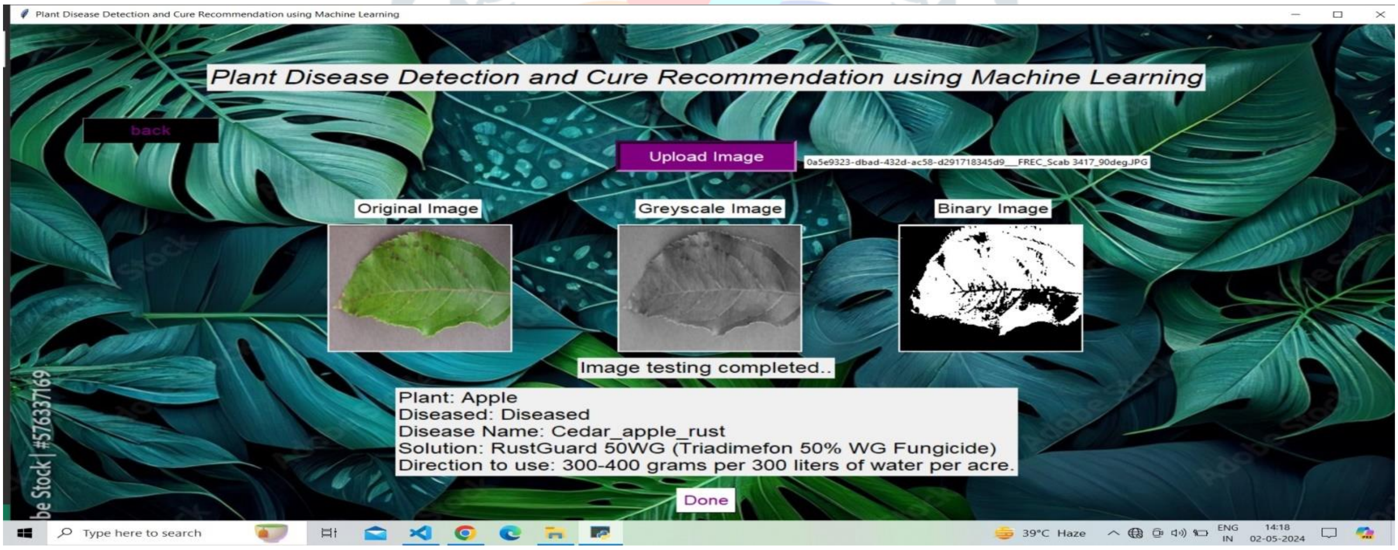

Fig 4. Image Conversion from original to greyscale to binary

3. Disease Detection and Cure Recommendation :

The figure 5. shows the disease detection and cure recommendation for the diseased plants. In this step the system will input the images of plant leaf for identifying and predicting the recommendation cure for the diseased plants. After the image uploading process the cnn model is trained on the images of plant leaf and the cnn model identifies the plants as healthy or diseased. If the cnn model identifies the plant as diseased then it will give the pesticide as the recommendation cure for the diseased plant and it will also provide the direction or action for the pesticide to be used to reduce the disease cure of the plants.

