April 23, 2023

A PROJECT REPORT
ON

”FARMHELP : PLANT DISEASE DETECTION USING NEURAL NETWORKS”

Submitted in partial fulfillment of the requirements
of the degree of

Bachelor of Engineering
in
Information Technology

by

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ACADEMIC YEAR

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Internal Approval Sheet

TERNA ENGINEERING COLLEGE, NERUL

Department of Information Technology
Academic Year 2022-23

CERTIFICATE

This is to certify that the project entitled
"FARMHELP : PLANT DISEASE DETECTION USING NEURAL NETWORKS"
is a bonafide work of:

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This Major Project Report – an entitled **"FARMHELP : PLANT DISEASE DETECTION USING NEURAL NETWORKS"** by following students is approved for the degree of **B.E. in *"Information Technology"***.

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DECLARATION

We hereby declare that project report entitled as **"FARMHELP: PLANT DISEASE DETECTION USING NEURAL NETWORKS"** is correct to best of our knowledge. The work described is our own and our individual contribution. All the sites from where we have taken help are been given credits in this report. We also declare that we have adhered to all principles of academic honesty and integrity and haven't misrepresented or falsified any idea/data/fact/source in our submission. We perceive that any violation of the above will cause disciplinary action by the institute and can also evoke penial actions from the sources which have thus not been correctly cited or from whom proper permission has not taken when required. We have also cited all the sources from which we have referred the information.

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ABSTRACT

Farmhelp aims at detecting whether the plant is diseased or not and if yes, classify the disease caused. Further, the system will provide a gist about the disease with few easy home remedies(if applicable) and guide the user to take proper consultation. Along with this, we are providing crop recommendation and fertilizer recommendation system. Convolutional Neural Network (CNN), a Deep Learning technique, is used which takes input from the user in the form of image data and displays the type of disease along with some remedies. Also, some other softwares used are Machine Learning(for recommendation system), Tensorflow(for preprocessing of data) and Google cloud server(for deployment). This, thus, would help in preventing the loss of crops resulting in an increase in production.

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CHAPTER 1

Introduction

This chapter describes the plant disease detection system used by farmers. Their features with the functions are well explained. The features of the systems proposed by us is described along with the scope, the users involved and the points that motivated us to select this topic for our project.

1.1 Introduction

India being an agro-based economy, farmers experience alot of problem in detecting and preventing diseases in plants. So there is a necessity in detecting diseases in plants which proves to be effective and convenient for Users. Relying on pure naked-eye observation to detect and classify diseases can be very unprecise .Therefore in field of agriculture, detection of disease in plants plays an important role. To detect a plant disease in very initial stage, use of disease detection technique is beneficial. So Deep learning and neural networks can be used to get more accurate result.

1.2 Features

Following are the features achieved by our system:

- To detect the crop disease using Convolutional Neural Network algorithm.
- The system is easy to understand by the layman persons too.
- To give right knowledge to the users about which disease the crop has using the image classification.

- To help predict disease and display the actions to be taken at the right time.
- To give right knowledge to the users about which crop to sow and which fertilizer to use in their field based on the soil data using Machine Learning.

1.3 Scope of Project

In this project, we have built a plant disease detection system consisting of the features such as detecting the disease,provide remedy,providing right knowledge of which crop should be grown,and which fertilizer to be used based on soil data. The system is built for the farmers to help them detect disease and take actions at the right time. This is a website application built using HTML, CSS, JavaScript and Flask. The system will be beneficial to users:

1. Farmers: To help increase their production and also prevent loss of plants with proper remedy.

Project Requirement:

Disease Detection:

- A home page to enter the dashboard.
- A dashboard to upload a image for plant disease detection.
- A page for showing the uploaded image of the plant.
- An page for showing whether the plant is diseased or not and if diseased remedy will also be displayed on that page.

Crop Recommendation:

- A home page for accessing the application.
- A form to enter different values of the soil contents present in the soil.
- A page which views the results of the crop recommended by the system based on the soil.

Fertilizer Recommendation:

- A home page for accessing the application.
- A form to enter different values of the soil contents present in the soil.
- A page which views the results of the fertilizer recommended by the system based on the soil.

Working of the System:

Home page: This is where the user lands when they first visit the website. From here, they can navigate to the other two pages.

Crop disease detection page:

This page allows the user to upload an image of a leaf and receive a prediction of whether or not the plant is diseased. To achieve this, you trained a neural network on a dataset of labeled images of healthy and diseased leaves. When a user uploads a new image, the model applies what it learned during training to classify the new image as healthy or diseased.

Crop recommendation page: This page helps the user determine which crop to grow based on certain input parameters. Specifically, the user inputs the type of soil they have, the color of the soil, the plant they want to grow, and the levels of sodium and potassium in the soil. Based on this information, the model predicts which crop is best suited for the given conditions.

Fertilizer recommendation page: This page is similar to the crop recommendation page, but instead of predicting the best crop to grow, it recommends which type of fertilizer to use based on the input parameters.

The model takes into account the type of soil, the color of the soil, the crop to be grown, and the levels of sodium and potassium in the soil. Based on this information, it predicts the most suitable fertilizer for the given conditions.

Additional Information:

All the results given by our system are given using the trained models using Deep Learning and ML.The result are much reliable as the models are trained with large datasets which provide a high accuracy of prediction.

1.4 Motivation of Project

The motivation behind using CNNs for plant disease detection is to address the issue of crop loss due to plant diseases. According to the Food and Agriculture Organization (FAO), plant diseases result in the loss of 20-40 percent of global crop production annually. Early detection of plant diseases is critical for farmers to take necessary actions to prevent further spread of the disease and minimize crop loss. Traditional methods of plant disease detection involve manual inspection of plants, which can be time-consuming, labor-intensive, and prone to human error. With the advancements in computer vision and machine learning, CNNs have emerged as a powerful tool for automating the detection of plant diseases. By using CNNs, it is possible to accurately classify plant images and detect early signs of disease, which can help farmers take prompt action to prevent further spread.The use of CNNs for plant disease detection has the potential to revolutionize agriculture by improving the efficiency and accuracy of disease detection, ultimately leading to increased crop yields and food security.

1.5 Organization of the report

Chapter 1 discusses about the traditional plant disease detection system used by the farmers. Their features and the security measures are also enlisted in this section. The section also includes the features of our system, scope of the project along with the users involved in using the system. It also describes the purpose of selecting this field and domain for our project.

Chapter 2 discusses about the work done by various research experts, students or any other personnel in the development of either a product or conducting a survey based on the present plant disease detection systems. The section further consists of table briefly summarizing all the works of researchers.

Chapter 3 consists of the problem statement that actually elaborates the problems faced by existing plant disease detection used by farmers for detection.The inaccuracy of relying on naked eyes for detection and also non-reliability.

Chapter 4 enlists all the technology stack of our project and the Gantt Chart that briefly shows the workflow for the development of the project for the current duration.

Chapter 5 defines all the proposed methodologies that are used up for building the project. It consists of the architecture diagrams with their descriptions, the system requirements that are necessary for the functioning of the website. The section also describes the system design consisting of the low fidelity and high-fidelity diagram along with the data flow diagram.

Chapter 6 consists of the outputs obtained from the implementation of the project. The section also elaborates the testing techniques used and the test cases involved for completing the testing process.

Chapter 7 consists of the conclusion in regard to our project development and future scope that could be implemented in the future in the advancement of this project.

1.6 Conclusion

In a modern environment with less knowledge of agriculture, it is important to have knowledge and an understanding of the factors that affect the cultivation before selecting any crop. In our website we have proposed an innovative approach for smart agriculture using Deep Learning and Machine Learning technology. Thus this system will be used to reduce the difficulties faced by the farmers and will increase the quantity and quality of work done by them. Thus the farmers can plant the right crop increasing his yield and also increasing the overall productivity of the nation.

CHAPTER 2

Literature Review

This chapter consists of the research works conducted by the research scholars in relation with the plant disease detection system. Furthermore, the chapter briefly summarizes all these work in a table consisting of the paper title, brief description, technology stacks and the features.

2.1 Major Issues in Existing System

Marzougui, F., Elleuch, M., Kherallah, M. [1], used pre- trained weights as a starting point to avoid a very long treat- ment. Followed by this, the proposed approach was compared to several artisanal shallow structure approaches based on machine learning. The proposed system achieved promising precision results on the plant leaves dataset, demonstrating the effectiveness of its approach for the detection of diseases.

The review by Liu, J., Wang, X. [2] provided a definition of plant diseases and pest detection problems and put forward a comparison with traditional plant diseases and pest detection methods. According to the difference in network structure, this study outlined the research on plant diseases and pests detec- tion based on deep learning in recent years from three aspects of classification network, detection network, and segmentation network, and the advantages and disadvantages of each method were summarized. Common datasets were introduced,and the performance of existing studies was compared. On this basis, possible challenges in practical applications of plant diseases and pest detection based on deep learning were discussed. In addition, many possible solutions and research ideas were proposed for the challenges, and several suggestions were given.

Pandian JA, Kumar VD, Geman O, Hnatiuc M, Arif M, Kanchanadevi K [3], proposed a fourteen-layered 'deep con- volutional neural network' (14-DCNN) to detect diseases in plant leaf using leaf images. A new dataset was created using numerous open datasets. 'Data Augmentation' tech- niques were then used to balance out the individual class sizes of the dataset. Three image augmentation techniques were used namely basic image manipulation (BIM), deep convolutional generative adversarial network (DCGAN) and neural style transfer (NST). The dataset consisted of about 147,500 images of 58 different 'healthy' and 'diseased' plant leaf classes along with one 'no-leaf' class. The proposed D- CNN model was trained in multi-graphics processing units (MGPUs) environment for exactly 1000 epochs. The random search with the coarse-to-fine searching technique was used to select the best hyper-parameter values in order to improve the training performance of the proposed model.

