SAVITRIBAI PHULE PUNE UNIVERSITY

A PROJECT REPORT ON

Crop Recommendation and Plant Leaf Disease Predication using CNN

SUBMITTED TOWARDS THE
PARTIAL FULFILLMENT OF THE REQUIREMENTS OF

BACHELOR OF ENGINEERING
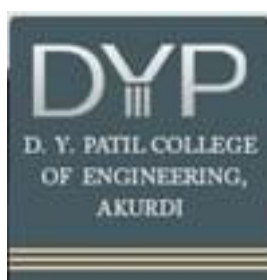in
COMPUTER ENGINEERING

BY

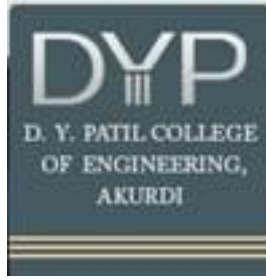|	
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CERTIFICATE

This is to certify that the Project Entitled

Crop Recommendation and Plant Leaf Disease Prediction using CNN

Submitted by

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is a bonafide work carried out by Students under the supervision of Mrs. Deepali M. Gohil and it is submitted towards the partial fulfillment of the requirement of Bachelor of Engineering (Computer Engineering).

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PROJECT APPROVAL SHEET

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Crop Recommendation and Leaf Disease Prediction using CNN

Is successfully completed by

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SAVITRIBAI PHULE PUNE UNIVERSITY,PUNE

ACADEMIC YEAR 2023-2024

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Abstract

The production of high-quality food depends on the agricultural sector, which also makes the largest contribution to growing economies and people. A revolutionary method of farming that aims to maximize crop productivity while reducing resource use and environmental effect is precision agriculture. In order to help farmers make educated decisions, this system approach combines Convolutional Neural Networks (CNN) for plant leaf disease prediction with crop recommendation systems. Given the growing need for environmentally friendly agricultural methods and the growing risk of crop diseases. Early detection of plant diseases can lower financial losses and increase the quality of food production through the use of automated or precise diagnostic techniques. These days, crop disease identification is a hot analytical topic. Therefore, it is essential to identify and categorize crop diseases in order to increase crop productivity and the economic process.

Acknowledgments

With immense pleasure, we present the project report as part of the curriculum of the B.E. Computer Engineering.

*It gives us great pleasure in presenting the preliminary project report on **'Crop Recommendation and leaf disease prediction using CNN'.***

*I would like to take this opportunity to thank my internal guide **Mrs. D. M. Gohil** for giving me all the help and guidance I needed. I am really grateful to them for their kind support. Their valuable suggestions were very helpful.*

*I am also grateful to **Dr. M. A. Potey**, Head of Computer Engineering Department, DYP-COE for his indispensable support, suggestions.*

*In the end our special thanks to **Mrs. F. S. Sayyad** for providing various resources such as laboratory with all needed software platforms, continuous Internet connection, for Our Project.*

<div align="right">

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</div>

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Crop Recommendation and leaf disease prediction using CNN

1.2   Project Option

BE Final Year Project

1.3 Internal Guide

Prof. Mrs. D. M. Gohil and Mrs. F. S. Sayyad

1.4   Sponsorship and External Guide

Not Sponsored

1.5 Technical Keywords (As per ACM Keywords)

1. Anaconda Navigator

2. Spyder

3. Tkinter Language.

4. Python

5. Encryption

6. CNN Algorithm

1.6 Problem Statement

To enhance agricultural practices, understanding soil types and their suitability for different crops is vital. Leveraging machine learning techniques, we propose a multi-step solution. Plant diseases, often caused by pests and pathogens, can lead to substantial yield losses. The proposed technology enables early detection of leaf diseases and continuous monitoring of cultivated areas, helping farmers mitigate losses and optimize crop selection, even at the onset of disease symptoms. Predicting crop yields is a significant agricultural issue. The main factors affecting agricultural yield are pesticides. Making judgements about agricultural risk management and forecasting the future requires accurate knowledge of crop yield history.