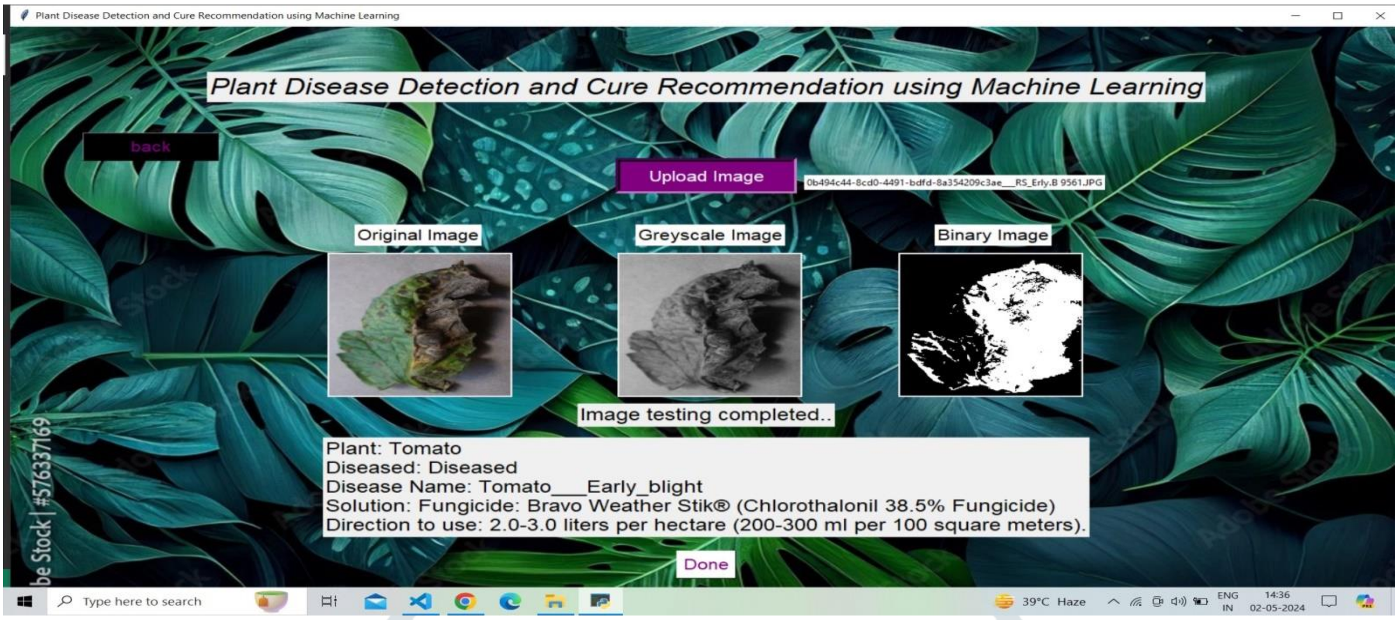

Fig 5. Disease Detection and Cure Recommendation

4. Apple Plant and Disease Cure :

The figure 6. shows the different types of categories of diseases the apple plant is suffering from. In this we have taken only one plant apple and we have predicted the different categories of diseases that the apple plant is suffering from. The following diagrams of categories of apple plant diseases are illustrated .