Muhammad Hammad Saleem, Johan Potgieter and Khalid Mahmood Arif in [4] provided a comprehensive explanation of Deep Learning models used to visualize various plant diseases. In addition to this, some research gaps were identified from which to obtain greater transparency for detecting diseases in plants, even before their symptoms appear clearly. The paper also stated that plant diseases affect the growth of their respective species, thus making its early identification very important.Several Machine Learning models had been employed for the detection and classification of plant diseases but, after the advancements in a subdivision of ML i.e Deep Learning (DL), this area of research appeared to have huge potential in terms of increased accuracy. Several developed DL architectures were implemented along with several visu- alization techniques to detect and classify the ailments. Also, several performance metrics were used for the assessment of these architectures or techniques.

Reference [5] dealt with a replacement approach to the development of a disease recognition model, supported leaf image classification, by the utilization of deep convolutional networks. All the essential steps required for implementing this disease recognition model were completely described throughout the paper, starting from gathering images to make a database, assessed by agricultural experts, and a deep learning framework to perform the deep Convolutional Neural Network training. The advance and novelty of the developed model illustrated its simplicity: healthy leaves and background im- ages are in line with other classes, enabling the model to distinguish between diseased leaves and healthy ones, or from the environment by using CNN.

Reference [6] provided the research progress of deep learn- ing technology in the field of crop leaf disease identification in recent years. The application of deep learning in plant disease recognition can avoid the disadvantages caused by the artificial selection of disease spot features, make plant disease feature extraction more objective as well as improve the research efficiency and technology transformation speed.In this paper, the authors L. Li, S. Zhang and B. Wang, presented the current trends and challenges for the detection of plant leaf disease using deep learning (DL) and advanced imaging techniques with the hopes that this research will be a valuable asset for those researchers who study the detection of plant diseases and pests. At the same time, they also discussed some of the current challenges and hurdles that need to be resolved.

A. KP and J. Anitha in [7], trained a deep learning model i.e. Convolutional Neural Network (CNN) to classify the different plant diseases. This model was used due to its massive success in image-based classification. The deep learning model provided a faster and more accurate predictions as compared to manual observations of the plant leaf. Here, the CNN model and pre-trained models namely VGG, ResNet, and DenseNet were trained using the dataset. Among them, the DenseNet model was observed to have achieved the highest accuracy.

Reference [8] presented a comprehensive review of the literature which aimed to identify the state of the art of the use of Convolutional Neural Networks (CNNs) in the process of diagnosis and identification of plant pest and diseases. Additionally, it presented some issues that were facing the models performance, and also indicated gaps that should be addressed in the future. From this review, it is possible to understand the innovative trends regarding the use of CNN's algorithms in the plant diseases diagnosis and to identify the gaps that need the attention of the research community.

Sai Reddy, B., Neeraja, S. [9] presented an automatic plant leaf damage detection and disease identification system. The first stage of the proposed method identified the type of the disease based on the plant leaf image using a method known as DenseNet.Stage two identified the damage in the leaf using deep learning-based semantic segmentation. Each 'RGB' pixel value combination in the image was extracted followed by supervised training that was performed on the pixel values using the 1D Convolutional Neural Network (CNN). The third stage suggested a remedy for the disease based on the disease type and the damage state observed. This gave an accuracy of 97.

Geetharamani G., Arun Pandian J. [10] put forth a novel plant leaf disease identification model following 'deep con- volutional neural network' (Deep CNN) concept. Six types of data augmentation methods were used namely: image flipping, gamma correction, noise injection, principal component anal- ysis (PCA) colour augmentation, rotation, and scaling. Com- pared to popular transfer learning approaches, the proposed model achieved a better performance when using the validation data. The model achieved 96.46 classification accuracy.

G. Shrestha, Deepsikha, M. Das and N. Dey in [11] pro- posed a 'CNN' based method for plant disease detection. Simulation study and analysis was done on dummy images in terms of 'time complexity' and the 'area of the infected region' using image processing technique. A total of 38 cases had been fed to the model, out of which 26 cases were of 'diseased' plant leaves . Test accuracy was 88.80 . Different performance matrices were derived for the sam

M. Sardogan, A. Tuncer and Y. Ozen [12] presented a 'Convolutional Neural Network (CNN) model and Learning Vector Quantization (LVQ) algorithm' based methodology for tomato leaf disease detection and categorization. The dataset contained about 500 images of tomato leaves with four symptoms of diseases. CNN for automatic feature extraction and categorization was modelled and 'Color' information was actively used for plant leaf disease researches. The filters were applied to three channels based on RGB components. Lastly, the LVQ had been fed with the output feature vector of convolution part for training the network.

2.2 Surveys and Comparison

Title	Method Used	Technologies Used	Advantages
A comparison of deep learning and artisanal shallow structure approaches for plant disease detection [1]	Pre-trained weights and deep learning	Machine learning	Achieved promising precision results on the plant leaves dataset
A review of deep learning approaches for plant disease and pest detection [2]	Deep learning classification, detection, and segmentation networks	Deep learning	Outlined research on plant diseases and pests detection based on deep learning, introduced common datasets, and proposed solutions to challenges in practical applications
A deep convolutional neural network approach to plant leaf disease detection [3]	14-layered deep convolutional neural network (DCNN) and data augmentation	Deep learning and image augmentation techniques	Achieved high accuracy through the use of data augmentation techniques and multi-GPU training

Deep learning models for plant disease detection and visualization [4]	Various deep learning models and visualization techniques	Deep learning	Identified research gaps and proposed solutions for early identification of plant diseases using deep learning models
Deep learning-based classification of plant diseases using convolutional neural networks [7]	Convolutional neural network (CNN) and pre-trained models (VGG, ResNet, and DenseNet)	Deep learning and pre-trained models	Achieved faster and more accurate predictions compared to manual observations of plant leaves using the DenseNet model
Automatic plant leaf damage detection and disease identification system [9]	DenseNet for disease identification and 1D CNN for semantic segmentation	Deep learning	Achieved 97% accuracy in identifying plant leaf damage and suggesting a remedy for the disease
A novel plant leaf disease identification model using deep convolutional neural networks [10]	Deep convolutional neural network (Deep CNN) and data augmentation	Deep learning and image augmentation techniques	Achieved high classification accuracy compared to popular transfer learning approaches
CNN-based method for plant disease detection [11]	Convolutional neural network (CNN) and image processing	Image processing and convolutional neural network	Achieved 88.8% accuracy in detecting plant diseases
A comparison of deep learning models and LVQ for plant disease classification [12]	Convolutional neural network (CNN) and Learning Vector Quantization (LVQ)	Deep learning and LVQ	Achieved high accuracy in classifying plant diseases using CNN and LVQ models

2.3 Conclusion

Thus, we have studied different techniques and systems including surveys and models. In all the literature survey for 12 papers were carried out and all of them were found to have some features especially on the technology of neural networks. Amongst all, 9 papers were taken forward for summarizing the content in the literature summarizing table.

CHAPTER 3

Problem Definition

Farmer's economic growth is determined by the quality of the goods they produce, which is dependent on plant growth and yield.As a result, in the field of agriculture, disease identification in plant leaves is important. It takes a long time to manually diagnose plant leaves' disease through naked eye.Pure naked-eye observation to detect and classify diseases can be very unprecise. Without proper identification of the disease , disease control measures can be a waste of time and money and can lead to further plant losses. Proper disease diagnosis is therefore vital.Thus, computational methods need to be developed to automate the process of disease detection and classification using leaf image classification.

CHAPTER 4

Planning and Formulation

This chapter enlists the technology stack for our system. This technology stack includes the programming language, scripting languages, frameworks, databases, etc. It also consists of a Gantt chart for the current semester which involves the series of tasks that we will go through for the development of our system.

4.1 Technology Used

1. **Backend-Flask**

   Flask is a back-end framework, which means that it provides the technologies, tools, and modules that can be used to build the actual functionalities of the web app rather than the design or look of it.

2. **Frontend-HTML, CSS, JavaScript**

   As a web developer, the three main languages we use to build websites are HTML, CSS, and JavaScript.

3. **Framework- Flask**

   Flask is considered one of the easiest frameworks to learn for beginners.

4.2 Gantt Chart (for Semester 8)

Fig 4.1 Gantt Chart for Semester 8

For this semester, we began in continuation with the semester 7 tasks and started on with design of high-fidelity diagram in the month of January and ended up with the implementation of the project in the month of April with the total of 15-week work.

4.3 Conclusion

Thus, we have defined the technology stack that will be applicable for the development of the website. As per the content, the website is developed with the framework of Flask and python. The Gantt chart defines that the work is done in the period of 15 weeks for this semester.

CHAPTER 5

Proposed Methodology

This section describes the system requirements that are necessary for working of the website. In addition to this, the chapter describes the architecture diagram and the system design components. The system design consists of the low-fidelity diagram and the high-fidelity diagram. The chapter further describes the ER diagram that is necessary for design of the data flow diagram.

5.1 System Requirements

1. Processor- i3 or above
2. RAM-4 GB minimum
3. Display-Super VGA with a resolution of 1024*768

All the system requirements are the normal requirements for a PC that would allow smooth functioning of an application and the display would be much enhancing.

