VIVEKANAND EDUCATION SOCIETY'S
INSTITUTE OF TECHNOLOGY

Department of Computer Engineering

Project Report on

Plant Disease Detection

In partial fulfilment of the Fourth Year (Semester–VII), Bachelor of Engineering

(B.E.) Degree in Computer Engineering at the University of Mumbai Academic Year 2023-2024

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CERTIFICATE OF APPROVAL

This is to certify that ***Isha Desai, Jessica Lalchandani, Trishala Jeswani*** of Fourth Year Computer Engineering, studying under the University of Mumbai have satisfactorily presented the project on "***Plant Disease Detection***" as a part of the coursework of PROJECT-I for Semester-VII under the guidance of ***Dr. (Mrs.) Sujata Khedkar*** in the year 2023-2024.

09/10/2023

Date

Internal Examiner	External Examiner

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Computer Engineering Department

COURSE OUTCOMES FOR B.E PROJECT

Learners will be to:-

Course Outcome	Description of the Course Outcome
CO 1	Do literature survey/industrial visit and identify the problem of the selected project topic.
CO2	Apply basic engineering fundamental in the domain of practical applications for problem identification, formulation and solution
CO 3	Attempt & Design a problem solution in a right approach to complex problems
CO 4	Cultivate the habit of working in a team
CO 5	Correlate the theoretical and experimental/simulations results and draw the proper inferences
CO 6	Demonstrate the knowledge, skills and attitudes of a professional engineer & Prepare report as per the standard guidelines.

Abstract

Agriculture is one of the main contributing sectors in the Indian economy. There are various issues hampering the growth of agricultural production in India. Plant disease is one major problem among others. The system proposes to aid the farmers in combating and taking quick actions to prevent losses due to disease proliferation. Deep learning tools are employed to generate analysis for the same. The farmers can acquire a quick analysis of the plant's health by providing an image of the plant's leaf. The application provides facilities to interact in various regional languages in order to cater the needs of a vernacular audience. Natural language processing techniques are used to translate the queries of the farmers. A website and an android application are a part of the proposed solution in order to provide a user-friendly interface. Chatbot embedded in the application and the website will assist the farmers with their queries by providing multilingual support.

Key Words: Farmers, Plant Disease detection, Deep Learning, Language translation, NLP.

Index

Chapter 1 : Introduction

This section gives a brief overview of the problem faced by the farmers and the solution that our proposed system aims to deliver.

1.1 Introduction

Agriculture, with its allied sectors, is the largest source of livelihood in India. 70 percent of India's rural households still depend primarily on agriculture for their livelihood, with 82 percent of farmers being small and marginal. India is the largest producer of milk, jute and pulses according to the 2012 census.

It is the second-largest producer of rice, wheat, sugarcane, cotton and groundnuts, as well as the second-largest fruit and vegetable producer, accounting for 10.9% and 8.6% of the world fruit and vegetable production, respectively. Farming is central to India's socio-economic development. Therefore, enhancements in technology to aid farmers, will help to accelerate India's growth trajectory.

All species of plants, wild and cultivated alike, are subject to disease. The occurrence and prevalence of plant diseases vary from season to season, depending on the presence of the pathogen, environmental conditions, and the crops and varieties grown. Some plant varieties are particularly subject to outbreaks of diseases while others are more resistant to them.

Plant diseases are posing a new challenge in the growth of India's agriculture. According to the survey conducted by The Economic Times "Crops worth Rs 50,000 crore are lost owing to pest and disease attacks every year".

There are many applications currently available in the market catering to the needs of the farmers. But they do not provide the facility of interacting in different state languages. There are many non-Hindi speaking states in India like West Bengal, Telangana, Tamil Nadu, Karnataka and Kerala. Even farmers in states like Maharashtra would prefer to get the information in Marathi. Therefore, it is the need of the hour to assist the farmers regarding the plant diseases, its causes and solutions in vernacular languages.

The objective of this project is to provide better agricultural assistance to the farmers in their regional language. To begin with the focus will primarily be Marathi and Hindi and later on the scope will be broadened to different state languages.

1.2 Motivation

The motivation for this project stems from the critical role that agriculture plays in the Indian economy and the numerous challenges faced by farmers, including plant diseases that can lead to significant crop losses. The project aims to empower farmers with advanced technology solutions to combat these challenges effectively. By leveraging deep learning tools, the system can provide quick and accurate analysis of plant health based on images of leaves. This technology-driven approach will enable farmers to take timely actions to prevent disease proliferation and minimise losses.

Furthermore, the project is motivated by the need to cater to the diverse linguistic and regional preferences of Indian farmers. By offering multilingual support through natural language processing techniques, the system ensures that farmers from various regions can easily interact with and benefit from the solution. This inclusivity is essential for reaching a wider audience and making the technology accessible to all.

The development of a user-friendly website and Android application, along with the integration of a chatbot, is another crucial aspect of the project's motivation. These interfaces provide a convenient and accessible means for farmers to access plant health analysis and seek assistance with their queries. Overall, the project's motivation lies in leveraging cutting-edge technology to enhance agricultural productivity, empower farmers, and address the unique challenges faced in the Indian agricultural sector.

1.3 Problem Definition

Plant disease is one of the biggest challenges faced by the farmers of India. The loss incurred each year due to the disease outbreak is huge and is increasing every year. The information regarding the causes, symptoms and treatment of diseases will help the farmers to reduce the losses incurred. But this alone is not enough. The identification of the disease type can be tricky and difficult for the farmers. To accelerate the treatment of the infested crops, an accurate and quick analysis of their state is required. There are various applications in the market producing insights regarding the crop disease, but they are mostly taking inputs and giving outputs in English language. The farmers from within the interiors of Indian villages need multilingual assistance in order to profit from the analysis.

1.4 Relevance Of The Project

The relevance of this project lies in its potential to address pressing issues within the Indian agricultural sector. Agriculture is a cornerstone of the Indian economy, but it faces numerous challenges, with plant diseases being a major concern. This project is highly relevant because it offers a technology-driven solution that can significantly improve agricultural productivity and reduce crop losses.

By harnessing deep learning tools for plant health analysis, the project empowers farmers to quickly detect and mitigate diseases, thus preserving crop yields and income. The inclusion of multilingual support through natural language processing ensures that the solution is accessible to a diverse range of farmers, making it highly relevant for the Indian context where linguistic diversity is substantial.

Moreover, the development of a user-friendly website and Android application, coupled with a chatbot for real-time assistance, ensures that the technology is not only effective but also practical and user-centric. This relevance is underscored by the potential to positively impact the livelihoods of millions of farmers across India, contributing to food security, economic growth, and sustainable agriculture in the country. In summary, the project's relevance lies in its ability to address critical agricultural challenges in India and empower farmers with innovative technology solutions.

1.5 Methodology used

The entire system is divided into 3 major parts – Plant Disease Prediction Model, Chatbot with multilingual support and Mobile and Web Application.

Plant Disease Prediction Model :

1. The input image is taken from the user. The image is of the leaf of the plant which is to be tested.
2. Analysis of the image is done using the Deep Learning models. The models are trained by using the Plant Village dataset which has approximately 9 different varieties of plant leaf images. The different stages for building the model are – Data Preprocessing and Cleaning, Quantization, Deployment, etc. The output of the final analysis is displayed on the mobile and web application.

Chatbot with Multilingual Support :

1. The user can type the query in the chatbot. The language options given are English, Hindi, Marathi, etc.
2. Analysis of the query is done using the Natural Language Processing model. The model is trained using the data from Kisan Call Center (KCC), Open Government Data (OGD) Platform India, etc. The different stages for building the model are – Language Understanding, Information Retrieval, Response Generation, etc. The response is displayed on the mobile and web application.

Mobile and Web Application :

1. The mobile and web applications have a very easy to navigate user interface. The output of both the models is displayed.
2. If further assistance is required then the helpline contact information is also available.

Chapter 2 : Literature Survey

The section offers compiled information of all the existing systems in the same domain as that of our proposed system.

2.1 Research papers referred

Sr. No.	Title	Summary	Citation
1.	A Survey on Chat-Bot system for Agriculture Domain.	The paper has reviewed various chatbots for the agriculture domain. The focus is on the chatbots which are developed using natural language processing and machine learning. The paper mainly focuses on two chatbots - "*ADANS: An Agriculture Domain Question Answering System using Ontologies*", "*AGRI-QAS Question-Answering System for Agriculture Domain".* ADANS uses a combination of Natural Language Processing(NLP) and semantic web technologies. AGRI-QAS focuses on processing unstructured data and provides responses for FACTOID queries such as 'which', 'what', 'who', 'where'.	P. Y. Niranjan, V. S. Rajpurohit and R. Malgi, "A Survey on Chat-Bot system for Agriculture Domain," 2019 1st International Conference on Advances in Information Technology (ICAIT), Chikmagalur, India, 2019, pp. 99-103, doi: 10.1109/ICAIT47043.2019.8987429.
2.	AgriBot - An intelligent interactive interface to assist farmers in agricultural activities.	In this paper, a chatbot is developed using Natural Language Processing technique. It caters to all the queries of the farmers regarding seeds, fertilisers, market prices, storage facilities, government schemes, etc. The crop statistics data is collected from Open Government Data (OGD) Platform in	D. Sawant, A. Jaiswal, J. Singh and P. Shah, "AgriBot - An intelligent interactive interface to assist farmers in agricultural activities," 2019 IEEE Bombay Section Signature Conference (IBSSC), Mumbai, India, 2019, pp. 1-6, doi: 10.1109/IBSSC47189.2019.8973066.