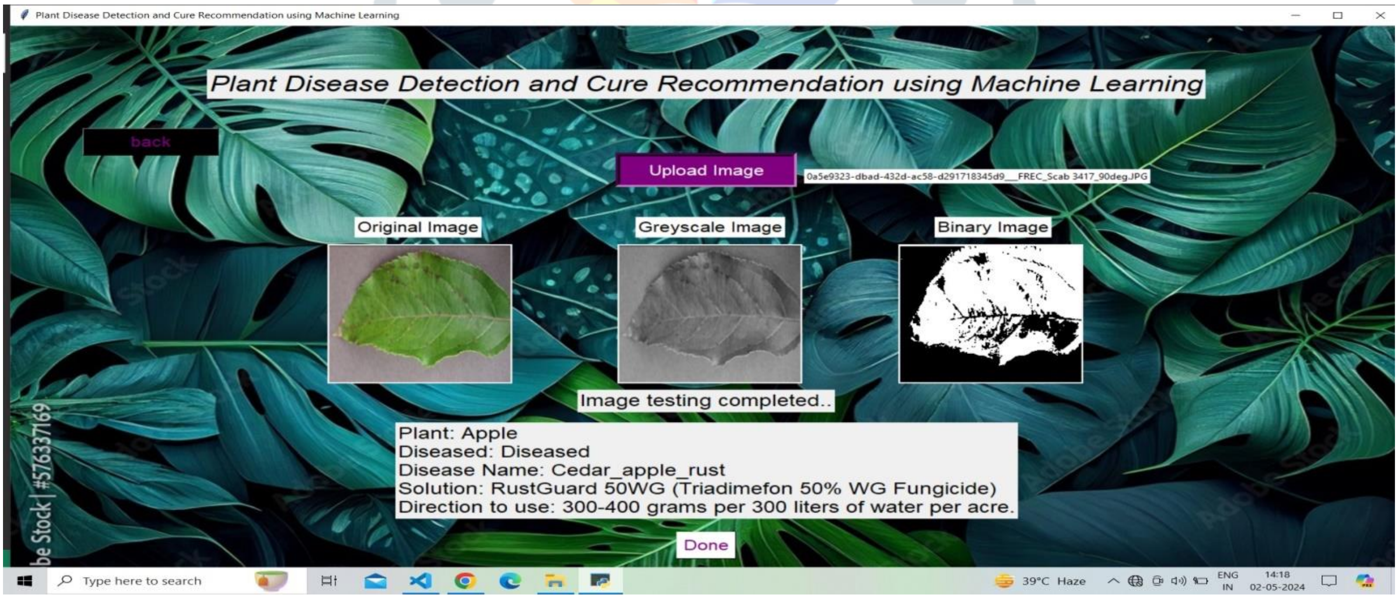

Fig 6. Apple Plant and Disease Cure

5. Tomato Plant and Disease Cure :

The figure 7. shows the different types of categories of diseases of the tomato plant is suffering from. In this we have taken only one plant tomato and we have predicted the different categories of diseases that the tomato plant is suffering from. The following diagrams of categories of tomato plant diseases are illustrated.

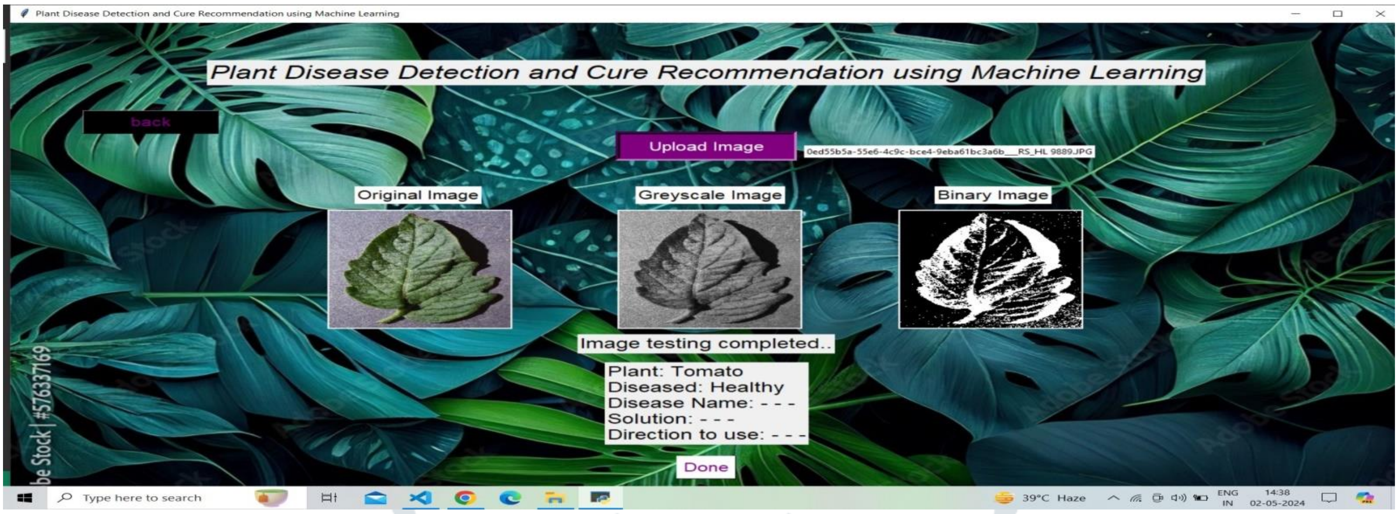

Fig 7. Tomato Plant and Disease Cure

6. Sugarcane Plant and Disease Cure :

The figure 8. shows the different types of categories of diseases of the sugarcane plant is suffering from. In this we have taken only one plant sugarcane and we have predicted the different categories of diseases that the sugarcane plant is suffering from. The following diagrams of categories of sugarcane plant diseases are illustrated .