5.2 Proposed System

Overall System Architecture:

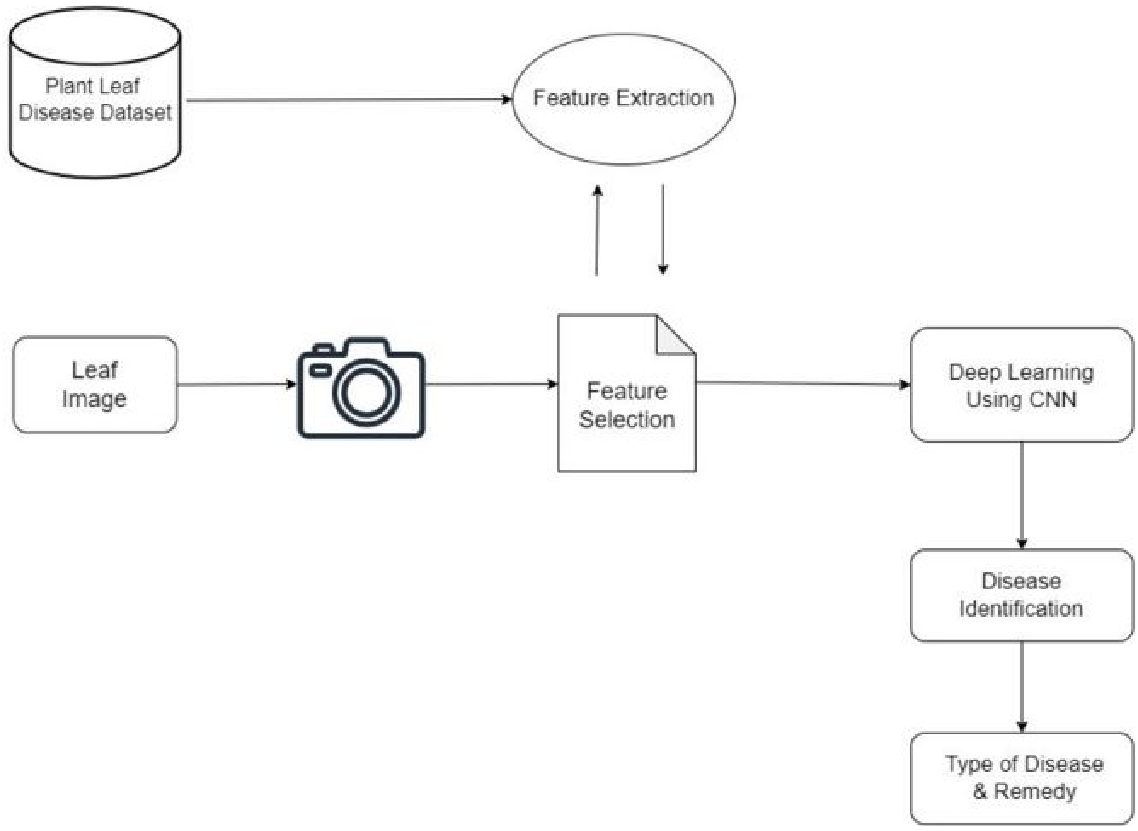

Figure 5.1 Architecture Diagram of Disease Detection Remedy

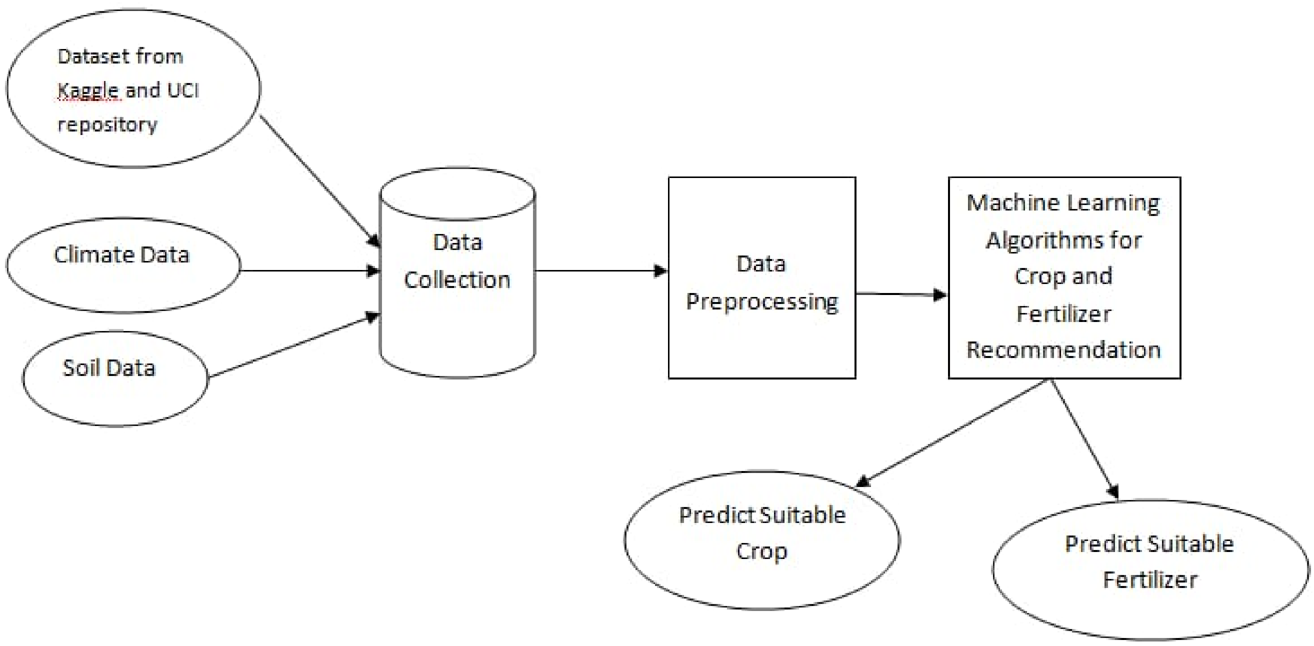

Figure 5.1 Architecture Diagram of Crop Fertilizer Recommendation

Frontend: The frontend is built using HTML, CSS, and JavaScript. It presents the user interface and collects user input. Backend: The backend is built using Python and Flask. It receives user requests and generates responses, and it interacts with the machine learning models to generate predictions. Machine learning models: The machine learning models are built using a convolutional neural network (CNN) to classify leaf images for the crop disease detection page. For the crop and fertilizer recommendation pages, you will need to train machine learning models that can process the input parameters and output the best crop or fertilizer to use. RESTful API: The API is built using Flask's RESTful framework. It allows the frontend to communicate with the backend and the machine learning models. Deployment: The application can be deployed to a web server using a cloud platform such as Heroku or AWS. It can be containerized using Docker to package the application and its dependencies.

Since this system is based on the architecture of CNN as discussed in the research papers.The recommendation for Crop Fertilizer is given by ML models.The Disease is detected using CNN model and also remedy is given.

CNN Internal Architecture:

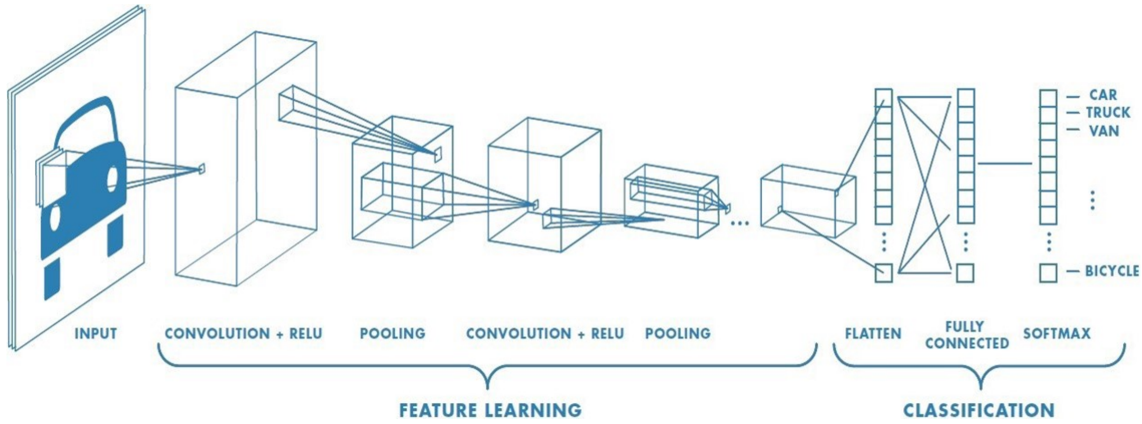

Figure 5.2 Internal Architecture Convolution Neural Network

This section describes the system requirements that are necessary for working of the website. In addition to this, the chapter describes the architecture diagram and the system design components. The system design consists of the low-fidelity diagram and the high-fidelity diagram. The chapter further describes the ER diagram that is necessary for design of the data flow diagram.

Convolutional Neural Networks, abbreviated as CNN, has a complex network structure and can perform convolution operations. As shown in Fig the convolutional neural network model is composed of input layer, convolution layer, pooling layer, full connection layer and output layer. In one model, the convolution layer and the pooling layer alternate several times, and when the neurons of the convolution layer are connected to the neurons of the pooling layer, no full connection is required. CNN is a popular model in the field of deep learning. The reason lies in the huge model capacity and complex information brought about by the basic structural characteristics of CNN, which enables CNN to play an advantage in image recognition. At the same time, the successes of CNN in computer vision tasks have boosted the growing popularity of deep learning. In the convolution layer, a convolution core is defined first. The convolution core can be considered as a local receptive field, and the local receptive field is the greatest advantage of the convolution neural network. When processing data information, the convolution core slides on the feature map to extract part of the feature information. After the feature extraction of the convolution layer, the neurons are input into the pooling layer to extract the feature again. At present, the commonly used methods of pooling include calculating the mean, maximum and random values of all values in the local receptive field [20, 21]. After the data entering several convolution layers and pooling layers, they enter the full-connection layer, and the neurons in the full-connection layer are fully connected with the neurons in the upper layer. Finally, the data in the full-connection layer can be classified by the softmax method, and then the values are transmitted to the output layer for output results. Feature Extraction - Convolution - The objective of the Convolution Operation is to extract the high-level features such as edges, from the input image. Pooling - Similar to the Convolutional Layer, the Pooling layer is responsible for reducing the spatial size of the Convolved Feature. Classification - Flattening - Flattening is used to convert all the resultant 2-Dimensional arrays from pooled feature maps into a single long continuous linear vector. Full Connection - Fully Connected Layer is simply, feed forward neural networks.