		India and the rainfall data in various regions of Maharashtra is collected from a web portal which is an initiative by the Department of Agriculture, Maharashtra. The algorithms used for prediction of the crops are K-nearest neighbour algorithm (Accuracy - 72.5%), Random forest (Accuracy - 78%), Decision Tree (Accuracy - 75%). The chatbot is designed using the DialogFlow API and if the chatbot fails to answer any query it is reassigned to the helpline centres.	
3.	E-Agriculture for Direct Marketing of Food Crops Using Chatbots.	In this paper, a chatbot is developed to warrant fair price of the produce to the farmers and consumers. In this, the farmer is ready to cultivate a particular crop which is required by the consumer at a certain price and then the consumer hires the farmer and his land and supplies him with all the inputs for water, seeds, etc. The farmer then cultivates the crop and gives the yield to the consumer in return getting paid for the job. This chatbot is based on creating a secure chain for the communication of farmer and consumer without the mediation of any third person. It is developed using Python 2.7.9, R language, Java script and PostgreSQL.	U. Kiruthika, S. K. S. Raja, V. Balaji and C. J. Raman, "E-Agriculture for Direct Marketing of Food Crops Using Chatbots," 2020 International Conference on Power, Energy, Control and Transmission Systems (ICPECTS), Chennai, India, 2020, pp. 1-4, doi: 10.1109/ICPECTS49113.2020.9337024.
4.	Plant Leaf Detection and Disease Recognition using Deep Learning.	In this paper, deep learning techniques, particularly Convolutional neural network (CNN) is used for plant leaf recognition and disease detection. images as a basis for recognizing several types of plant diseases. This study provides an efficient solution for detecting diseases in apple, corn, grapes, potato, sugarcane, and tomato leaves. The images are resized and have 96x96 resolution. Certain data augmentation techniques are used such as rotating the images by 25 degrees, flipping and shifting of images horizontally and vertically. The model trained 75 epochs using a batch size of	S. V. Militante, B. D. Gerardo and N. V. Dionisio, "Plant Leaf Detection and Disease Recognition using Deep Learning," 2019 IEEE Eurasia Conference on IOT, Communication and Engineering (ECICE), Yunlin, Taiwan, 2019, pp. 579-582, doi: 10.1109/ECICE47484.2019.8942686.

		32. The final accuracy of the model is 96.5%.	
5.	Smartphone Application for Deep Learning-Based Rice Plant Disease Detection.	In this paper, a deep learning based rice disease detection system is developed so that rice plant disease control can be carried out and the yield can be maximised. The smartphone application captures the images of the rice plant leaves and the classification gives the type of the disease. The different types of diseases for the rice plant are Brown Spot, Leaf Blast and Hispa. Apart from this, if the leaf is healthy then that also is shown in the results. The images are resized to 200x200 pixels. The performance of this system with VGG16 architecture has a train accuracy value of 100% and a test accuracy value of 60%.	H. Andrianto, Suhardi, A. Faizal and F. Armandika, "Smartphone Application for Deep Learning-Based Rice Plant Disease Detection," 2020 International Conference on Information Technology Systems and Innovation (ICITSI), Bandung, Indonesia, 2020, pp. 387-392, doi: 10.1109/ICITSI50517.2020.9264942.
6.	Detection of Banana Leaf and Fruit Diseases Using Neural Networks.	In this paper, ANN algorithm is used to detect the diseased banana fruit and its leaf. It is a multiclass classification and hence the accuracy for each class is different. The system takes an input image of both the banana leaf and the banana fruit and predicts whether the plant is diseased or healthy. The diseases detected are classified into two parts -- Leaf Diseases (Black Sigatoka, Freckle Leaf), Fruit Diseases (Anthracnose, Freckle Fruit). The images are resized to 256x256 pixels and various techniques are used for noise removal.	N. Saranya, L. Pavithra, N. Kanthimathi, B. Ragavi and P. Sandhiyadevi, "Detection of Banana Leaf and Fruit Diseases Using Neural Networks," 2020 Second International Conference on Inventive Research in Computing Applications (ICIRCA), Coimbatore, India, 2020, pp. 493-499, doi: 10.1109/ICIRCA48905.2020.9183006.
7.	IoT Enabled Efficient Detection and Classification of Plant Diseases for Agricultural Applications.	In this paper, an Internet of Things (IoT) enabled disease detection system is used to detect and classify the bunchy top of banana and sigatoka diseases in hill banana plants. Classification is done using both Random Forest and KNN. Random Forest Classification technique works better. The parameters	R. D. Devi, S. A. Nandhini, R. Hemalatha and S. Radha, "IoT Enabled Efficient Detection and Classification of Plant Diseases for Agricultural Applications," 2019 International Conference on Wireless Communications Signal Processing and Networking (WiSPNET),

		(temperature, soil moisture, pH score) are measured using temperature/humidity sensor and soil moisture sensor that are interfaced with Raspberry Pi3. The images are resized to 256x256 pixels and the system has an overall detection accuracy of 99%.	Chennai, India, 2019, pp. 447-451, doi: 10.1109/WiSPNET45539.2019.9032727.
8.	Black Rot Disease Detection in Grape Plant (Vitis vinifera) Using Color Based Segmentation & Machine Learning.	In this paper, Black Rot disease is detected. The PlantVillage Dataset is used, which contains images of grape plant leaves affected from Block Rot Disease as well as the pictures of healthy leaves. HSV and L*a*b* colour models are used for the segmentation purposes. K-means clustering is used to segregate the brown area from the green area The machine learning is done using the Support Vector Machine Classifier and the results are analysed on different Kernels of SVM (93.3% with Linear Kernel, 94.1% with RBF Kernel and 93.9% with Polynomial Kernel).The highest accuracy achieved is 94.1%.	Kirti and N. Rajpal, "Black Rot Disease Detection in Grape Plant (Vitis vinifera) Using Colour Based Segmentation & Machine Learning," 2020 2nd International Conference on Advances in Computing, Communication Control and Networking (ICACCCN), Greater Noida, India, 2020, pp. 976-979, doi: 10.1109/ICACCCN51052.2020.9362812.
9.	Artificial Intelligence in Smart Agriculture: Modified Evolutionary Optimization Approach for Plant Disease Identification.	In this paper, apple leaf is tested and diseases such as Apple scab, Black rot, Apple Cedar-rust are detected. The system uses Deep Neural Network (DNN). The Robust Speed Up Feature (SURF), which allows achieving greater identification and classification precision, is used to remove functionalities and to refine the Modified Grasshopper Optimization Algorithm (MGOA). The accuracy of the proposed model is 98.49%.	J. S. H. Al-bayati and B. B. Üstündağ, "Artificial Intelligence in Smart Agriculture: Modified Evolutionary Optimization Approach for Plant Disease Identification," 2020 4th International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT), Istanbul, Turkey, 2020, pp. 1-6, doi: 10.1109/ISMSIT50672.2020.9255323.
10.	Improved Segmentation Approach for Plant Disease Detection.	The paper focuses on detection of tomato leaf diseases. This work is based on three tomato leaf diseases, they are - Bacterial Spot, Late Blight and Septorial Spot. The proposed model focuses on	M. A. Rahman, M. M. Islam, G. M. Shahir Mahdee and M. W. Ul Kabir, "Improved Segmentation Approach for Plant Disease Detection," 2019 1st International Conference on Advances

		implementing an improved segmentation technique using a combination of thresholding and morphological operations. For classification, the deep neural network is used. The accuracy of the proposed model is 99.25%.	in Science, Engineering and Robotics Technology (ICASERT), Dhaka, Bangladesh, 2019, pp. 1-5, doi: 10.1109/ICASERT.2019.8934895.
11.	Machine Learning-based for Automatic Detection of Corn-Plant Diseases Using Image Processing.	In this paper, corn plant disease is detected. The different corn diseases are Gray Leaf Spot, Common Rust, Northern Leaf Blight. The images are transformed to 64x64 pixels. Various image processing features to detect colour such as RGB, local features on images such as scale-invariant feature transform (SIFT), speeded up robust features (SURF), and Oriented FAST and rotated BRIEF (ORB), and object detector such as histogram of oriented gradients (HOG) are used. Several machine learning algorithms are used, such as, support vector machines (SVM), Decision Tree (DT), Random forest (RF), and Naive Bayes (NB). RGB is the feature with best accuracy and for machine learning methods, SVM with linear kernels achieves the best performance in most cases.	B. S. Kusumo, A. Heryana, O. Mahendra and H. F. Pardede, "Machine Learning-based for Automatic Detection of Corn-Plant Diseases Using Image Processing," 2018 International Conference on Computer, Control, Informatics and its Applications (IC3INA), Tangerang, Indonesia, 2018, pp. 93-97, doi: 10.1109/IC3INA.2018.8629507.
12.	Plant Disease Detection and Classification using CNN Model with Optimised Activation Function.	In this paper, the diseased plant leaves are detected, Convolutional Neural Networks (CNN) is used. The different diseases detected are Anthracnose, Antharasis Bacterial Blight, Cercospora Leaf Spot, Black Rot. The study develops a new activation function and the experimental results on trained databases show that the developed activation function has improved the CNN model accuracy and performance i.e. new accuracy is 95%. Further area affected by disease is calculated by using K – means clustering algorithm.	S. Y. Yadhav, T. Senthilkumar, S. Jayanthy and J. J. A. Kovilpillai, "Plant Disease Detection and Classification using CNN Model with Optimised Activation Function," 2020 International Conference on Electronics and Sustainable Communication Systems (ICESC), Coimbatore, India, 2020, pp. 564-569, doi: 10.1109/ICESC48915.2020.9155815.