1.7 Abstract

The production of high-quality food depends on the agricultural sector, which also makes the largest contribution to growing economies and people. A revolutionary method of farming that aims to maximize crop productivity while reducing resource use and environmental effect is precision agriculture. In order to help farmers make educated decisions, this system approach combines Convolutional Neural Networks (CNN) for plant leaf disease prediction with crop recommendation systems. Given the growing need for environmentally friendly agricultural methods and the growing risk of crop diseases. Early detection of plant diseases can lower financial losses and increase the quality of food production through the use of automated or precise diagnostic techniques. These days, crop disease identification is a hot analytical topic. Therefore, it is essential to identify and categorize crop diseases in order to increase crop productivity and the economic process.

1.8 Goals and Objectives

The main goals and objective of the system are as follows:

1. The goal is to empower users in the field of agriculture. The aim is to provide a robust learning platform that equips users with knowledge about crop management and plant diseases, enabling them to make well-informed decisions.

2. To offer a reliable crop recommendation system that considers factors like soil conditions and climate, thereby helping users improve their crop yields.

3. Our objective is to implement a trustworthy disease detection system that accurately identifies plant diseases.

1.9   Relevant mathematics associated with the Project

Let S represent the entire system, where S = I, P, O.

Where:

- I represents the input, which consists of image data.

- P represents the procedures or operations applied to the input, using I to make predictions.

- O represents the output, which includes the system's predictions related to crop selection and plant leaf disease.

Input (I):

- I is composed of image data, which serves as input to the system.

Procedures (P):

- P consists of the operations performed using the input (I) to make predictions. These operations include the assessment of the image data to determine both crop predictions and plant leaf disease predictions.

Output (O):

- represents the system's predictions, which include crop recommendations and the detection of plant leaf diseases.

1.10   Names of Conferences / Journals where papers can be published

- IEEE/ACM Conference/Journal

- Conferences/workshops in IITs

- Central Universities or SPPU Conferences

1.11 Review of Conference/Journal Papers supporting Project Idea

- **Name:** A Systematic Literature Review on Plant Disease Detection: Motivations, Classification Techniques, Datasets, Challenges, and Future Trends

  Standard: Inf. Process. Syst.

  Author: Wasswa Shafik Ali Tufail, Abdallah Namoun, Liyanage Chandratilak De Silva , Rosyzie Anna Awg Haji Mohd Apong

  Year: 2023

- **Name:** Crop Prediction Based on Characteristics of the Agricultural Environment Using Various Feature Selection Techniques and Classifiers

  Author: S. P. Raja, Barbara Sawicka, Zoran Stamenkovic, And G. Mariammal

  Year: 2022

- **Name:** Fast Plant Leaf Recognition Using Improved Multiscale Triangle Representation and KNN for Optimization

  Author: Jianyu Su, Meihua Wang, Zhenxin Wu, And Qingliang Chen

  Year: 2020

1.12   Plan of Project Execution

Sr. No.	Task	Duration	Start Date	End Date
1.	Group Formation	6	21 July	26 July
2.	Decide Area of Interest	2	26 July	28 July
3.	Search Topic	5	28 July	2 Aug
4.	Topic Selection	5	2 Aug	7 Aug
6.	Search Related Information	12	7 Aug	19 Aug
7.	Understanding Concept	7	19 Aug	26 Aug
8.	Search Essential Document Software	6	26 Aug	1 Sep
9	Problem Definition	2	1 Sep	3 Sep
10	Literature Survey	5	3 Sep	8 Sep
11.	SRS	12	8 Sep	20 Sep
12.	Project Planning	20	20 Sep	10 Oct
13.	Modeling and design	20	10 Oct	30 Oct
14.	Technical Specification	15	31 Oct	15 Nov
15.	Report & PPT	5	15 Nov	20 Nov

Table 1.1: Project Planner

2. Technical Keywords

2.1   Area of Project

A project on "Crop Recommendation and Plant Leaf Disease Prediction" involves developing a technology-driven solution that helps farmers make informed decisions about crop selection and provides early detection of plant diseases. It encompasses various components, including data collection, machine learning models, technology integration, education, and monitoring. The project aims to improve crop yields, reduce disease-related losses, and promote sustainable farming practices while considering regulatory and ethical aspects. Its scope may vary depending on resources and objectives but generally involves a comprehensive approach to modernize agriculture.