5.3 System Design

5.3.1 Low Fidelity Diagram:

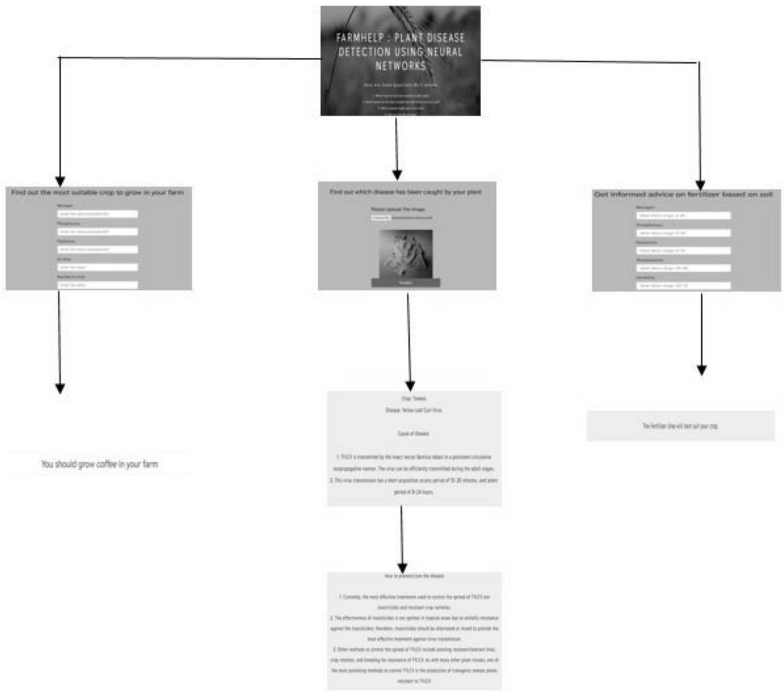

Figure 5.3 Low Fidelity Diagram

Low fidelity diagram is the low-level mockups of an application. It focuses on the logical parts of an application rather than the actual ones. It is composed of blocks where each block represents an element of the application. Examples include logo, images, tabs, etc. Each block is assumed such that the element will be present here as shown in figure 5.3

5.3.2 High Fidelity Diagram:

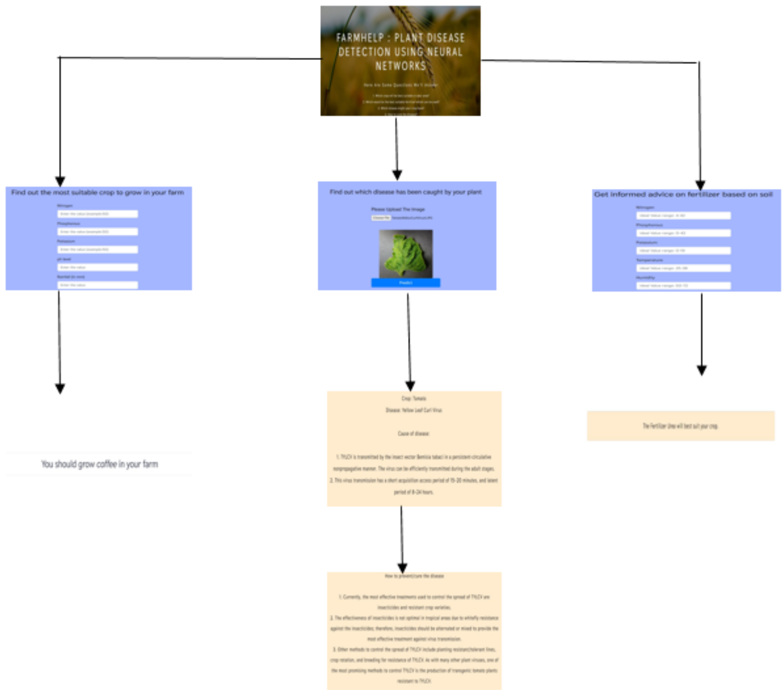

Figure 5.4 High Fidelity Diagram

The high-fidelity diagram is the one which gives an idea about the actual look of an application. The blocks of the low-fidelity are replaced with the respective images, logos, buttons, tabs, etc. The colors are also provided. It seems the application is ready in terms of design.

5.3.3 Data Modelling Diagram:

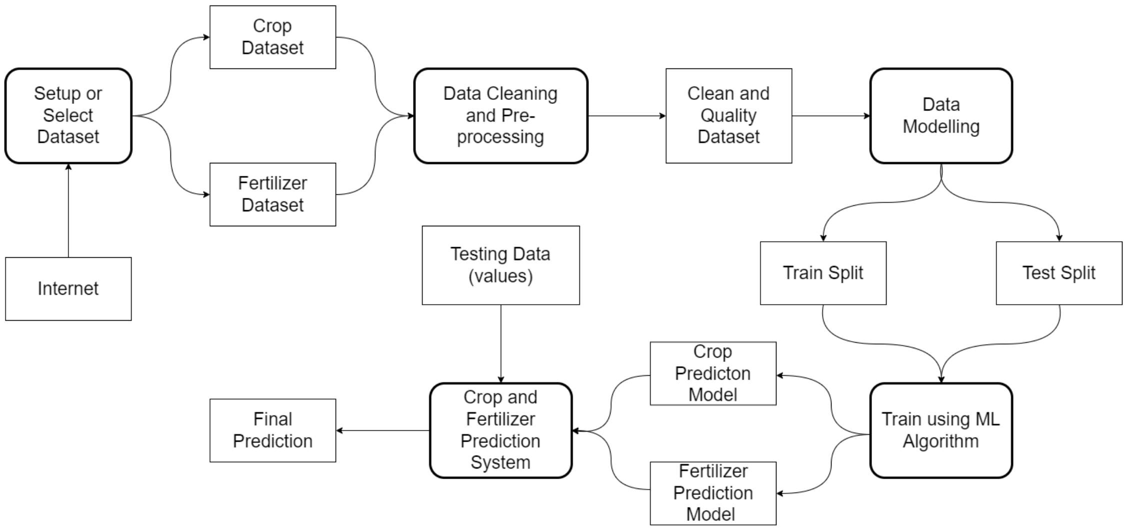

Figure 5.5 Data flow diagram

Figure 5.5 represents a data flow diagram of the plant disease detection system.Entities: • User: represents a user of the web application.

- id: unique identifier for each user
- username: the user's username
- password: the user's password (stored securely, for example using encryption or hashing)
- email: the user's email address
- LeafImage: represents an image of a leaf uploaded by the user
- id: unique identifier for each image
- userid: the id of the user who uploaded the image
- predictedclass: the predicted class (healthy or diseased) of the leaf image based on the machine learning model
- Crop: represents a crop that can be recommended by the web application
- id: unique identifier for each crop
- soiltype: the type of soil that the crop grows best in

- sodiumlevel: the optimal level of sodium in the soil for the crop
- potassiumlevel: the optimal level of potassium in the soil for the crop
- Fertilizer: represents a type of fertilizer that can be recommended by the web application
- id: unique identifier for each fertilizer
- name: the name of the fertilizer
- cropid: the id of the crop that the fertilizer is recommended for
- soiltype: the type of soil that the fertilizer is recommended for
- color: the color of the soil that the fertilizer is recommended for
- sodiumlevel: the optimal level of sodium in the soil for the fertilizer
- potassiumlevel: the optimal level of potassium in the soil for the fertilizer

Relationships: • One user can upload multiple leaf images.

- One leaf image is associated with one user and has one predicted class.
- One crop can have multiple fertilizers recommended for it.
- One fertilizer is recommended for one crop and can be used for multiple types of soil and soil nutrient levels.

5.4 Conclusion

Thus, we have defined the system requirements needed for the proper functioning of the website. The architecture of the system was also designed based on the CNN architecture. The system design was done where the low-fidelity and high-fidelity mockups were constructed on Figma tool. In addition, the data flow diagram was constructed which actually resembles the ER diagram and the mapping constraints in the database among the tables.

CHAPTER 6

Results and Discussions

The chapter contains the output obtained after implementation of the system. The screenshots and a brief description for each output is mentioned. The section also explains the testing techniques and some of the test cases that are taken into consideration for designing the system.

6.1 Experimental Results and Discussions

The images presented below are the outputs of our system.

Figure 6.1 Homepage of Plant Disease Detection System

The image in figure 6.1 represents the homepage of plant disease detection system. It consists of the features and the facilities offered by the system. From the home page we can navigate to the other two pages . This is where the user lands when they first visit the website.

Figure 6.2 Upload image page

This page allows the user to upload an image of a leaf and receive a prediction of whether or not the plant is diseased.