Table 1 : Literature Survey

2.2 Articles referred

1. AI for the farmer

Link : https://indiaai.gov.in/article/ai-for-the-farmer
Indian agriculture is leveraging AI solutions to improve productivity and address challenges. With vast data from farmers and farmers, AI can empower agriculture, healthcare, education, and urban infrastructure. Indian agri-tech startups have raised over $1 billion in the financial year 2019-20, and India's agricultural exports reached $37.4 billion in 2019. AI applications in agriculture are expected to grow to $8.38 billion by 2030, with the Indian agri-tech market valued at $204 million. AI can improve farm productivity, remove supply chain constraints, and increase market access, with a $4 billion opportunity by 2026. India's agriculture sector is embracing AI to improve productivity and control input wastage. The government has developed an AI-powered crop yield prediction model, utilizing remote sensing data from ISRO and other sources. The system is being implemented in 10 districts across India. Indian startups are also implementing AI-based solutions in agriculture, such as assessing crop damage, mapping farmers' zones, and developing predictive analytics. However, to scale these solutions, increased investments, particularly from venture capitalists, are needed. India's diverse soil types, climate, and topography offer immense opportunities for AI development in agriculture.

2. AI impact on India

Link : https://indiaai.gov.in/article/ai-impact-on-india-how-ai-will-transform-indian-agriculture
India is attracting investment in agri-tech, with around 72 AI in Agriculture startups. Microsoft, in collaboration with ICRISAT, has developed an AI Sowing App that sends sowing advisories to farmers without installing sensors or incurring capital expenditure. The government is supporting agri-tech through public-private partnerships and grants. The market valuation is expected to reach US$ 30-35 billion by 2025, with India being the world's third-largest recipient of agritech funding and the third-largest number of agritech start-ups. This growth is expected to transform India's agriculture and attract private equity and venture capital investments.

2.4 Patent Search

1. Autonomous Robotic Machine for Disease Detection in Crop Leaf

This invention relates to an autonomous robotic machine for disease detection in crop leaf. Particularly this invention relates to a portable automatic robotic machine for detecting the ill crop leaf through the application of image processing and analysis. In this invention there is provided an autonomous robotic machine for disease detection in crop leaf comprising four motors, adapted to be connected to a microcontroller, a power supply being provided to facilitate electric functionality of robot, a high resolution camera adapted to be connected to a microcontroller, being provided to capture panoramic images, an infrared sensor, adapted to be connected to a microcontroller, being provided to analyse temperature of the plants, a path detection module, being provided to direct robot on correct route, a positioning system adapted to be connected to a current amplifier, being provided to communicate definite location coordinates to the microcontroller, a wireless network functionality, being provided to enable wireless operation of robot.

2. OCTOPIDER : A doorstep solution for Farmers

The invention OCTOPIDER: A doorstep solution for Farmers is a Continuing agriculture using a device "OCTOPIDER" that is going to bring a new era in the field of agriculture. A well-designed device enables the farmer to know various types of field characteristics in mainly eight different sectors of the farm such as soil type, plant disease, nutrient availability, weather forecast, moisture level, pH level, growth of plant, crop characteristics along with work history. It is a robotic model which can move in both land as well as in air according to the need of work. It is easily movable and can be controlled with any android phone which consist of an app. An app also performs a major task which starts further the work of the device. It performs the task like informing the nearest KVK about unknown disease in the farm, transporting their product to various mandi, knowing the price of various farm equipment in the market and its availability.

3. Transforming Agriculture Through MOR

The invention Transforming Agriculture Through MOR is a Smart agriculture using MOR which mainly consists of a virtual assistant and the monitoring centre. It comprises a well-designed data driven map that enables the farmers to know the type of crops grown and their diseases in their area. It also enables them to know the potential Agri-markets along with prevailing prices in their location. In the case of a virtual assistant, it acts like a multitasker, which can do major tasks like plant disease detection, irrigation status, soil nutrient status, weather forecast prediction along with their work history. It can also automatically inform the nearest KVK (Krishi Vigyan Kendra) about the major problems that the farmer (user) is facing. The invention is also looking at the selection of correct yield for farming and Several factors influence the yield of crops like rain, C-Deg- temperature, soil, Crop prediction helps Indian farmers in choosing the right and real-time crop for plantation to maximise their earning.

2.5 Existing Systems

Plant Disease Detection Applications -

1. Agrio - Plant Health App

Agrio is a mobile app for Android and iOS designed to assist growers in sustainable plant protection. Using advanced image recognition with artificial neural networks, it identifies plant diseases by learning from tagged examples. The app evolves through user feedback, improving its accuracy and treatment recommendations over time.

2. Plantix - your crop doctor

Plantix is a crop doctor app available on Android and iOS that serves as a valuable tool for farmers. It aids in plant disease detection through image recognition technology. Users can capture pictures of their crops, and the app identifies potential issues based on visual cues. Plantix offers insights into pest infestations, nutrient deficiencies, and diseases. The app also provides recommended solutions and farming advice, contributing to effective crop management.

3. TIA - Plantcare made easy

TIA-PlantCare is a comprehensive plant care application that streamlines the process of nurturing your plants. The app encompasses user-friendly features, including plant identification and tailored care recommendations. It may also foster a community aspect, allowing plant enthusiasts to share valuable insights and tips. With a commitment to simplicity, TIA-PlantCare aims to make the intricacies of plant care easily accessible to users of all levels of expertise.

4. PlantCam - AI Plant Identifier

PlantCam is an Android and iOS app designed to effortlessly identify plants through the power of AI. This user-friendly application utilises advanced image analysis, allowing users to capture plant photos for swift and accurate identification. With a seamless interface, PlantCam makes plant recognition easy and accessible, catering to both gardening enthusiasts and curious nature lovers.q

5. Flora : Plant Care and Identifier

Flora is a comprehensive plant care and identification application, accessible on both Android and iOS platforms. This user-friendly app not only streamlines plant care routines through features like watering reminders and fertilisation schedules but also offers a robust plant identification tool. Leveraging advanced image recognition technology, Flora allows users to effortlessly identify a diverse range of plants. By integrating both plant care assistance and identification capabilities, the app provides a holistic and convenient experience for plant enthusiasts.

6. CropWise Grower - Kisan App

CropWise Grower-Kisan App is a robust mobile application designed to empower growers in managing their crops effectively. This multifaceted app offers a suite of features, including crop management tools, real-time weather updates, market price information, and expert advice. By providing a comprehensive platform, CropWise aims to optimise farming processes, enabling growers to make informed decisions for maximising crop yields and overall agricultural productivity.

- Chatbots

1. KissanGPT

Kissan GPT stands as an advanced agricultural tool, integrating artificial intelligence to assist farmers. Using the powerful GPT model, it provides personalised advice based on crop, weather, and soil data. Beyond recommendations, the app serves as a knowledge hub, offering articles on modern farming techniques and market trends. Its user-friendly interface allows farmers to input specific details, refining suggestions over time. Kissan GPT fosters a collaborative community where farmers can share experiences and insights, creating a supportive network. In essence, it's a comprehensive digital companion, leveraging AI to enhance farming practices and collective knowledge in a user-friendly manner.

2. FarmChat

The Audio-only FarmChat interface consists of only two buttons:

A red ‘microphone’ button that the user needs to click to provide speech input,

A blue ‘play’ button, which enables the user to listen to the chatbot’s last response again.

Users can click on the blue button any number of times to repeat the most recent response. While the bot is playing the last response, the blue button can be clicked again to pause the response. After the user’s speech input is received, the interface shows a waiting icon and does not allow the user to click any of the buttons.

2.6 Lacuna in the existing systems

There are many applications currently available in the market catering to the needs of the farmers.
But they do not provide the facility of interacting in different state languages.
There are many non-Hindi speaking states in India like West Bengal, Telangana, Tamil Nadu, Karnataka and Kerala.
Even farmers in states like Maharashtra would prefer to get the information in marathi.
Therefore it is the need of the hour to assist the farmers regarding the plant diseases, its causes and solutions in vernacular languages.

2.7 Comparison of existing systems and proposed area of work

Comparison -

1. The existing chatbots don't have multilingual support.
2. Very few provide bilingual support in English and Hindi. Chatbots for farmers in Marathi language are very rare.
3. Even if some chatbots provide multilingual support, they don't have the plant disease detection module available.
4. If the chatbot is not able to solve some query then the helpline numbers and the further course of action are not provided.
5. The existing plant disease detection systems focus on only one particular plant such as tomato, corn, rice, etc.
6. There is no such system available which can detect leaf disease for many plants.
7. The accuracy of the chatbots providing regional language support is not very high due to the lack of proper datasets.
8. Most of the plant disease detection applications are for the house plants and the ones which are available for the crops are very less accurate.

The proposed system aims to give a comprehensive solution to plant disease proliferation faced by farmers in India. The system will take in user input in the form of an image, and provide a consolidated analysis on the crop health. This analysis will help the farmers take quick action to save the crop and thus reduce the losses. Deep learning tools will be employed to produce the analysis. The project aims to deliver the information to the farmers in varied languages other than English. In order to reach out to the farmers from remote places in India who are not comfortable with English, the system will be providing multilingual support. An NLP based chatbot will be embedded in the website and android application to provide assistance in vernacular languages.

2.8 Focus Area

- Plant Disease Diagnosis:

Use-Case: Users can upload images of plant leaves to the mobile and web application for disease diagnosis.
Benefit: Farmers and gardeners can quickly identify diseases affecting their plants, enabling timely intervention.

- Multilingual Chatbot Support:

Use-Case: Users can interact with the chatbot in multiple languages, such as English, Hindi, Marathi, etc.
Benefit: Enhances accessibility for users who prefer to communicate in their native languages, improving user experience.

- Knowledge Sharing and Recommendations:

Use-Case: The chatbot provides information on plant diseases, prevention methods, and recommended treatments.
Benefit: Educates users on plant health, empowering them to make informed decisions for plant disease prevention and management.