2.2   Technical Keywords

1. Anaconda Navigator

2. Spyder

3. Tkinter Language.

4. Python

5. Encryption

6. CNN Algorithm

3. Introduction

In today's ever-evolving agricultural landscape, the integration of technology is revolutionizing the way we approach crop cultivation and disease management. "Crop Recommendation and Plant Leaf Disease Prediction" is a cutting-edge project at the intersection of agriculture and technology. It seeks to address the pressing challenges faced by farmers by providing them with data-driven solutions. This project is divided into two crucial components. The first component focuses on crop recommendation, utilizing historical data, soil analysis, and weather information to advise farmers on the best crop choices for their specific region. The second component involves plant leaf disease prediction, employing image recognition and predictive modeling to detect and forecast disease outbreaks in their early stages.

3.1   Project Idea

To develop the "Crop Recommendation and Plant Leaf Disease Prediction using CNN" project, the idea stems from the need to empower farmers with data-driven decision-making. The project is inspired by the potential of modern technology, such as CNNs, to aid in crop selection and disease identification. It draws upon the importance of agricultural knowledge and the benefits of user-friendly interfaces. The aim is to create a tool that combines education and practical solutions, ultimately improving agriculture, reducing crop losses, and enhancing food security.

3.2   Motivation of the Project

The motivation for the "Crop Recommendation and Leaf Disease Prediction using CNN" project is to harness the power of data-driven technologies to address critical challenges in agriculture. By employing Convolutional Neural Networks (CNNs), the project aims to enhance crop management and food security. It empowers farmers with personalized crop recommendations and early disease detection, enabling them to make informed decisions, optimize resource utilization, and protect their crops. In an era of changing environmental conditions, this project underscores the importance of data-driven solutions to boost agricultural productivity and ensure global food security.

3.3 Literature Survey

- **A Systematic Literature Review on Plant Disease Detection: Motivations, Classification Techniques, Datasets, Challenges, and Future Trends**
  Plant pests and diseases are a significant threat to almost all major types of plants and global food security. Therefore, many smart agricultural practices are deployed to control plant diseases and pests. In this study, we conduct a systematic literature review and present a detailed survey of the studies employing data collection techniques and publicly available datasets. To begin the review, 1349 papers were chosen from five major academic databases, namely Springer, IEEE Xplore, Scopus, Google Scholar, and ACM library. Several crops, including grapes, rice, apples, cucumbers, maize, tomatoes, wheat, and potatoes, have tested mainly on the hyperspectral imagery and vision-centered approaches. Support Vector Machines and Logistic regression classifiers demonstrated an increased accuracy in experiments compared to traditional classifiers

- **Crop Prediction Based on Characteristics of the Agricultural Environment Using Various Feature Selection Techniques and Classifiers**
  This systematic review in the past, farmers were able to decide on the crop to be cultivated, monitor its growth, and determine when it could be harvested. Today, rapid changes in environmental conditions have made it difficult for the farming community to continue to do so. Consequently, in recent years, machine learning techniques have taken over the task of prediction, and this work has used several of these to determine crop yield. To ensure that a given machine learning model works at a high level of precision, it is imperative to employ efficient feature selection methods to preprocess the raw data into an easily computable Machine Learning friendly dataset. Optimal feature selection arises to ensure that only the most relevant features are accepted as a part of the model.

- **Fast Plant Leaf Recognition Using Improved Multiscale Triangle Representation and KNN for Optimization**
  The paper concludes by due to the complexity and similarity of plant leaves; it is very important to study an effective leaf-feature extraction method to improve the recognition rate of plant leaves. In this method the curvature features of the contour, the texture features and the shape area feature are extracted to provide a multiscale leaf feature description, and a new adaptive KNN for optimization method is proposed to improve the retrieval rate of leaf datasets.

- **Chaotic Jaya Optimization Algorithm With Computer VisionBased Soil Type Classification for Smart Farming**

  Smart Farming utilizes advanced technologies namely data mining, machine learning, the Internet of Things, and data analytics for collecting the data, predicting the outcomes and training the system. One of the most significant parameters is proper soil prediction which decides the proper crop and is manually executed by the agriculturalists. Hence, the farmer's efficacy can be improved by producing automated tools for soil type classification. This study presents a Chaotic Jaya Optimization Algorithm with Computer Vision based Soil Type Classification (CJOCV-STC) for smart farming. The presented CJOCV-STC technique applies CV with metaheuristic algorithms for the automated soil classification process, which identifies the soil into distinct types.