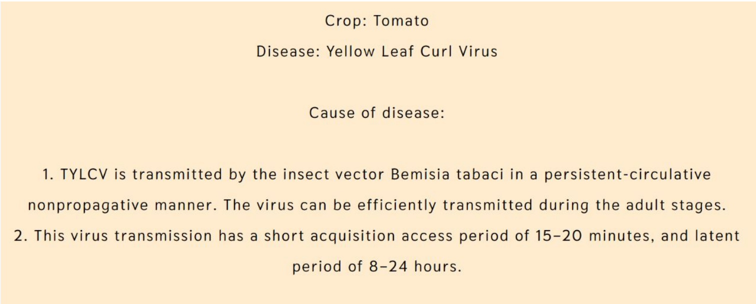

Figure 6.3 Detection page

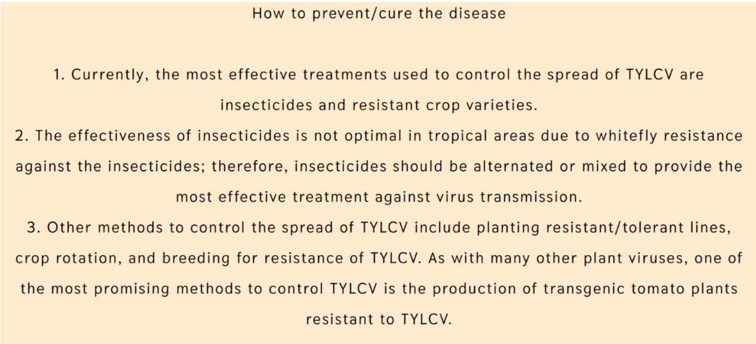

Figure 6.3 Detection page

This shows the disease detected for the uploaded image .The causes of the disease is also predicted with the remedy for the disease.

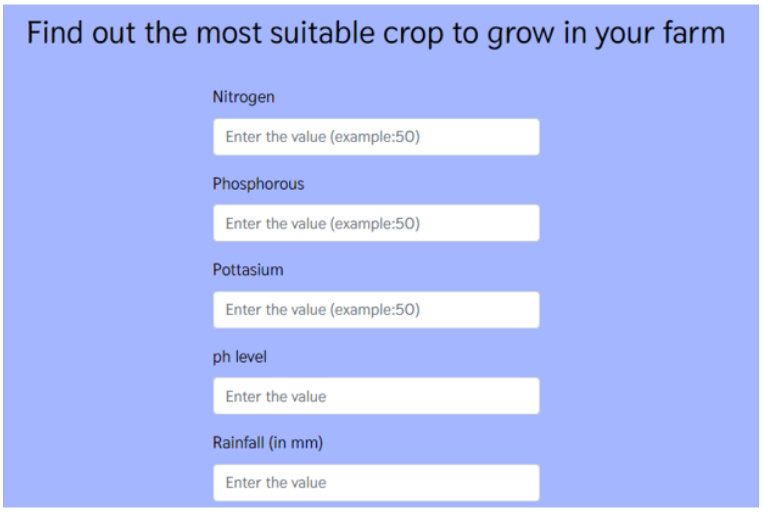

Figure 6.4 Crop input form

The crop input form takes the input of different contents in the soil and accordingly predicts the best crop that can be grown for high production.

Figure 6.5 Fertilizer input form

The fertilizer input form takes the input of different contents in the soil and accordingly predicts the best fertilizer that will suit the soil for high production.

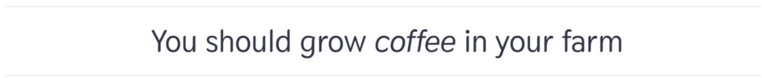

Figure 6.6 Crop Recommendation page

This page views the results obtain my the model for the given set of value in the Crop input form.It recommends the crop that can be grown.

Figure 6.7 Fertilizer Recommendation page

This page views the results obtain my the model for the given set of value in the Fertilizer input form.It recommends the fertilizer that can be used.

6.2 System Testing

Testing is one of the most important quality assurance measures. Software testing is a manual or automatic investigation done to ensure the participants with information regarding the quality of the system or service that is under testing. The system testing is done in order to see that the system meets the features and requirements that were considered in the design phase.

6.2.1 Software Testing:

It is an investigation done to ensure the participants with information regarding the quality of the system or service that is under testing. There are four phases in the software testing.

6.2.2 Unit Testing: A unit is the smallest testable part of an application. Each unit has a unique behavior. The test that are carried out on these units are referred to as unit test. The principal reasons for unit testing are:

a. Verify the functionalities of the modules under test.

b. Find undiscovered errors.

c. Ensure quality of software.

6.2.3 System Testing: Several modules constitute a project. If the project is a long-term project, many developers are engaged in this project each one developing a module. These modules will be integrated and several errors may arise. The testing done at this stage is called system testing.

6.2.4 Integration Testing: It is a type of testing wherein the testing is done to check the interfacing of the components. It actually means that once various modules of the system are integrated will it behave the same or there will be error.

6.2.5 User Acceptance Testing: When custom software is built for one user, a series of acceptance tests are conducted to enable the user to validate all requirements.

There are a number of potential operational benefits of UAT:

a. Validation of all manual and clerical procedures.

b. Verification of control procedures and constraints to prevent improper use and enforce security standards.

c. Checking of error-processing and exception procedures.

6.2.6 White Box Testing: White box testing is a testing in which the software tester has knowledge of the inner workings, structure and the language of the software, or at least its purpose. It is used to test areas that cannot be reached from a black box level.

6.2.7 Black Box Testing: Black box testing is testing the software without any knowledge of the inner workings, structure or language of the module being tested. Black box tests, as most other kinds of tests, must be written from a definitive source document, such as specification or requirements documents. It is the testing technique in which the software is treated as the black box, i.e., you cannot see into it. The test provides inputs and responds to outputs without considering how the software works.

In our case, since we were actually aware of the technology stack and the process flow of system, we prefer to go ahead with the white box testing wherein the section 6.2.8 enlists the various test cases that we have designed and tested.

6.2.8 Test Cases

Test case	Actual result	Predicted result
Crop disease detection page		
Healthy leaf	Healthy	Healthy
Diseased leaf	Diseased	Diseased
Non-leaf image	Error message	Error message
Poor lighting/low resolution	Accurate prediction	Accurate prediction
Crop recommendation page		
Certain type of soil	Best crop recommended	Best crop recommended
Different type of soil	Different crop recommended	Different crop recommended
Soil not in database	Error message	Error message
Fertilizer recommendation page		
Certain type of soil and specific crop	Best fertilizer recommended	Best fertilizer recommended
Different type of soil and crop	Different fertilizer recommended	Different fertilizer recommended
Combination not in database	Error message	Error message

Fig 6.2 Test Cases

CHAPTER 7

Conclusion and Future Scope

The chapter finally describes the developed system and its features. It also describes the functionalities of key users of the system. The section briefly summarizes the whole work done till now. At last, the chapter discusses about the future advancements that can be achieved with this system.

7.1 Conclusion

Plant diseases have been a significant concern in agriculture for years. Precision agriculture has enabled early disease detection and the minimization of losses through optimal decisions based on the results of DeepLearning methods. DL provide solutions with highly-accurate results that enables fast processing thus helps users to detect disease and provide treatment successfully.In a modern environment with less knowledge of agriculture, it is important to have knowledge and an understanding of the factors that affect the cultivation before selecting any crop. In our website we have proposed an innovative approach for smart agriculture using Deep Learning and Machine Learning technology. Thus this system will be used to reduce the difficulties faced by the farmers and will increase the quantity and quality of work done by them. Thus the farmers can plant the right crop increasing his yield and also increasing the overall productivity of the nation.

7.2 Future Scope

Our future work is aimed at an improved data set with a large number of attributes and also implements yield prediction.This will improve the model and also their will be an increase in agriculture production.We can also add an e-commerce site for selling the fertlizers.

References

[1] Marzougui, F., Elleuch, M., Kherallah, M. (2020). A Deep CNN Approach for Plant Disease Detection. 2020 21st Inter- national Arab Conference on Information Technology (ACIT). doi:10.1109/acit50332.2020.9300072.

[2] Liu, J., Wang, X. Plant diseases and pests detection based on deep learning: a review. Plant Methods 17, 22 (2021). https://doi.org/10.1186/s13007-021-00722 9.

[3] Pandian, J.A.; Kumar, V.D.; Geman, O.; Hnatiuc, M.; Arif, M.; Kanchanadevi, K. Plant Disease Detection Using Deep Convolutional Neural Network. Appl. Sci. 2022, 12, 6982. https://doi.org/10.3390/ app12146982.

[4] Saleem, M.H.; Potgieter, J.; Arif, K.M. Plant Disease Detec- tion and Classification by Deep Learning. PlanNetworks, 8, 468. https://doi.org/10.3390/pla

[5] Srivastava, Prakanshu / Mishra, Kritika / Awasthi, Vibhav / Sahu, Vivek/ Pal, Pawan Kumar. (2021). PLANT DISEASE DETECTION USING CONVOLUTIONAL NEURAL NETWORK. International Journal of Advanced Research. 09.691-698.10.21474/IJAR01/12346.

[6] L. Li, S. Zhang and B. Wan,g, ”Plant Disease Detection and Chasification by Deep Learning—A Review,” in IEEE Access, vol. 9, pp. 56683-56698, 2021, doi: 10.1109/ACCESS.2021.3069646.

[7] A. KP and J. Anitha, ”Plant disease classification using deep learning,” 2021 3rd International Conferethe nce on Signtypesrocessing and Communithe cation (ICPSC), Coimthe batore, India, 2021, pp. 407-411, doi: 10.1109/ICSPC51sizes2021.9451696.

[8] S. M. Omer, K. Z. Ghafoor, and S. K. Askar, “Plant Disease Diagnosing Based on Deep Learning Techniques: A Survey and Research Challenges”, ARO, vol. 11, no. 1, pp. 38-47, Feb. 2023.

[9] Sai Reddy, B., Neeraja, S. Plant leaf disease classification and damage detection system using deep learning models. Multimed Tools Appl 81, 24021–24040 (2022). https://doi.org/10.1007/s11042-022-12147-0.