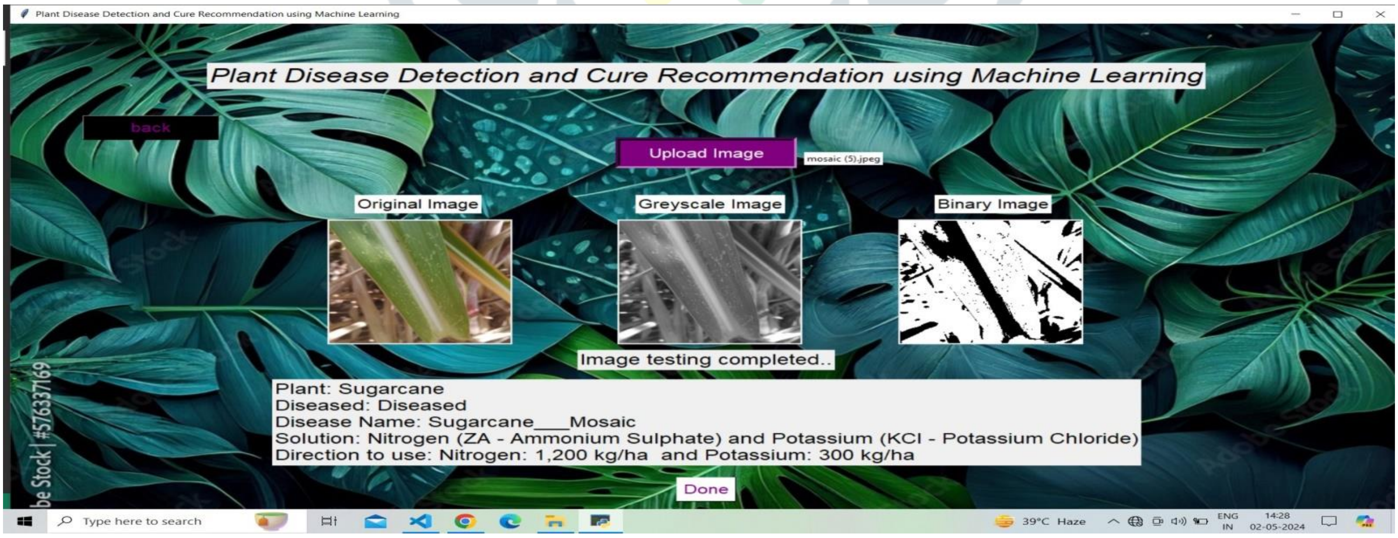

Fig 8. Sugarcane Plant and Disease Cure

VI. CONCLUSION :

Plant disease detection using machine learning presents a significant opportunity to transform agriculture by enhancing crop health, minimizing chemical usage and boosting productivity. However, realizing its full potential requires overcoming challenges, ensuring widespread accessibility to farmers, and promoting collaboration among stakeholders in the agriculture and technology domains.

The deep learning approach led to a powerful leaf identification system that performs better than state-of the art systems. Extend our system by using deep learning and correctly process the extracted features. The project also highligths the various methodologies that have been used for disease detection in plants.
Successful application of machine learning and deep learning models in plant disease detection holds great promise for revolutionizing agricultural practices and mitigating crop losses. However, realizing its full potential requires overcoming challenges, ensuring widespread accessibility to farmers, and promoting collaboration among stakeholders in the agriculture and technology domains.