- **Machine learning based Pedantic Analysis of Predictive Algorithms in Crop Yield Management**

  Machine learning means the process of making the system to learn from the previous experiences that help in prediction. In this paper, a conjectural evaluation on diverse prediction algorithms like support vector machines, recurrent neural networks, K nearest neighbour regression, Naïve Bayes, BayesNet, support vector regression etc., is done and its performance are described on the basis of error rates and accuracy level in crop yield. BayesNet shows the higher accuracy of about 97.53% and RNN has less percentage error rates that dominate other algorithms in harvest prediction

4. Problem Definition and scope

4.1   Problem Statement

Predicting crop yields is a significant issue in agriculture. The main factors affecting agricultural yield are pesticides and weather (rain, temperature, etc.). Making judgments about agricultural risk management and forecasting the future requires accurate knowledge of crop yield history. The ability to monitor large fields of crops and automatically identify disease symptoms as soon as they appear on plant leaves makes automatic detection of plant diseases an important research topic.

4.1.1   Goals and objectives

Goals**:**
1. Disease Management Enhancement: Enhance disease control in agriculture by providing accurate plant disease diagnosis and treatment recommendations.

2. Educational Empowerment: Empower users with knowledge about crop management and plant diseases through a comprehensive learning platform.

3. Data Security and Trust: Ensure the security and privacy of user data, establishing trust in the system.

4. Informed Decision-Making: Help users make informed decisions about crop selection based on soil and climate conditions.

Objectives:
1. Crop Recommendation System: Develop a reliable crop recommendation system considering various agricultural factors.

2. Disease Detection Implementation: Implement a trustworthy disease detection system that accurately identifies plant diseases.

3. User-Friendly Interfaces: Provide easy-to-use interfaces, including mobile apps, for convenient user interaction.

4. Continuous Improvement: Regularly update and enhance the system to ensure accuracy and reliability in providing recommendations and disease detection.

4.1.2   Statement of scope

This project aims to develop a user-centric system that provides crop recommendations based on soil and climate conditions and enables users to identify and manage plant diseases using Convolutional Neural Networks (CNNs). The scope encompasses the creation of a comprehensive learning platform, crop recommendation algorithms, disease detection models, user-friendly interfaces, data security measures, and continuous system improvements. It excludes agricultural equipment or physical infrastructure development. The project's primary focus is on empowering users in agriculture through education, informed decision-making, and enhanced disease management.

4.2   Major Constraints

- Data Availability: Accurate crop prediction relies on a wealth of data, including historical weather data, soil data, crop type and variety data, and farming practices. Gathering and maintaining this data can be challenging, especially in developing regions.

- Data Quality: The quality and accuracy of the data used for prediction are critical. Inaccurate data can lead to unreliable predictions.

- Weather Variability: Weather conditions significantly affect crop yields. Predicting weather accurately over long periods can be challenging.

- Pest and Disease Outbreaks: Pests and diseases can devastate crops, and their occurrence is difficult to predict accurately.

4.3   Methodologies of Problem solving and efficiency issues

In the "Crop Recommendation and Leaf Disease Prediction using CNN" project, problem-solving involves data-driven methodologies, leveraging CNNs for accurate predictions. Efficiency issues are addressed through optimized model training and data preprocessing. Efficient feature extraction and thorough data analysis enhance the precision of crop recommendations, while multi-stage disease prediction techniques improve early disease detection. These methodologies ensure informed agricultural decisions and resource management, fostering improved efficiency in crop management.

4.4   Outcome

1. **Improved Crop Management:** Farmers benefit from personalized crop recommendations, optimizing resource utilization and increasing crop yields.

2. **Early Disease Detection:** Early identification of plant leaf diseases empowers farmers to take timely preventive measures, reducing crop losses.

3. **Sustainable Agriculture:** Precautionary measures based on disease predictions contribute to sustainable agriculture practices, preserving crop health.

4. **Data-Driven Decision-Making:** The project showcases the effectiveness of data-driven decision-making in agriculture, offering insights for informed choices.

5. **Enhanced Food Security:** By increasing agricultural productivity and minimizing crop losses, the project contributes to global food security in an ever-changing agricultural landscape

4.5   Applications

1. Early and accurate detection and diagnosis of plant diseases are key factors in plant production and the reduction of both qualitative and quantitative losses in crop yield.