[10] Geetharamani G., Arun Pandian J., Identification of plant leaf diseases using a nine-layer deep convolutional neural network, Computers Electrical Engineering, Volume 76,2019,Pages 323-338,ISSN 0045-7906, https://doi.org/10.101
(https://www.sciencedirect.com/science/article/pii/S004579061930003)

[11] G. Shrestha, Deepsikha, M. Das and N. Dey, ”Plant Disease Detection Using CNN,” 2020 IEEE Applied Signal Processing Conference (ASPCON), Kolkata, India, 2020, pp. 109-113, doi: 10.1109/ASP- CON49795.2020.92767

[12] M. Sardogan, A. Tuncer and Y. Ozen, "Plant Leaf Disease Detec- tion and Classification Based on CNN with LVQ Algorithm," 2018 3rd International Conference on Computer Science and Engineering (UBMK), Sarajevo, Bosnia and Herzegovina, 2018, pp. 382-385, doi: 10.1109/UBMK.2018.8566635

Appendix A

Log Book Screenshots

terna
Knowledge to Empower

Log Book

Terna Engineering College, Nerul, Navi Mumbai, 400706

Information Technology Department

Project Title: Plant Disease Detection Using Neural Network

Group No: 10

Group Members: Boora Satishchandra
Sah Smitasomya
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Supervisor: Dr. Vijayalaxmi Kadrolli

University of Mumbai (Academic Year-2022-23)

COURSE OUTCOMES (as per project specific)

CO No.	COURSE OUTCOME	POs covered	PSOs covered
CO1	Identify problems based on societal /research needs.	PO1,PO3,PO5	PSO1, PSO2,PSO3
CO2	Apply Knowledge and skill to solve societal problems in a group.	PO1,PO3,PO9,PO10	PSO1,PSO2,PSO3
CO3	Develop interpersonal skills to work as a member of a group or leader.	PO9,PO10,PO11,PO12	PSO1,PSO2,PSO3
CO4	Draw the proper inferences from available results through theoretical/ experimental/simulations.	PO3,PO4,PO12	PSO1,PSO2,PSO3
CO5	Analyze the impact of solutions in societal and environmental context for sustainable development.	PO6,PO7,PO8	PSO1,PSO2,PSO3
CO6	Use standard norms of engineering practices	PO3,PO4,PO5,PO8	PSO1,PSO2,PSO3
CO7	Excel in written and oral communication.	PO3,PO4,PO5,PO8	PSO1,PSO2,PSO3
CO8	Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.	PO10,PO11,PO12	PSO1,PSO2,PSO3
CO9	Demonstrate project management principles during project work.	PO1,PO11,PO12	PSO1, PSO2,PSO3

CO-PO-PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		3	1		1								1		
CO2	2		2						3	1			1		
CO3									3	2	3	1	1		
CO4			1	2				1				1	1		
CO5						1		2					1		
CO6			1	1	1								1		
CO7			1							2			1		
CO8										1	1	2	1		
CO9	1									2	2	2	1		

PROJECT SCHEDULE

(Can be redefined as per project requirement)

Milestone No.	Planned Milestones	Completion Date		Achieved	Remarks
		Planned	Actual	Y/N	
M1	Updated the UI of the disease section	14/01/2023	14/01/2023	Y	
M2	Implementation of the chatbot	04/02/2023	04/02/2023	Y	
M3	Implementation IOT component for data extraction	25/02/2023	25/02/2023	Y	
M4	Implementation of E-commerce section	15/03/2023	15/03/2023	Y	
M5	Integration in the Application	18/04/2023	18/04/2023	Y	

PROJECT GANTT CHART

(Can be redefined as per project requirement)

No	Project Activity/Milestone	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
M1	Updated the UI of the disease section														
M2	Implementation of the chatbot														
M3	Implementation IOT component for data extraction														
M4	Implementation of E-commerce section														
M5	Integration in the Application														

Appendix B

Paper Publication Details

Published paper

FarmHelp : Neural Network Based Plant Disease Detection System

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***Abstract*—In growing nations like India, agriculture plays a huge role, but there are still major concerns about food security. Plant diseases are the primary cause of squandered crops. Early detection of plant diseases is crucial since they have an impact on how much food is produced. To recognize and categorize plant leaf diseases, a variety of machine learning models are employed. However, deep learning has a significant deal of potential for improved accuracy. This article provides a thorough explanation of how Deep Learning models are used to visualize different plant illnesses and offer appropriate advice for curing these problems. Our goal is to determine whether the plant is sick or not and if it is, to identify the type of illness that caused it. Along with this, the system will give a general overview of the illness, suggest a few straightforward home cures (if necessary), and direct the user toward getting the appropriate consultation. Convolutional Neural Network (CNN), a deep learning model is employed to recognize and categorize plant leaf diseases, to display the type of ailment as well as potential treatments after receiving input from the user in the form of picture data. Other programs utilized include Google Cloud/ AWS Cloud Server, and also TensorFlow which will be used for data preprocessing. Applying CNN algorithm, it is investigated that an average classification accuracy of 97.87% can be achieved to perform the classification of the leaf diseases. Hence, this would aid in increasing productivity and reducing crop loss.**

***Index Terms*—Plant Disease, TensorFlow, Convolution Neural Network (CNN), Deep Learning, Agriculture**

I. Introduction

Farming produces majority of the world's food and textiles. It can be called the science and art of growing crops, cultivating soil and raising livestock. Agriculture progressed slowly for about thousands of years. Farmers traditionally have used a variety of methodologies to protect their crops from pests and diseases. To control insects, they have used herb-based venoms on crops, hand-picked insects from the plants, bred strong crop varieties, and rotated crops. Pest control chemicals are now used by nearly all farmers, particularly in developed countries. Crop losses and prices have dropped dramatically as a result of the use of chemicals. Most crops are lost due to a lack of storage space, transportation, and plant diseases. More than 15 percent of crops in India are lost due to disease, making it one of the most pressing issues to address. The ability to produce enough food to meet the needs of more than 7 billion people is still preserved by modern technology. However, a number of factors, such as temperature change, the decline in pollinators, plant diseases, and others continue to threaten food security[1]. In addition to posing a threat to global food security, plant diseases can have negative effects on small holder farmers whose livelihoods depend on robust yields. To increase the growth and productivity of agricultural plants, diseases must be identified and treated. For traditional machine vision-based plant diseases and pests detection methods, conventional image processing algorithms or manual design of features plus classifiers are often used[2]. The Deep Learning (DL) approach is a subcategory of Machine Learning (ML), which was introduced in 1943 when threshold logic was introduced to build a computer model closely resembling the biological pathways of humans. This field of research is still evolving; its evolution can be divided into two time periods i.e from 1943–2006 and from 2012–until now. Machine Learning (ML) models have been employed for the detection and classification of plant diseases but, after the advancements in Deep Learning (DL), this area of research appears to have great potential in terms of increased accuracy. Also, many developed/modified DL architectures are implemented along with several visualization techniques like box plots, histograms, charts, heat maps etc. to detect and classify the symptoms of plant diseases[4]. DL has been widely used in image and video processing, voice processing, and natural language processing. Along with this, it has also become a research hotspot in the field of agricultural plant protection, such as plant disease recognition and pest range assessment, etc. The application of deep learning in plant disease recognition can avoid the disadvantages caused by artificial selection of disease spot features, also make plant disease feature extraction more objective, and improve the efficiency of research and technology transformation speed[6].

II. Literature Review

The goal of the literature review is to understand the knowledge that is already available on the Plant Disease Classification System. The study of the research helped in choosing the best algorithm and feature extraction technique for effective results.

Marzougui, F., Elleuch, M., Kherallah, M. [1], used pre-trained weights as a starting point to avoid a very long treatment. Followed by this, the proposed approach was compared to several artisanal shallow structure approaches based on machine learning. The proposed system achieved promising precision results on the plant leaves dataset, demonstrating the effectiveness of its approach for the detection of diseases.

The review by Liu, J., Wang, X. [2] provided a definition of plant diseases and pest detection problems and put forward a comparison with traditional plant diseases and pest detection methods. According to the difference in network structure, this study outlined the research on plant diseases and pests detection based on deep learning in recent years from three aspects of classification network, detection network, and segmentation network, and the advantages and disadvantages of each method were summarized. Common datasets were introduced,and the performance of existing studies was compared. On this basis, possible challenges in practical applications of plant diseases and pest detection based on deep learning were discussed. In addition, many possible solutions and research ideas were proposed for the challenges, and several suggestions were given.

Pandian JA, Kumar VD, Geman O, Hnatiuc M, Arif M, Kanchanadevi K [3], proposed a fourteen-layered 'deep convolutional neural network' (14-DCNN) to detect diseases in plant leaf using leaf images. A new dataset was created using numerous open datasets. 'Data Augmentation' techniques were then used to balance out the individual class sizes of the dataset. Three image augmentation techniques were used namely basic image manipulation (BIM), deep convolutional generative adversarial network (DCGAN) and neural style transfer (NST). The dataset consisted of about 147,500 images of 58 different 'healthy' and 'diseased' plant leaf classes along with one 'no-leaf' class. The proposed D-CNN model was trained in multi-graphics processing units (MGPUs) environment for exactly 1000 epochs. The random search with the coarse-to-fine searching technique was used to select the best hyper-parameter values in order to improve the training performance of the proposed model.

Muhammad Hammad Saleem, Johan Potgieter and Khalid Mahmood Arif in [4] provided a comprehensive explanation of Deep Learning models used to visualize various plant diseases. In addition to this, some research gaps were identified from which to obtain greater transparency for detecting diseases in plants, even before their symptoms appear clearly. The paper also stated that plant diseases affect the growth of their respective species, thus making its early identification very important.Several Machine Learning models had been employed for the detection and classification of plant diseases but, after the advancements in a subdivision of ML i.e Deep Learning (DL), this area of research appeared to have huge potential in terms of increased accuracy. Several developed DL architectures were implemented along with several visualization techniques to detect and classify the ailments. Also, several performance metrics were used for the assessment of these architectures or techniques.