- User Assistance and Helpline Integration:

Use-Case: The mobile and web application offer helpline contact information for further assistance.
Benefit: Users can connect with experts or support services for personalised guidance in addressing specific plant health issues.

Chapter 3 : Requirements

The section gives a very detailed explanation of the working of our system and explains the intricacies of the technologies used.

3.1 Proposed model

The proposed system aims to give a comprehensive solution to plant disease proliferation faced by farmers in India. The system will take in user input in the form of an image, and provide a consolidated analysis on the crop health. This analysis will help the farmers take quick action to save the crop and thus reduce the losses. Deep learning tools will be employed to produce the analysis. The project aims to deliver the information to the farmers in varied languages other than English. In order to reach out to the farmers from remote places in India who are not comfortable with English, the system will be providing multilingual support. An NLP based chatbot will be embedded in the website and android application to provide assistance in vernacular languages.

3.2 Functional Requirements

- Give the correct diagnosis of the type of plant disease.
- Chatbot should give accurate solutions to the queries of the user.
- The articles related to agriculture should be updated real time, and reflect the new advancements in the field of agriculture.
- The website should translate into multiple languages instantly without any lag.
- The information regarding the various government schemes and policies related to farming should be provided to the user in the simplest terms possible.

3.3 Non-Functional Requirements

- Immediate retrieval of the information.
- The type of disease predicted should be accurate.
- The information regarding the schemes and the polices provided should be reliable.

3.4 Hardware & Software Requirements

1. Android Mobile Phone
2. Web Browser
3. Camera

3.5 Technology and Tools utilised

Mobile application:
Android Studio
Java
XML
Flutter
Dart
Firebase

Chatbot:
iNLTK
DialogFlow
IBM Watson Assistant

Front-End:
HTML, CSS, JavaScript

Back-End:
Python (Backend language)
Flask or Django (Python web frameworks) for building the API endpoints
TensorFlow (for deep learning model implementation)

API Development:
RESTful API using Flask

3.6 Constraints of working

The data obtained from the Kisan Call Centre (KCC) for the chatbot is only available in English. In order to understand and respond in different regional languages the chatbot will need a dataset of varied Indian Languages.
This dataset will have to be made manually.

Chapter 4 : Proposed Design

The section explains the architecture and gives a granular view of the working modules. The work flow followed throughout the project is also elaborated.

4.1 Block Diagram :

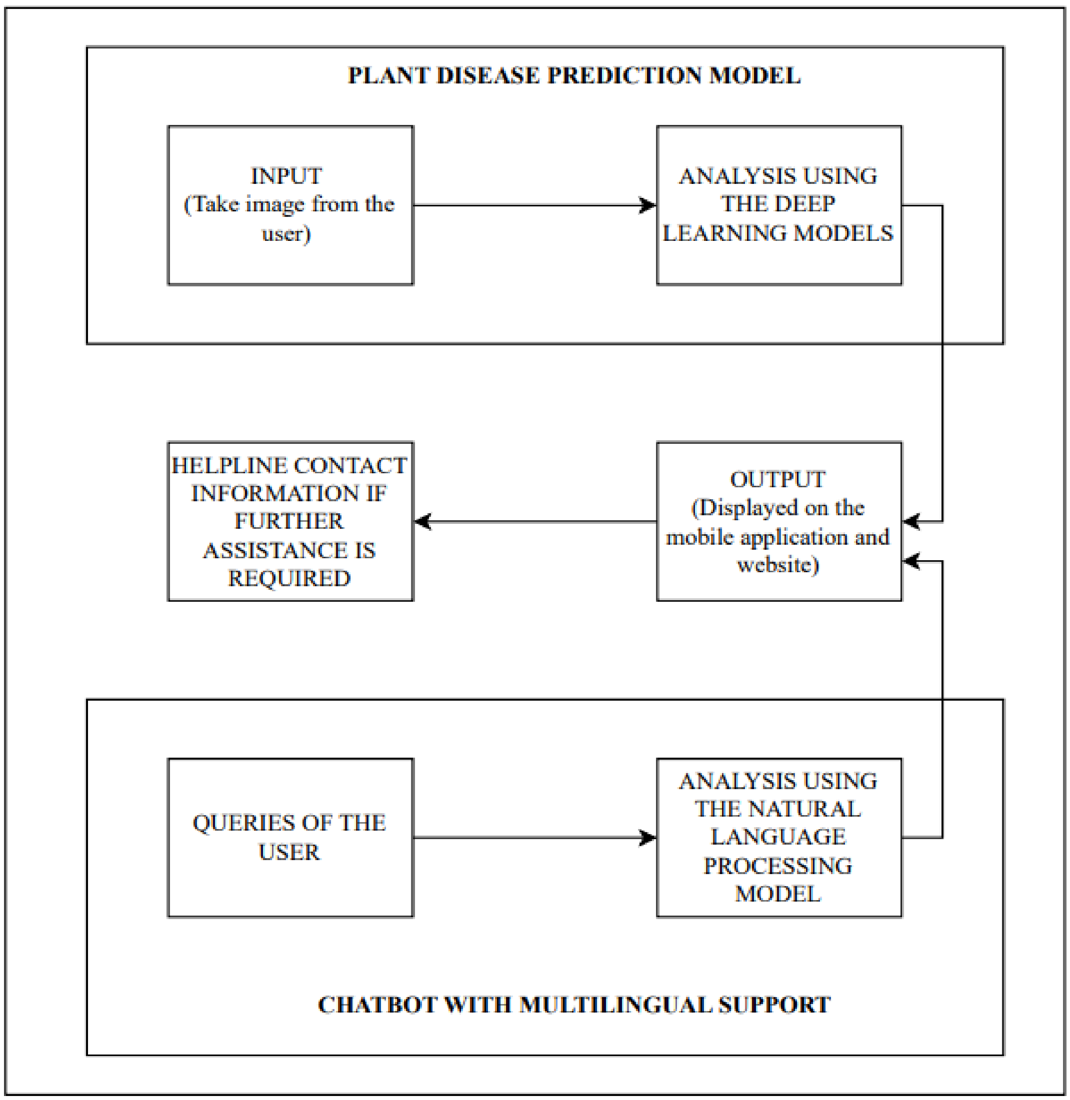

Figure 1 : Block Diagram

The entire system is divided into 3 major parts – Plant Disease Prediction Model, Chatbot with multilingual support and Mobile and Web Application.

Plant Disease Prediction Model :

1. The input image is taken from the user. The image is of the leaf of the plant which is to be tested.
2. Analysis of the image is done using the Deep Learning models. The models are trained by using the Plant Village dataset which has approximately 14 different varieties of plant leaf images. The different stages for building the model are – Data Preprocessing and Cleaning, Quantization, Deployment, etc. The output of the final analysis is displayed on the mobile and web application.

Chatbot with Multilingual Support :

1. The user can type the query in the chatbot. The language options given are English, Hindi, Marathi, etc.
2. Analysis of the query is done using the Natural Language Processing model. The model is trained using the data from Kisan Call Center (KCC), Open Government Data (OGD) Platform India, etc. The different stages for building the model are – Language Understanding, Information Retrieval, Response Generation, etc. The response is displayed on the mobile and web application.

Mobile and Web Application :

1. The mobile and web applications have a very easy to navigate user interface. The output of both the models is displayed.
2. If further assistance is required then the helpline contact information is also available.