2. Crop yield prediction is an essential predictive analytics technique in the agriculture industry.

3. It is an agricultural practice that can help farmers and farming businesses predict crop yield in a particular season when to plant a crop, and when to harvest for better crop yield.

4.6   Hardware Resources Required

1. System - (Intel i7, 16GB RAM, 1 TB HDD, Internet)

2. Node - (4GB RAM, 128GB HDD, Monthly bandwidth 1.5 times the data being rented)

3. User - (Any device with internet capability)

4.7   Software Resources Required

1. Python 3.x

2. Tkinter

3. Java

4. Spyder

5. DB Browser - SQLite

5. Project Plan

5.1   Project Estimates

The iterative model was used as the development model for the system implementation. The iterative model is a type of software development life cycle (SDLC) that focuses on a simple, initial implementation that gradually increases in complexity and features until the final system is complete.

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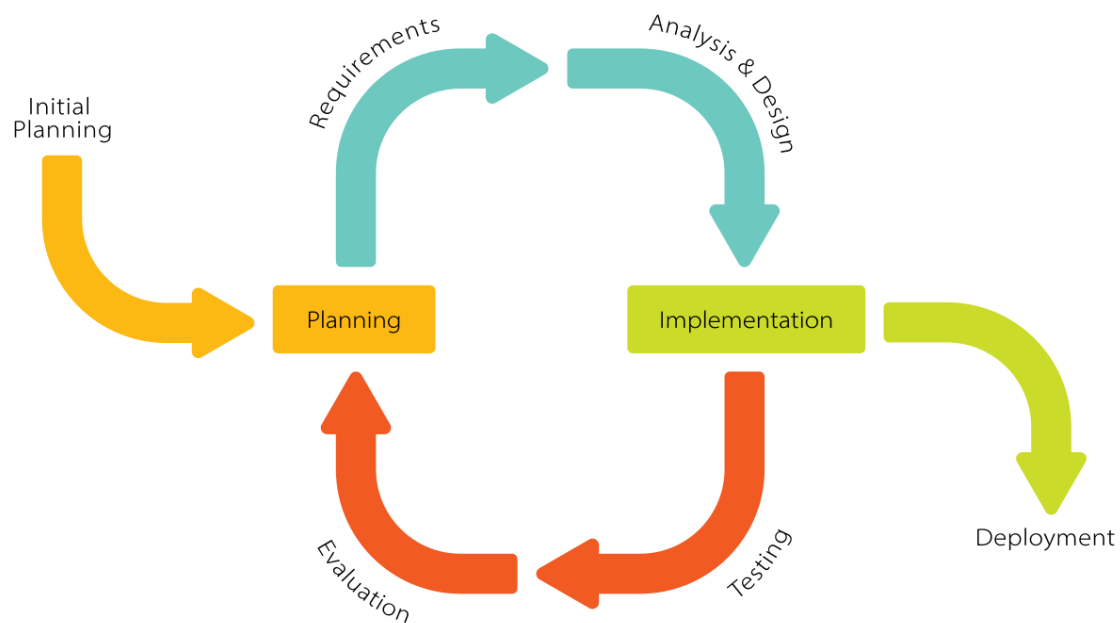
Figure 5.1: Iterative Development Model

- **A Design phase :** in which a software solution to meet the requirements is designed. This may be a new design, or an extension of an earlier design.

- **An Implementation and Test phase :** when the software is coded, integrated and tested.

- **A Review phase :** in which the software is evaluated, the current requirements are reviewed, and changes and additions to requirements proposed.

5.1.1   Reconciled Estimates

5.1.1.1   Cost Estimates

The initial cost estimate of the project before beginning the implementation process is INR 11000 for in-house resources . This cost may vary. This estimate is subject to change according to the change according to the particular item.

5.1.1.2 Time Estimates

The initial time estimate for the complete implementation of the primary objectives is 55-60 days depending on the schedule of the developers. The secondary objectives require an additional efforts. Also, depending on the stage of development, the testing and debugging would require an additional of 15 days.