Reference [5] dealt with a replacement approach to the development of a disease recognition model, supported leaf image classification, by the utilization of deep convolutional networks. All the essential steps required for implementing this disease recognition model were completely described throughout the paper, starting from gathering images to make a database, assessed by agricultural experts, and a deep learning framework to perform the deep Convolutional Neural Network training. The advance and novelty of the developed model illustrated its simplicity: healthy leaves and background images are in line with other classes, enabling the model to distinguish between diseased leaves and healthy ones, or from the environment by using CNN.

Reference [6] provided the research progress of deep learning technology in the field of crop leaf disease identification in recent years. The application of deep learning in plant disease recognition can avoid the disadvantages caused by the artificial selection of disease spot features, make plant disease feature extraction more objective as well as improve the research efficiency and technology transformation speed.In this paper, the authors L. Li, S. Zhang and B. Wang, presented the current trends and challenges for the detection of plant leaf disease using deep learning (DL) and advanced imaging techniques with the hopes that this research will be a valuable asset for those researchers who study the detection of plant diseases and pests. At the same time, they also discussed some of the current challenges and hurdles that need to be resolved.

A. KP and J. Anitha in [7], trained a deep learning model i.e. Convolutional Neural Network (CNN) to classify the different plant diseases. This model was used due to its massive success in image-based classification. The deep learning model provided a faster and more accurate predictions as compared to manual observations of the plant leaf. Here, the CNN model and pre-trained models namely VGG, ResNet, and DenseNet were trained using the dataset. Among them, the DenseNet model was observed to have achieved the highest accuracy.

Reference [8] presented a comprehensive review of the literature which aimed to identify the state of the art of the use of Convolutional Neural Networks (CNNs) in the process of diagnosis and identification of plant pest and diseases. Additionally, it presented some issues that were facing the models performance, and also indicated gaps that should be addressed in the future. From this review, it is possible to understand the innovative trends regarding the use of CNN's algorithms in the plant diseases diagnosis and to identify the gaps that need the attention of the research community.

Sai Reddy, B., Neeraja, S. [9] presented an automatic plant leaf damage detection and disease identification system. The first stage of the proposed method identified the type of the disease based on the plant leaf image using a method known as DenseNet.Stage two identified the damage in the leaf using deep learning-based semantic segmentation. Each 'RGB' pixel value combination in the image was extracted followed by supervised training that was performed on the pixel values using the 1D Convolutional Neural Network (CNN). The third stage suggested a remedy for the disease based on the disease type and the damage state observed. This gave an accuracy of 97 %.

Geetharamani G., Arun Pandian J. [10] put forth a novel plant leaf disease identification model following 'deep convolutional neural network' (Deep CNN) concept. Six types of data augmentation methods were used namely: image flipping, gamma correction, noise injection, principal component analysis (PCA) colour augmentation, rotation, and scaling. Compared to popular transfer learning approaches, the proposed model achieved a better performance when using the validation data. The model achieved 96.46 % classification accuracy.

G. Shrestha, Deepsikha, M. Das and N. Dey in [11] proposed a 'CNN' based method for plant disease detection. Simulation study and analysis was done on dummy images in terms of 'time complexity' and the 'area of the infected region' using image processing technique. A total of 38 cases had been fed to the model, out of which 26 cases were of 'diseased' plant leaves . Test accuracy was 88.80 %. Different performance matrices were derived for the same.

M. Sardogan, A. Tuncer and Y. Ozen [12] presented a 'Convolutional Neural Network (CNN) model and Learning Vector Quantization (LVQ) algorithm' based methodology for tomato leaf disease detection and categorization. The dataset contained about 500 images of tomato leaves with four symptoms of diseases. CNN for automatic feature extraction and categorization was modelled and 'Color' information was actively used for plant leaf disease researches. The filters were applied to three channels based on RGB components. Lastly, the LVQ had been fed with the output feature vector of convolution part for training the network.

III. Problem Definition

Problem Identified:

India is renowned as a nation of farmers, and there are acres dedicated to agriculture. The plants become sick because of a variety of circumstances, including temperature, pollution, pests, and many more. Sometimes these infected plants are not visible enough to determine the type of illness that it has produced. This results in mass deduction of food production.

Solution Proposed:

As per the literature survey, various research papers state the use of deep learning methods to provide solution to the problem stated above, out of which CNN is highly used. While some models focus on specific plants, others pose as a general solution to various plants for disease identification. This project focuses on studying and identifying whether or not the plant is diseased. If so, we provide a brief overview of the illness, suggest various natural treatments, and advise the user to seek an appropriate medical advice. As for the working, the 'Convolutional Neural Network' deep learning approach utilized here receives input from the user and shows the type of disease, along with a description of it and possible treatments. The goal of this project is to pinpoint the disease's type and offer a cure. Consequently, it contributes to increased output and the prevention of crop loss to a greater extent.

IV. Proposed Methodology

A neural network used for deep learning has numerous layers. It is a subset of machine learning, and it also does away with some of the standard data pre-processing steps. These neural networks use a combination of data inputs, weights, and bias using a large quantity of data in an effort to simulate the human brain. Additionally, it has covert layers that could improve and optimize the accuracy. Similar to this, real-world deep learning systems are so seamlessly integrated into goods and services that customers are completely oblivious to the intricate data processing going on behind the scenes. One of the common libraries for implementing neural networks is Tensorflow. Adopting best practices for model tracking, performance monitoring, and data automation.

A. Image Acquisition

Image acquisition is the very first step in image processing. This step is also called as pre-processing in image processing. It includes retrieving the image from a source. In image acquisition, a plant image is acquired and used as the target image for further processing in the system. There are fourteen different kind of diseased plant leaves in this project namely apple, blueberry, cherry, corn, grape, orange, peach, potato, pepper, raspberry, soybean, squash, strawberry and tomato. This would make up a total of 12 classes to be classified including 'healthy' plant leaf as one of them. About 80% of the images of each class will be used for training the classifier while the remaining 20% will be used for testing and validation. In Fig. 2 we can see a sample of different leaf image from each class in the dataset.

B. Cleaning and Image restoration

The next step after acquiring plant leaf image is cleaning of data which includes in improving the quality of the raw image and enhance the features of the image so that more information can be extracted from it. There exist two image restoration steps which is resizing and contrast enhancement. All the images obtained from Plant Village dataset are to be resized to 256 x 256 to ensure linearity in the datasets. After resizing the images, the contrast of the image will then enhanced to make the objects in the images more distinguishable to be processed. Data augmentation will also be applied to the dataset images.

Here data augmentation has to be done as we may not have enough diverse sets of images and so we need to rotate, flip and adjust contrast to create more training sample

C. Segmentation

One of the most difficult steps of image processing is segmentation. It involves splitting an image into its constituent parts or objects. The main goal of image segmentation is to obtain the region of interest (ROI) of the diseased plant leaf from image. In this scenario, the background of the dataset, which is in grey includes no information while the foreground is the plant leaf, which will be analyzed by the system. Hence, a mask must be created to mask out the background of the image which will result the image to be left with only pixels containing the image of the leaf with black background. After masking the image background, the healthy part of the leaf image will be then masked for calculating the diseased affected area in percentage. Calculation of the affected is done by the following formula:

$$\text{Affected Area (\%)} = \frac{\text{Diseased Area}}{\text{Total area of the leaf}} \times 100\%$$

$$x_{ij}^{l} = \sum_{a=0}^{m-1} \sum_{b=0}^{m-1} \omega_{ab} y_{(i+a)(j+b)}^{l-1}$$

This is just a convolution, which we can express in 'Matlab' using

conv2(x, w, 'valid ')

Then, the convolutional layer applies its nonlinearity:

$$y_{ij}^{l} = \sigma(x_{ij}^{l})$$

D. Feature Extraction

Once the image segmentation is completed, the segmented image features would be extracted to train the classifier. The algorithm that we will be using is CNN to perform feature extraction. Convolutional Neural Network or CNN is mainly used for image/ object recognition and classification. It is a type of artificial neural network and is used to detect diseasein plant leaves. In CNN, convolution and pooling are the two major functions where pooling is used to reduce the size of an image, and convolution is used to detect edges of patterns in an image. Suppose that we have some N × N square neuron layer which is followed by our convolutional layer.

E. Classification

Later, the features that were extracted from the previous stage will fed to the SVM classifier as inputs and it maps these features into high-dimensional feature spaces using its kernel function. SVM is a type of kernel-based supervised machine learning algorithm that would deliver analysis of data for classification tasks. In this work, multi class SVM is applicable as the basic SVM which only works with two classes. The algorithm will attempt to search natural clustering of the labelled training data to groups and then map new unlabelled data into these newly formed groups.

For User Interface design we will be using HTML,CSS and JavaScript. Lastly, the website will undergo testing and deployment on the Flask platform. In the website architecture, firstly the user has to upload the captured image of plant leaf. Then the applied algorithm will extract features from the data and compare it with the data from the dataset. Lastly the model will identify whether the plant leaf is diseasedor healthy and if diseased then its type of disease will also be predicted with appropriate remedies. Following is the working architecture of the user interface of the website for predicting diseased plant leaves.

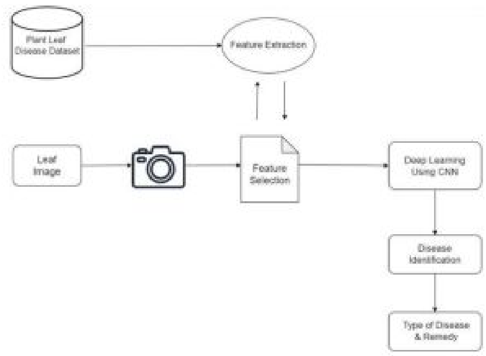

Fig. 1. Workflow of User Interface for plant disease prediction

Feature 1: The database consists of all the different plant leaf diseases which are taken into account as shown in the figure 1.