4.2 Modular Diagram :

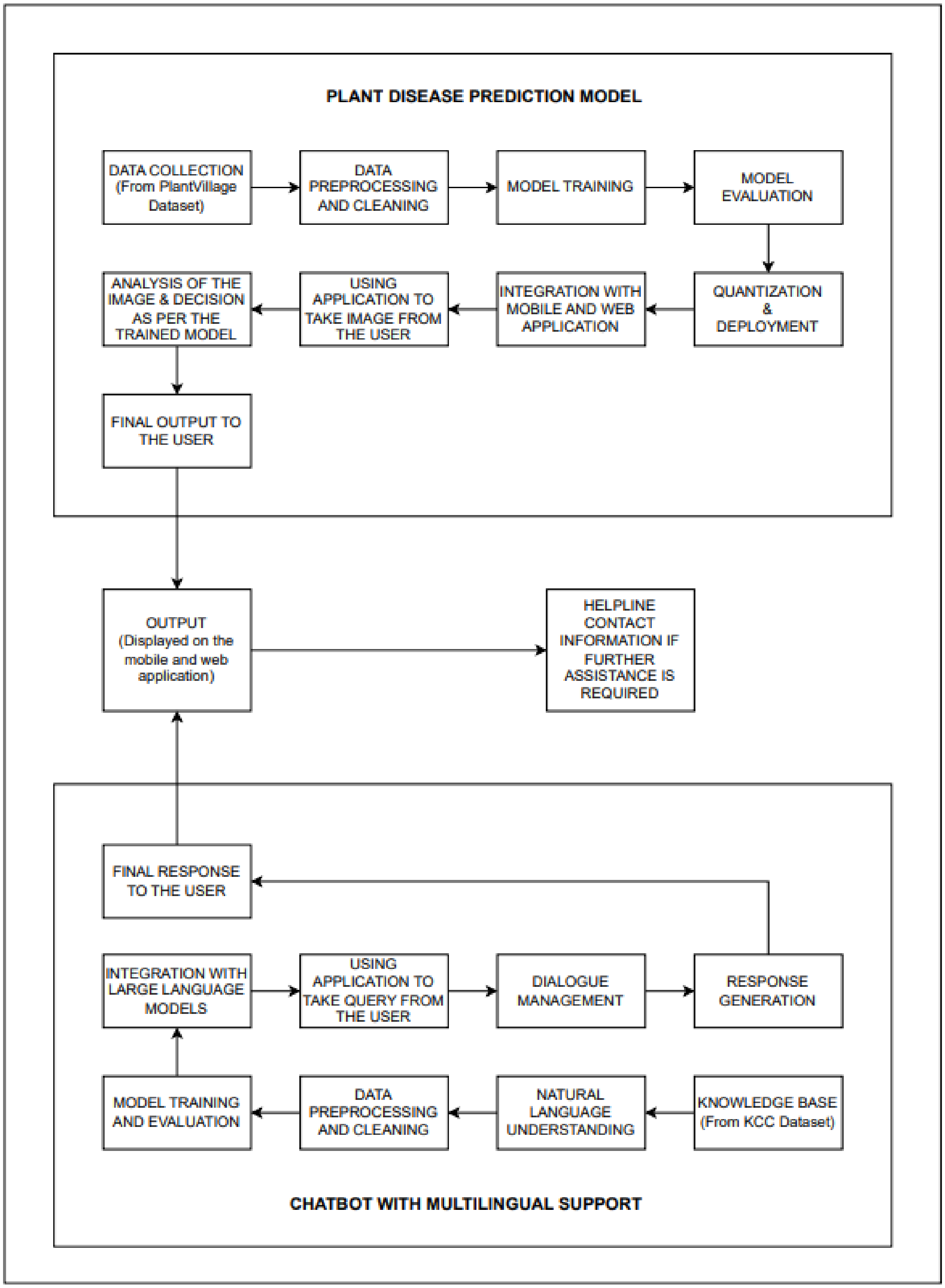

Figure 2 : Modular Diagram

Plant Disease Prediction Model

1. Data Collection :

Gathering a comprehensive dataset of plant images, including healthy and diseased samples, is essential. PlantVillage dataset is used which contains 9 types of plants along with several diseases pertaining to each plant.
Collect data related to different plant varieties and diseases.

2. Data Preprocessing and Cleaning :

This block involves tasks like image resizing, noise reduction, and data augmentation to prepare the dataset for training.
Data cleaning ensures high-quality input for the model.

3. Model Training :

Train deep learning models (e.g., Convolutional Neural Networks - CNNs) using the preprocessed dataset.
The training process involves feature extraction and model optimization.

4. Model Evaluation :

Assess the model's performance using validation datasets and metrics such as accuracy, precision, recall, and F1-score.
Fine-tune the model based on evaluation results.

5. Quantization & Deployment :

Quantization is a technique to optimise the model for deployment on resource-constrained devices (e.g., mobile devices).
Deploying the model to production environments using tflite.

6. Integration with mobile and web application :

Ensuring seamless integration of the Plant Disease Prediction Model with the Mobile and Web Application.
Developing APIs or endpoints for communication between the application and the model.

7. Input image from user :

Implement functionality in the application to allow users to upload plant images for analysis. Process user input to prepare images for prediction.

8. Analysis of the image :

The inference engine runs predictions on user-submitted images using the trained model.
It interprets the model's output, determining the likelihood and type of disease.

9. Final output to the user :

Present the analysis results to users in an understandable format.
Include information about the detected disease, severity, and recommended actions.
Present the analysis results to users in an understandable format.
Include information about the detected disease, severity, and recommended actions.

Chatbot with Multilingual Support

1. Knowledge Base :

This contains the information and data that the chatbot uses to respond to user queries.
It can include structured databases, FAQs, documents, or other data sources.

2. Natural Language Understanding :

NLU is responsible for processing user queries and understanding their intent, entities, and context.
Building blocks within NLU may include:
Intent Recognition: Identifying the user's intent or purpose behind the query.
Entity Extraction: Extracting specific pieces of information from the user's query.
Context Management: Maintaining context throughout the conversation for more coherent responses.

3. Data preprocessing and Cleaning :

This block involves tasks like stemming, stop-words removal, etc. to prepare the dataset for training.
Data cleaning ensures high-quality input for the model.

4. Model Training and Evaluation :

Training the model using Artificial Neural Networks (ANN) and Natural Language Processing (NLP). Evaluating the model using parameters like accuracy, loss function, etc.

5. Integration with Large Language Models :

Creating a large language model. This block involves integrating with external services or APIs to leverage the model's capabilities.

6. Query from user :

This is the user-facing component where users interact with the chatbot.
It includes elements like chat windows, input fields, buttons, and menus for user interaction.

7. Dialogue Management :

Dialogue management controls the flow of the conversation and decides what responses to generate.
It may involve a rules-based system, a decision tree, or more advanced techniques like reinforcement learning for dialogue optimization.

8. Response Generation :

This block creates the chatbot's responses based on the user's query and the knowledge base.
Techniques may include template-based responses, dynamic content insertion, or even natural language generation using large language models.

9. Final Response to the user :

This block involves tracking the performance of the chatbot, including user interactions, errors, and user satisfaction.
Analytics help improve the chatbot's capabilities over time.

Output in the desired format :
Output for the image analysis and the chatbot in the proper format is presented to the users via the mobile and web applications.

- Helpline numbers and further assistance if required :

This block focuses on the fact that some of the queries cannot be solved by our chatbot hence further assistance is required. In case of disease detection, for further purchase of pesticides, fertilisers, etc requires contact information.

4.3 Detailed Design

- DFD Level 0

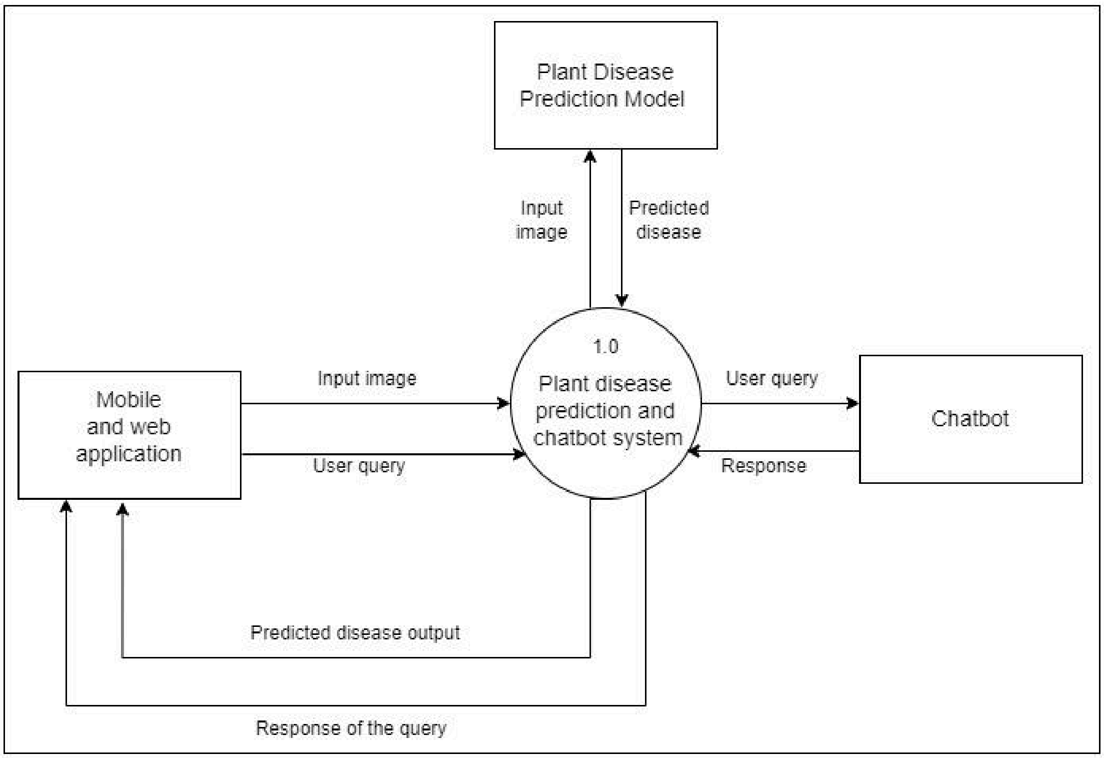

Figure 3 : DFD Level 0

The "Plant Disease Prediction Model" receives the "Input Image" from the "Mobile and Web Application" and provides the "Processed Image" to the "Mobile/Web Application."
The "Chatbot" receives the "User Query" from the "Mobile and Web Application" and provides the "Chatbot Response" to the "Mobile/Web Application."
The "Mobile/Web Application" acts as a central hub, receiving data from both the "Plant Disease Prediction Model" and the "Chatbot" and displaying results to the user