VII. FUTURE SCOPE :

Future Scope involves improving the accuracy of disease detection in plants by gathering and collecting more diverse datasets of plant images. This often involves developing real time monitoring of plant health to improve crop health and sustainable growth of agriculture. Future scope also involves creating and developing a user friendly interface which will help the famers or agricultural workers to effectively and efficiently access and accordingly interpret the results of disease detection in plants through a web or desktop application. In future researchers should organize a proper dataset covering all areas of agriculture and enhance the available technologies to increase the productivityof primary sectors.

REFERENCES :

[1] K. P .Asha Rani, S. Gowrishankar, "Pathogen-Based Classification of Plant Diseases: A Deep Transfer Learning Approach for Intelligent Support System" IEEE Access, Vol. 11, 2023.
[2] Khalid M. Hosny, Farid M. Samy, Walaa M. EL-Hady, "Multi-Class Classification of Plant Leaf Diseases Using Feature Fusion of Deep Convolutional Neural Network and Local Binary Pattern" IEEE Access, Vol. 11, 2023.
[3] Dongmo Wilfried, Apollinaire Tagne, Florent Retraint "Field Plant: A Dataset of Field Plant Images for Plant Disease Detection and Classification with Deep Learning" IEEE Access, Vol. 11, 2023.
[4] Wasswa Shafik, Ali Tuffail, Abdallah Namoun "A Systematic Literature Review on Plant Disease Detection: Motivations, Classification Techniques, Datasets,Challenges and Future Trends" IEEE Access, Vol. 11,2023.
[5] Krishan Kumar, Brajesh Kumar, Vibhor Kumar "Detection of Apple Plant Diseases Using Leaf Images Through Convolutional Neural Network'' "State Transition-Based for Cooperative Shot Boundary Detection" IEEE Access, Vol. 11, 2023.
[6] MS Deepa, MS Rashmi N, MS Chinmai Shetty "A Machine Learning Technique for Identification of Plant Diseases in Leaves" IEEE, Vol. 9, 2021.
[7] Majji V. Applalanaidu, G Kumar-avelan "A Review of Machine Learning Approaches in Plant Leaf Disease Detection and Classification" in IEEE, Vol. 9, 2021.
[8] Vishnu S Babu, R. Sateesh Kumar, R. Sundar "A Comparative Study on Disease Detection of Plants using Machine Learning Techniques" IEEE, Vol. 9, 2021.
[9] Shujuan Zhang, Bin Wang "Plant Disease Detection and Classification by Deep Learning-A Review" IEEE, Vol. 9, 2021.
[10] Mrs N . Saranya, Ms L. Palvitra, Ms.Ragavi" A Comparative Study on Disease Detection of Plants using Machine Learning Techniques" IEEE, Vol. 9, 2021.
[11] Sumathi Bhimavararpu, Vinitha Panicker "Analysis and Characterization of Plant Diseases using Transfer Learning" IEEE, Vol. 11, 2020.
[12] Manoj Kumar , Pranav Gupta , Puneet Madhav "Disease Detection in Coffee Plants Using Convolutional Neural Network" IEEE, Vol. 11, 2020.
[13] Zhaohua Huang, Ally Qin, Aparna Menon "Grape Leaf Disease Detection and Classification using Machine Learning" IEEE, Vol. 11, 2020.
[14] Kirti, Navin Rajpal "Black Rot Disease Detection in Grape Plant (Vitis vinifera) Using Colour Based Segmentation and Machine Learning" IEEE, Vol. 11, 2020.
[15] Mrs. Shruti ,U. Dr Nagaveni, V.Dr.Raghavendra B.K "A Review on Machine Learning Classification Techniques for Plant Disease Detection" IEEE, Vol. 11, 2019.
[16] Sammy Militante, Bobby Gerardo "Plant Leaf Detection and Disease Recognition using Deep Learning" IEEE, Vol. 11, 2019.

[17] Shrikant Shinde, Pratik Ghatte, Vedant Phadtare, Tushar Madane, Chetan Kholgade, "A Survey on Plant Disease Detection Using Machine Learning" in JETIR, Vol. 11, Issue 3, pp.h715-h718, March 2024.