Feature 2: The module is trained repetitively to attain maximum accuracy. If a new image is given to the model then its features are compared with the features that will be already trained from the database. It will then provide the appropriate result.

Feature 3: The proposed system gives a gist of the disease detected along with some simple remedies (if applicable) to consider before consulting an expert.

V. Result

A database containing all the various plant leaf diseases that we will be considering can be seen in fig 2. To achieve the highest level of accuracy, the model is repeatedly trained. When the model receives a new image, its features will be compared to those that have already been trained and stored in the database. It will then deliver the necessary outcome.

To test the accuracy of this model we are using 10 % (20,638) images from the Plant Disease dataset and 10 % images for validation. These images are from 38 different classes. 10 % of each class is randomly selected for testing. Our model gives us more than 97.87 % accuracy on those images as well by telling whether the leaf is healthy or diseased.

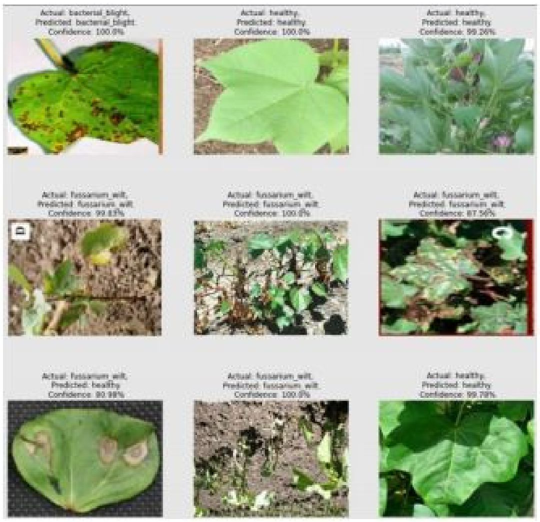

Fig. 2. Images of Database containing healthy and diseased leaves

Below is the Training and Validation accuracy and loss graphs generated by our model on testing dataset shown in figure 3. In accuracy graph displayed on left side below, the training accuracy is higher than the validation graph. As per the graph training accuracy has reached 97% and validation accuracy has reached 92% . Whereas in loss graph displayed on right side below, the training loss is lesser than the validation graph. According to the graph, training loss is 6% and validation loss is 29%. We have gained these accuracy and loss values because of training the model using 50 epochs to achieve such good result.

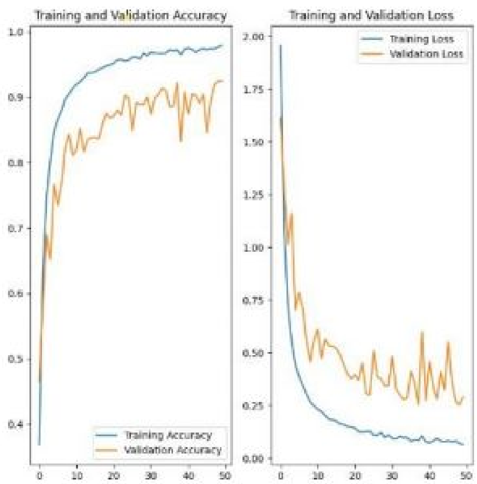

Fig. 3. Training and Validation graph of diseased plant leaves

Following is an image of our front-end wherein the user has to upload a captured image of a plant leaf which will help in identifying whether the plant leaf is healthy or diseased.

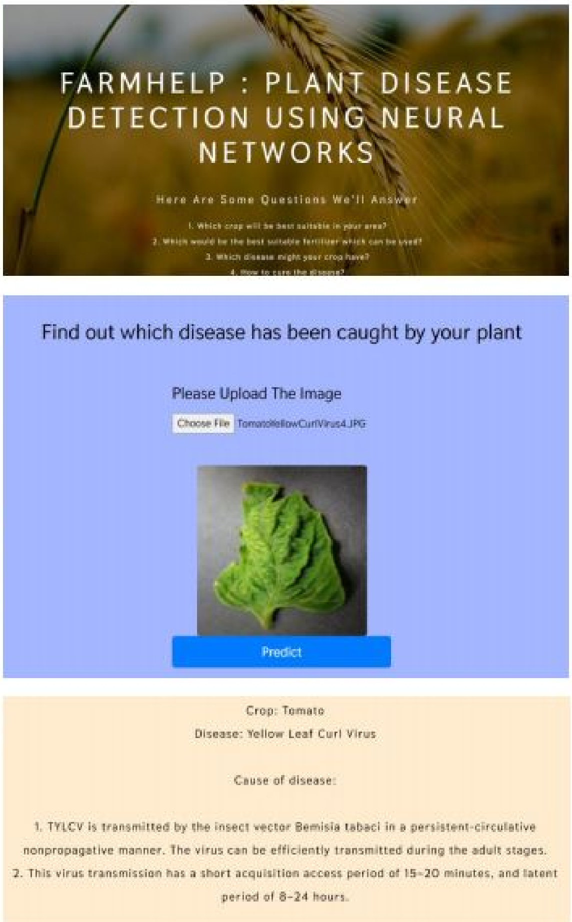

Fig. 4. User Interface for the user to upload an image

VI. Conclusion

In this paper, plant leaf disease detection and classification method are presented based on Convolutional Neural Network using Deep Learning. The dataset consists of 500 plant leaf images which consist of apple, blueberry, cherry,corn, grape, orange, peach, potato, pepper, raspberry, soybean, squash, strawberry and tomato leaves. Three different input matrices have been obtained for R, G, and B channels to start convolution on every image in the dataset. Each input image matrix of the dataset has been convoluted. Max pooling, reLU activation function, and softmax activation function have been implied to the output matrix. The analysis has been carried out on healthy and diseased leaf images to perform classification. It is concluded that the proposed method effectively recognizes different types of leaf diseases for the respective type of leaf. To improve recognition rate in the classification process different filters or different sizes of convolutions could be used as well.

VII. Future Scope

Future research will focus on real-time data gathering issues and multi-object deep learning models that can detect plant illnesses from a group of leaves rather than a single leaf. Additionally, we are attempting to integrate the trained model we developed into a mobile application. It will eventually assist farmers and the agricultural industry in identifying leaf diseases in real-time and offering advice or solutions.

References

[1] Marzougui, F., Elleuch, M., Kherallah, M. (2020). A Deep CNN Approach for Plant Disease Detection. 2020 21st International Arab Conference on Information Technology (ACIT). doi:10.1109/acit50332.2020.9300072

[2] Liu, J., Wang, X. Plant diseases and pests detection based on deep learning: a review. Plant Methods 17, 22 (2021). https://doi.org/10.1186/s13007-021-00722-9

[3] Pandian, J.A.; Kumar, V.D.; Geman, O.; Hnatiuc, M.; Arif, M.; Kanchanadevi, K. Plant Disease Detection Using Deep Convolutional Neural Network. Appl. Sci. 2022, 12, 6982. https://doi.org/10.3390/app12146982

[4] Saleem, M.H.; Potgieter, J.; Arif, K.M. Plant Disease Detection and Classification by Deep Learning. PlanNetworks, 8, 468. https://doi.org/10.3390/plants8110468

[5] Srivastava, Prakanshu / Mishra, Kritika / Awasthi, Vibhav / Sahu, Vivek / Pal, Pawan Kumar. (2021). PLANT DISEASE DETECTION USING CONVOLUTIONAL NEURAL NETWORK. International Journal ofAdvanced Research. 09.691-698.10.21474/IJAR01/12346.

[6] L. Li, S. Zhang and B. Wan,g, "Plant Disease Detection and Chasification by Deep Learning—A Review," in IEEE Access, vol. 9, pp. 56683-56698, 2021, doi: 10.1109/ACCESS.2021.3069646

[7] A. KP and J. Anitha, "Plant disease classification using deep learning," 2021 3rd International Conferethe nce on Signtypesrocessing and Com- munithe cation (ICPSC), Coimthe batore, India, 2021, pp. 407-411, doi: 10.1109/ICSPC51sizes2021.9451696.

[8] S. M. Omer, K. Z. Ghafoor, and S. K. Askar, "Plant Disease Diagnosing Based on Deep Learning Techniques: A Survey and Research Challenges", ARO, vol. 11, no. 1, pp. 38-47, Feb. 2023.

[9] Sai Reddy, B., Neeraja, S. Plant leaf disease classification and damage detection system using deep learning models. Multimed Tools Appl 81, 24021–24040 (2022). https://doi.org/10.1007/s11042-022-12147-0

[10] Geetharamani G., Arun Pandian J., Identification of plant leaf diseases using a nine-layer deep convolutional neural network, Computers Electrical Engineering, Volume 76,2019,Pages 323-338,ISSN 0045-7906, https://doi.org/10.1016/j.compeleceng.2019.04.011. (https://www.sciencedirect.com/science/article/pii/S0045790619300023)

[11] G. Shrestha, Deepsikha, M. Das and N. Dey, "Plant Disease Detec- tion Using CNN," 2020 IEEE Applied Signal Processing Conference (ASPCON), Kolkata, India, 2020, pp. 109-113, doi: 10.1109/ASP- CON49795.2020.9276722.

[12] M. Sardogan, A. Tuncer and Y. Ozen, "Plant Leaf Disease Detection and Classification Based on CNN with LVQ Algorithm," 2018 3rd International Conference on Computer Science and Engineering (UBMK), Sarajevo, Bosnia and Herzegovina, 2018, pp. 382-385, doi: 10.1109/UBMK.2018.8566635

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Appendix D

Gantt Chart from Sem 7 to Sem 8