- DFD Level 1

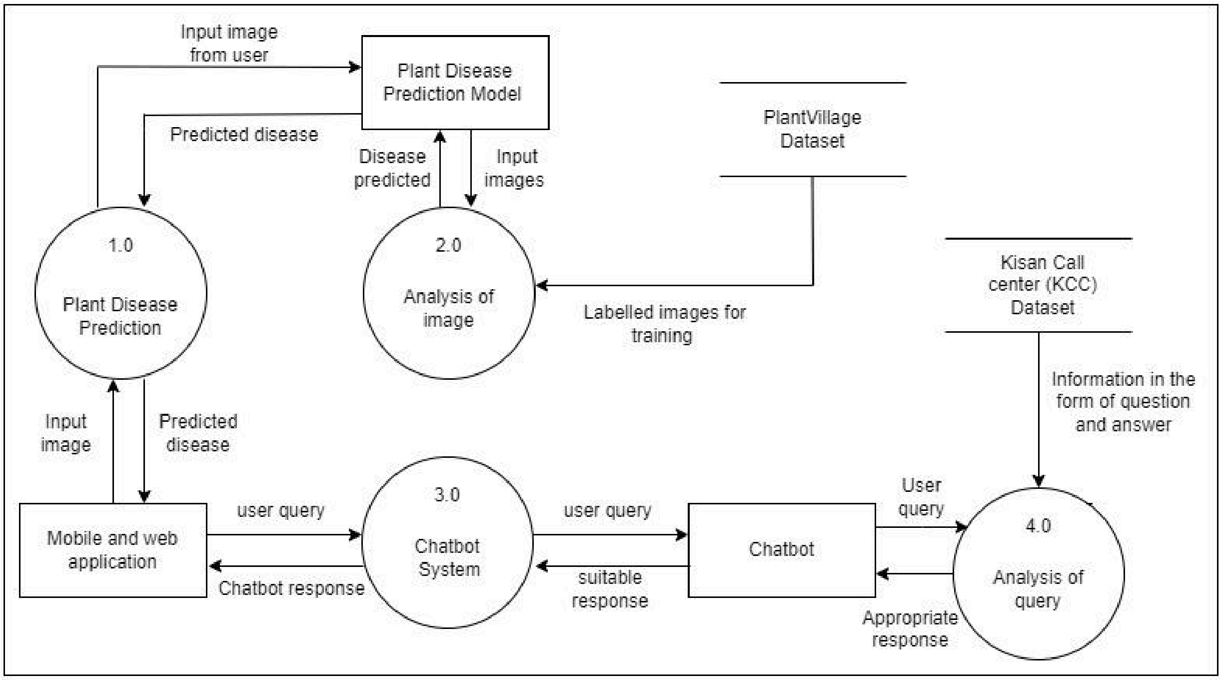

Figure 4 : DFD Level 1

The "Plant Disease Prediction Model" entity receives the "Input image" and forwards it to the "Analysis of Image" process.
The "Analysis of Image" process, which is a part of the "Plant Disease Prediction Model," analyses the user's query using natural language understanding techniques.
The "Plant Disease Prediction" process then generates a "Predicted disease response" based on the analysis and sends it to the "Mobile/Web Application."The "Chatbot" entity receives the "User Query" and forwards it to the "Analysis of Query" process.
The "Analysis of Query" process, which is a part of the "Chatbot," analyses the user's query using natural language understanding techniques.
The "Chatbot" process then generates a "Chatbot Response" based on the analysis and sends it to the "Mobile/Web Application."

- DFD Level 2

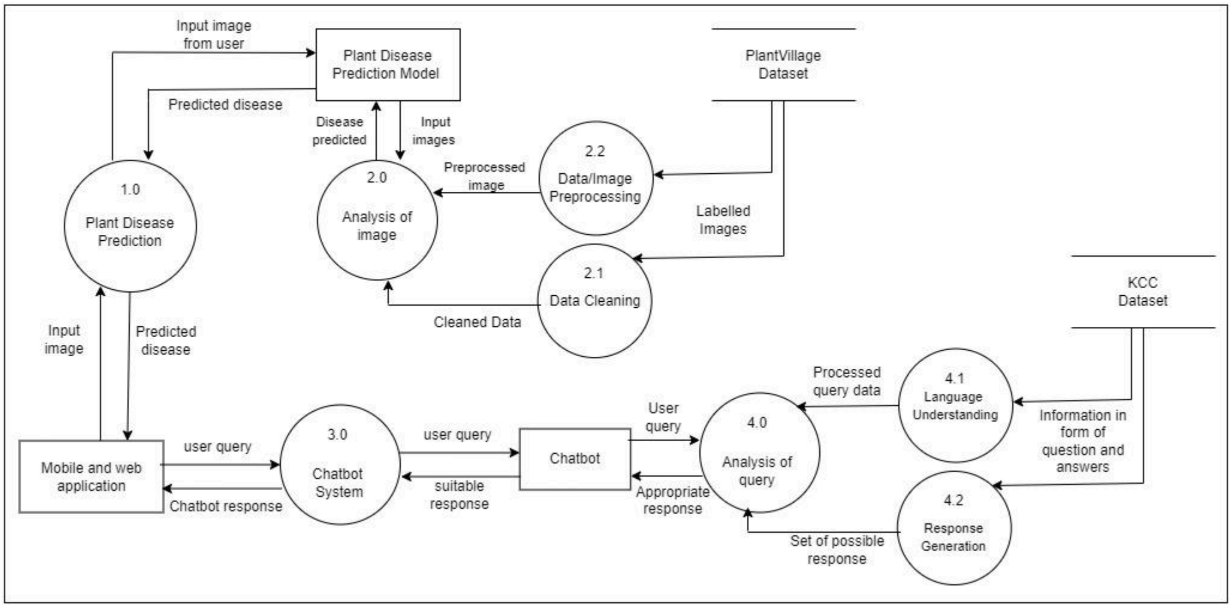

Figure 5 : DFD Level 2

This diagram goes deeper into the Analysis processes. The "Analysis of Image" process includes the following sub processes - Data/Image preprocessing and Data Cleaning. Input data from "Analysis of Image" to data cleaning and preprocessing processes and the resulting "Cleaned and Preprocessed Data" back to the original process.
The "Analysis of Query" process includes the following sub processes - Language Understanding and Response Generation. Input data from "Analysis of Image" to the subprocesses and the "Preprocessed query data and set of possible responses" back to the original process.

ER Diagram:

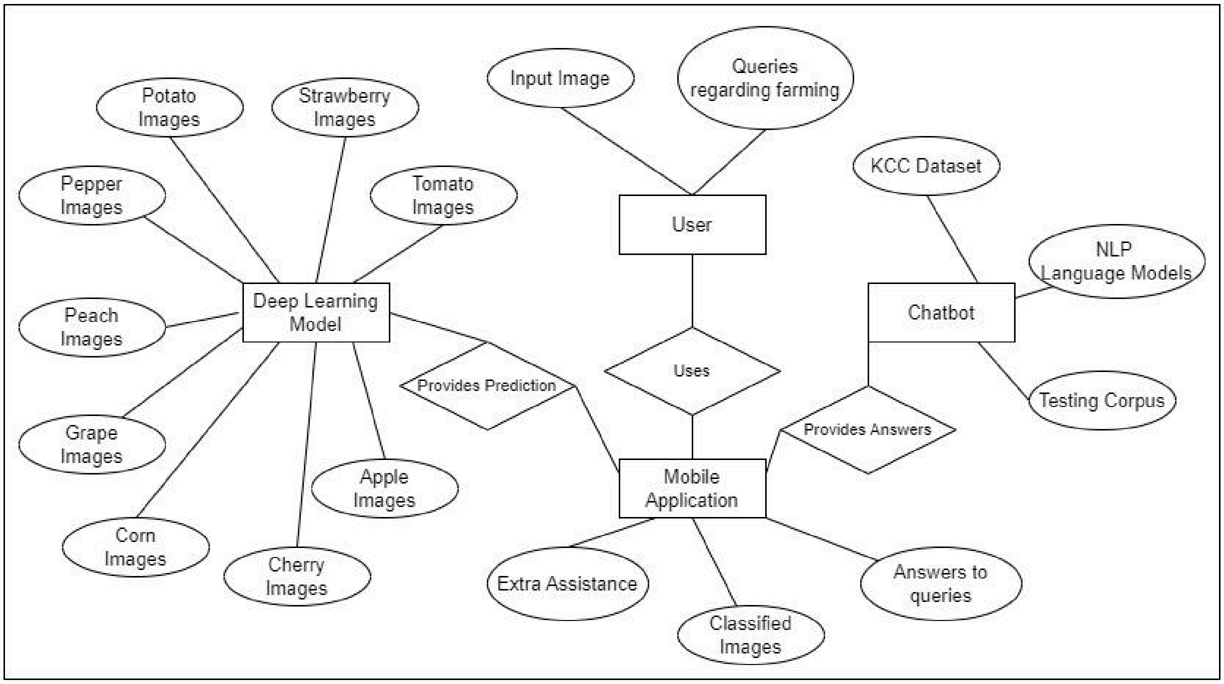

Figure 6 : ER Diagram

The Deep Learning Model is trained using datasets of 9 different plants. The plants are as follows - Bell Pepper, Potato, Strawberry, Tomato, Peach, Grapes, Apple, Corn, Cherry, Tomato. The mobile application takes an input image from the user and the deep learning model provides the prediction of the crop disease. The chatbot is trained using the KCC dataset, NLP, ANN, etc. The queries of the user are given to the chatbot via the mobile application and the appropriate response is provided to the user.

4.4 Proposed Algorithms

1. NLP Pipeline

The different phases of the NLP pipeline include - Tokenization, converting to lower case, stemming, excluding punctuation characters and applying the Bag Of Words approach. Each phase in detail is as follows -

- Tokenization : The entire query which was passed as a string is converted into different tokens.

- Lower case + Stemming : The tokens are converted to lowercase and then stemming is performed using the PorterStemmer Algorithm.
- Excluding punctuation characters : Punctuation characters such as "?,:,;,,,*,<,>" are excluded for smooth functioning and for the bag of words approach.
- Bag of Words : Bag of Words Approach is used to and after using softmax the final probability is calculated. If the probability is greater than 0.9 then the query is classified into that tag and the appropriate response from the response array is returned.

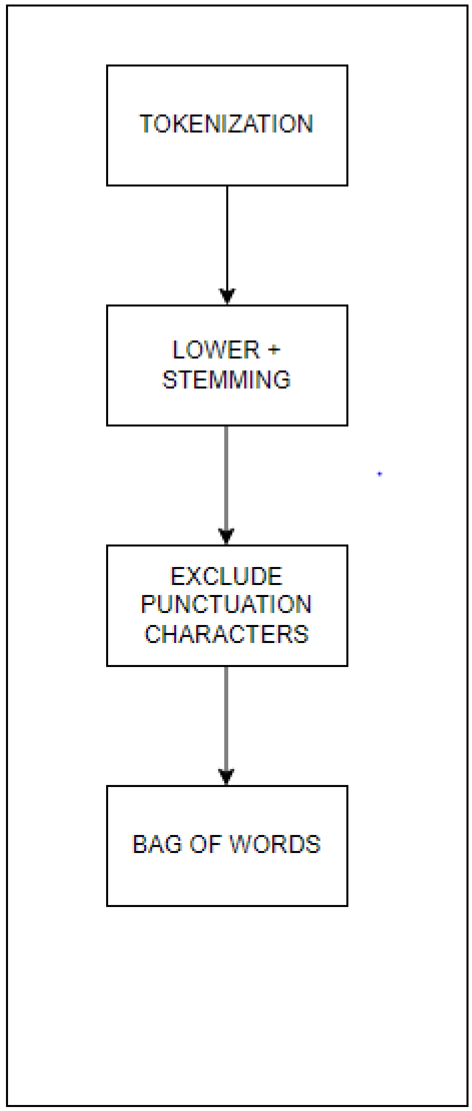

Figure 7 : NLP Pipeline

2. Chatbot Pipeline

The different phases of the chatbot pipeline is Training data, Train-Test Split, Bag of Words Approach, Feed Forward Neural Network, Output. Each phase in detail is as follows -

- Training data : The training data is in the json format. The json file has several tags along with the query and the responses. This is used for training the ANN model.

- Train-Test Split : The queries and responses are used as the input data and the tags are the predicted output.
- Bag Of Words : Bag of Words Approach is used to and after using softmax the final probability is calculated. If the probability is greater than 0.9 then the query is classified into that tag and the appropriate response from the response array is returned.
- Feed Forward Neural Network : The neural network used has 3 layers. Then softmax is used for calculating the probabilities and the final output.
    - Output : The output is the tag if the probability calculated is greater than 0.9.

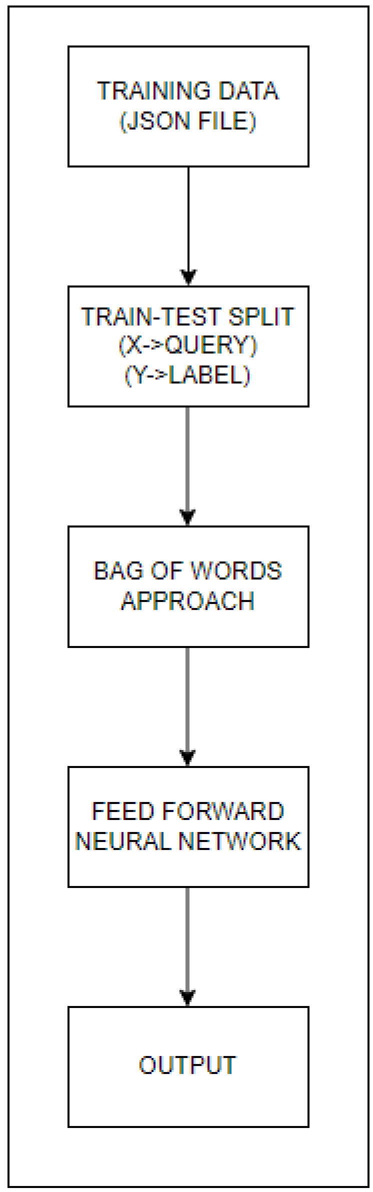

Figure 8 : Chatbot Pipeline

3. Feed Forward Neural Network

- Model Architecture:

The model has three linear layers :
input_size: The size of the input features.
hidden_size: The size of the hidden layer.
num_classes: The number of output classes.

- Activation Function:

The Rectified Linear Unit (ReLU) activation function is applied after each linear layer.
ReLU introduces non-linearity to the model, allowing it to learn complex patterns in the data.

- Forward Pass:

In the forward method, the input tensor x is passed through the linear layers and ReLU activation functions.
The output of the final linear layer is returned without applying any activation function.

- Softmax:

Softmax activation is typically used in the final layer for multi-class classification tasks to obtain class probabilities.

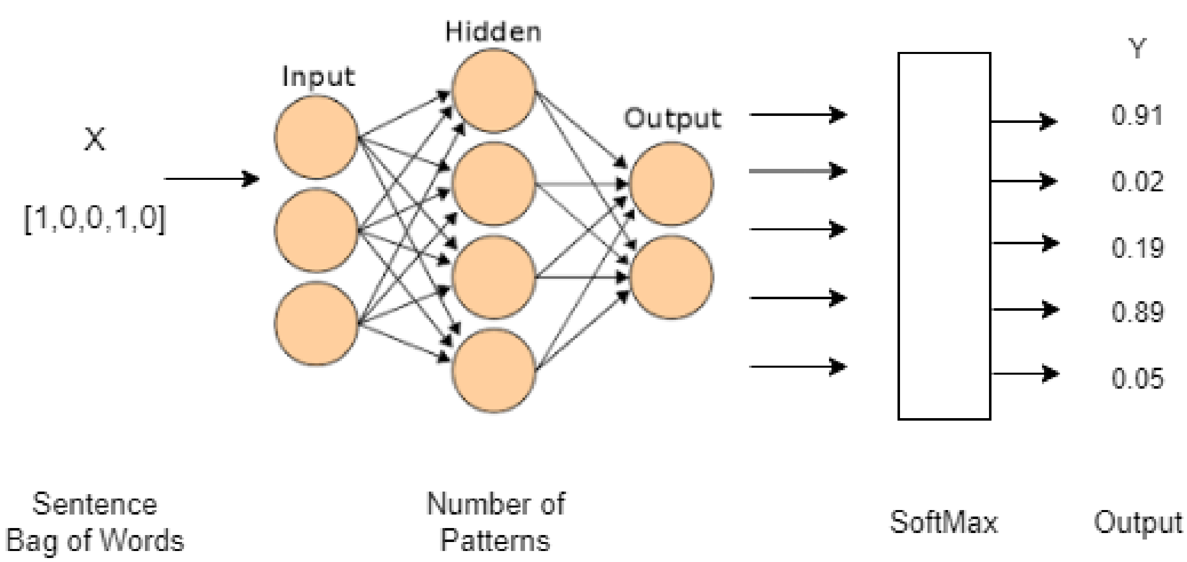

Figure 9 : Feed Forward Neural Network

4.5 Project Tracking and Scheduling

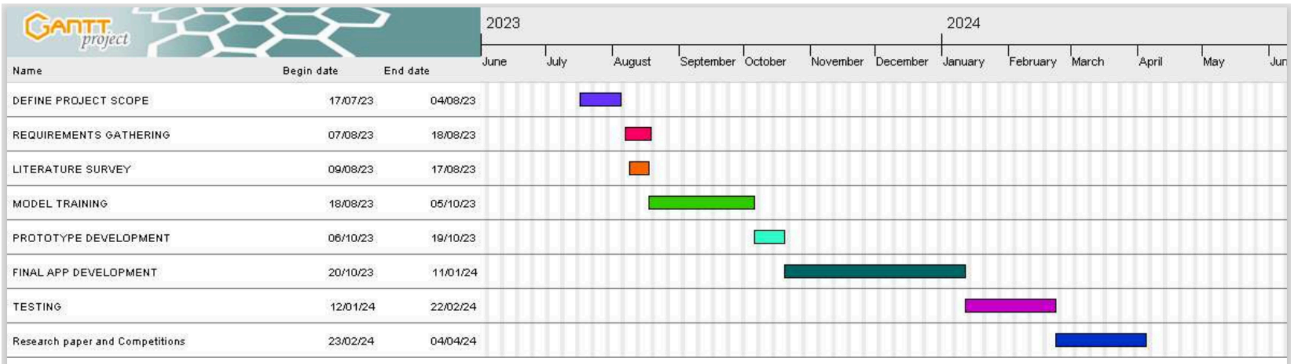

Figure 10 : Gantt Chart

The gantt chart visualises the timeline of the different phases of the project, starting from defining the project scope till the completion of the project.

5. Results and Discussions

Confusion Matrix is a machine learning method used to measure a classifier's performance. It helps to visualise and summarise the performance of a classification algorithm. It plots actual vs. predicted i.e., actual classes vs. the classes predicted by the model.

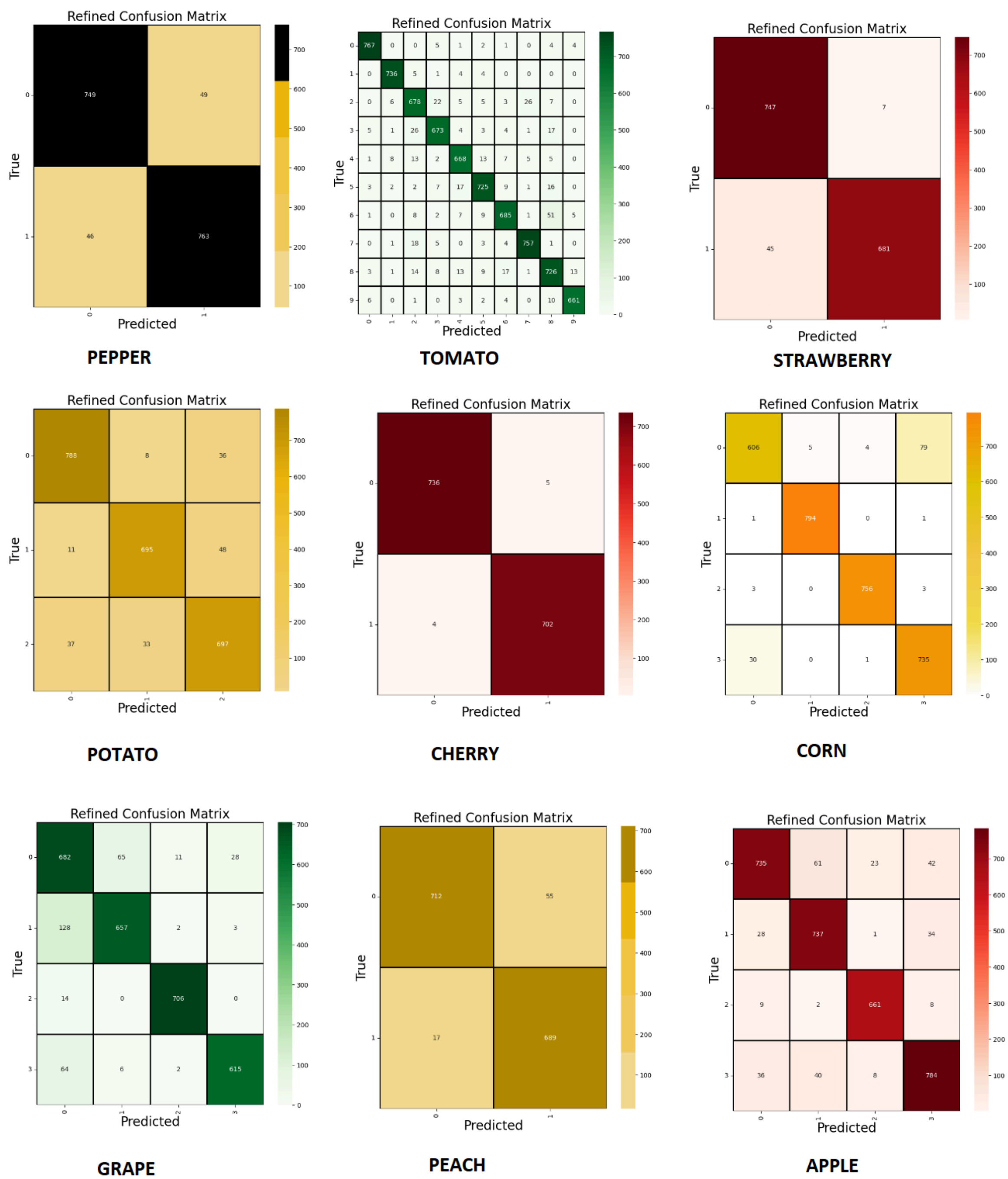

Figure 11 : Confusion Matrix

Epochs of Chatbot Training:

- Number of Epochs: 1000 epochs are used for training the chatbot. Epochs refer to the number of times the entire training dataset is passed through the neural network. Typically, multiple epochs are used to allow the model to learn patterns in the data.

- Loss Function: The loss function is a measure of how well the model is performing. A loss of 0.0000 is ideal and suggests that the model has perfectly learned the training data. However, in real-world scenarios, achieving exactly 0.0000 loss is rare and could potentially indicate overfitting to the training data.

```
272 227
Epoch [100/1000], Loss: 0.1749
Epoch [200/1000], Loss: 0.0011
Epoch [300/1000], Loss: 0.0001
Epoch [400/1000], Loss: 0.0000
Epoch [500/1000], Loss: 0.0000
Epoch [600/1000], Loss: 0.0000
Epoch [700/1000], Loss: 0.0000
Epoch [800/1000], Loss: 0.0000
Epoch [900/1000], Loss: 0.0000
Epoch [1000/1000], Loss: 0.0000
final loss: 0.0000
training complete. file saved to data.pth
```

Figure 12 : Chatbot Performance

6. Plan of action for the next semester

- The Chatbot implementation focus will primarily be on Marathi and Hindi.
- Extra Features such as the articles related to agriculture will be provided
- Quick access to various government schemes and facilities available for the farmers will be provided.
- Real time translation of the website will be achieved.

7. Conclusions

The proposed project aims to address the pressing issue of plant diseases and their detrimental impact on farmers in India. By leveraging deep learning tools and natural language processing techniques, the system endeavours to provide quick and accurate analysis of plant health based on leaf images, assisting farmers in combating diseases and preventing losses. The incorporation of regional languages, starting with Marathi and Hindi, demonstrates a commitment to catering to the vernacular audience and ensuring accessibility for farmers across diverse linguistic backgrounds. The implementation of a user-friendly website and android application with a multilingual chatbot further enhances the platform's usability and effectiveness. Overall, this project's objective is to provide better agricultural assistance to farmers in their regional languages, significantly contributing to reducing losses caused by disease proliferation and empowering farmers with vital information for improved crop management.

8. References

[1] P. Y. Niranjan, V. S. Rajpurohit and R. Malgi, "A Survey on Chat-Bot system for Agriculture Domain," 2019 1st International Conference on Advances in Information Technology (ICAIT), Chikmagalur, India, 2019, pp. 99-103, doi: 10.1109/ICAIT47043.2019.8987429.

[2] D. Sawant, A. Jaiswal, J. Singh and P. Shah, "AgriBot - An intelligent interactive interface to assist farmers in agricultural activities," 2019 IEEE Bombay Section Signature Conference (IBSSC), Mumbai, India, 2019, pp. 1-6, doi: 10.1109/IBSSC47189.2019.8973066.

[3] U. Kiruthika, S. K. S. Raja, V. Balaji and C. J. Raman, "E-Agriculture for Direct Marketing of Food Crops Using Chatbots," 2020 International Conference on Power, Energy, Control and Transmission Systems (ICPECTS), Chennai, India, 2020, pp. 1-4, doi: 10.1109/ICPECTS49113.2020.9337024.

[4] S. V. Militante, B. D. Gerardo and N. V. Dionisio, "Plant Leaf Detection and Disease Recognition using Deep Learning," 2019 IEEE Eurasia Conference on IOT, Communication and Engineering (ECICE), Yunlin, Taiwan, 2019, pp. 579-582, doi: 10.1109/ECICE47484.2019.8942686.

[5] H. Andrianto, Suhardi, A. Faizal and F. Armandika, "Smartphone Application for Deep Learning-Based Rice Plant Disease Detection," 2020 International Conference on Information Technology Systems and Innovation (ICITSI), Bandung, Indonesia, 2020, pp. 387-392, doi: 10.1109/ICITSI50517.2020.9264942.

[6] N. Saranya, L. Pavithra, N. Kanthimathi, B. Ragavi and P. Sandhiyadevi, "Detection of Banana Leaf and Fruit Diseases Using Neural Networks," 2020 Second International Conference on Inventive Research in Computing Applications (ICIRCA), Coimbatore, India, 2020, pp. 493-499, doi: 10.1109/ICIRCA48905.2020.9183006.

[7] R. D. Devi, S. A. Nandhini, R. Hemalatha and S. Radha, "IoT Enabled Efficient Detection and Classification of Plant Diseases for Agricultural Applications," 2019 International Conference on Wireless Communications Signal Processing and Networking (WiSPNET), Chennai, India, 2019, pp. 447-451, doi: 10.1109/WiSPNET45539.2019.9032727.

[8] Kirti and N. Rajpal, "Black Rot Disease Detection in Grape Plant (Vitis vinifera) Using Colour Based Segmentation & Machine Learning," 2020 2nd International Conference on Advances in Computing, Communication Control and Networking (ICACCCN), Greater Noida, India, 2020, pp. 976-979, doi: 10.1109/ICACCCN51052.2020.9362812.

[9] J. S. H. Al-bayati and B. B. Üstündağ, "Artificial Intelligence in Smart Agriculture: Modified Evolutionary Optimization Approach for Plant Disease Identification," 2020 4th International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT), Istanbul, Turkey, 2020, pp. 1-6, doi: 10.1109/ISMSIT50672.2020.9255323.

[10] M. A. Rahman, M. M. Islam, G. M. Shahir Mahdee and M. W. Ul Kabir, "Improved Segmentation Approach for Plant Disease Detection," 2019 1st International Conference on Advances in Science, Engineering and Robotics Technology (ICASERT), Dhaka, Bangladesh, 2019, pp. 1-5, doi: 10.1109/ICASERT.2019.8934895.

[11] B. S. Kusumo, A. Heryana, O. Mahendra and H. F. Pardede, "Machine Learning-based for Automatic Detection of Corn-Plant Diseases Using Image Processing," 2018 International Conference on Computer, Control, Informatics and its Applications (IC3INA), Tangerang, Indonesia, 2018, pp. 93-97, doi: 10.1109/IC3INA.2018.8629507.

[12] S. Y. Yadhav, T. Senthilkumar, S. Jayanthy and J. J. A. Kovilpillai, "Plant Disease Detection and Classification using CNN Model with Optimized Activation Function," 2020 International Conference on Electronics and Sustainable Communication Systems (ICESC), Coimbatore, India, 2020, pp. 564-569, doi: 10.1109/ICESC48915.2020.9155815.

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

[14] T. Maginga, J. Nsenga, P. Bakunzibake and E. Masabo, "Smallholder farmer-centric integration of IoT and Chatbot for early Maize diseases detection and management in pre-visual symptoms phase," 2022 IEEE Global Humanitarian Technology Conference (GHTC), Santa Clara, CA, USA, 2022, pp. 369-372, doi: 10.1109/GHTC55712.2022.9911047.

[15] V. Rajesh Kumar, K. Pradeepan, S. Praveen, M. Rohith and V. Vasantha Kumar, "Identification of Plant Diseases Using Image Processing and Image Recognition," 2021 International Conference on System, Computation, Automation and Networking (ICSCAN), Puducherry, India, 2021, pp. 1-4, doi: 10.1109/ICSCAN53069.2021.9526493.

[16] Deepa, R. N and C. Shetty, "A Machine Learning Technique for Identification of Plant Diseases in Leaves," 2021 6th International Conference on Inventive Computation Technologies (ICICT), Coimbatore, India, 2021, pp. 481-484, doi: 10.1109/ICICT50816.2021.9358797.

9. Appendix

9.1 List of Figures

9.2 List of Tables