5.1.2 Project Resources

5.1.2.1 People:

1. Project Members (Sakshi Dherange, Shital Mehetre, Vrushali Datir, Vrushali Patil)
2. Guide (Mrs. Deepali. M. Gohil)
3. Co-Guide (Mrs. Farina Sayyed)

5.1.2.2 Hardware

1. CPU Speed (2GHz)
2. RAM 8GB

5.1.2.3 Software

1. Operating System: Ubuntu 16.04 and above/Windows 8 and above.
2. IDE :Pycharm, Spder.
3. Frontend: Tikenter 4. Backend: Python

5.2 Risk Management w.r.t. NP Hard analysis

This section discusses Project risks and the approach to managing them.

5.2.1 Risk Identification

For risks identification, review of scope document, requirements specifications and sched-ule is done. Answers to questionnaire revealed some risks.

1. **Have top software and customer managers formally committed to support the project?**

   Crop Recommendation and leaf disease prediction using CNN which can only benefit the stakeholders. In today's times, top software and customer managers have not formally committed to support the project but in near future they will.

2. **Are end-users enthusiastically committed to the project and the system/product tobe built?**

Yes, Users will get complete benefit from the system and hence they are interested in it.

3. Are requirements fully understood by the team and its customers?

Yes, SRS has underlined all the requirements very clearly.

4. Have customers been involved fully in the definition of requirements?

Yes, the customers will get complete benefit from the system and hence they are interestedin it.

5. Do end-users have realistic expectations?

Yes.

6. Does the software engineering team have the right mix of skills?

Yes. The team was divided into Three groups - Android, Web and Backend teams according to the skills.

7. Are project requirements stable ?

Yes**.**

8. Is the number of people on the project team adequate to do the job?

Yes.

9. Do all customer/user constituencies agree on the importance of the project and on the requirements for the system/product to be built?

Yes. The project mainly focuses on data storage and cost efficient storage solutions whichis the core important part of the current digital world.

5.2.2 Risk Analysis

- Attacker goals

  We need to consider what an attacker's goals might be. The standard goals of any attacker in any security-relevant context are typically attacks against integrity, confidentiality, and availability.

- Privacy

  The privacy of the users matter the most. And this is supposed to be anonymous.

5.2.3 Overview of Risk Mitigation, Monitoring, Management

- To reduce the risks following actions can be taken:

  - Continuous data monitoring for real-time updates.
  - User training and technical support for the CNN model.
  - Predictive analytics to preemptively address potential issues.
  - Scalability options for handling increased data and user load

5.3   Project Schedule

5.3.1   Project task set

- UI modules

- Database designing

- Model building

- Integration after new model built

- Deployment

5.3.2   Task network
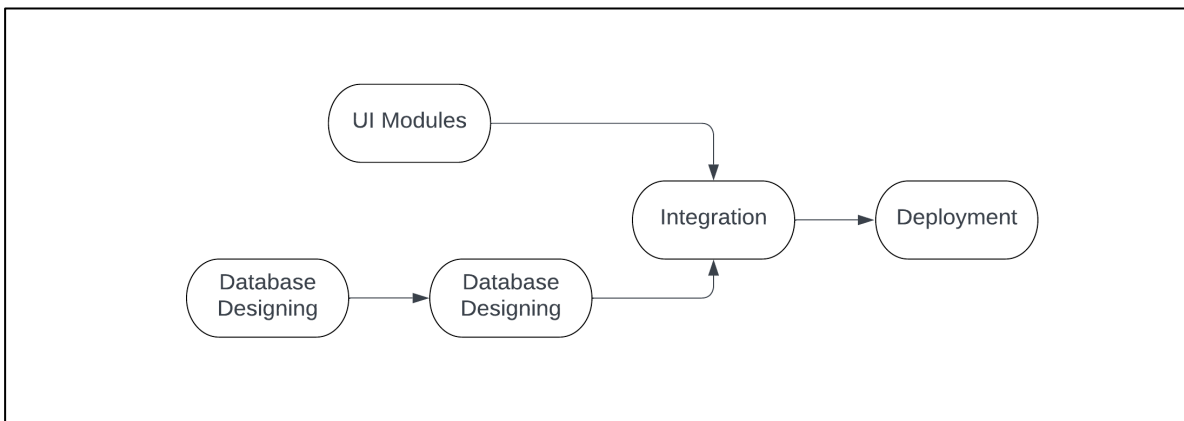
Figure 5.2: Fig. Task Network

5.3.3   Timeline Chart
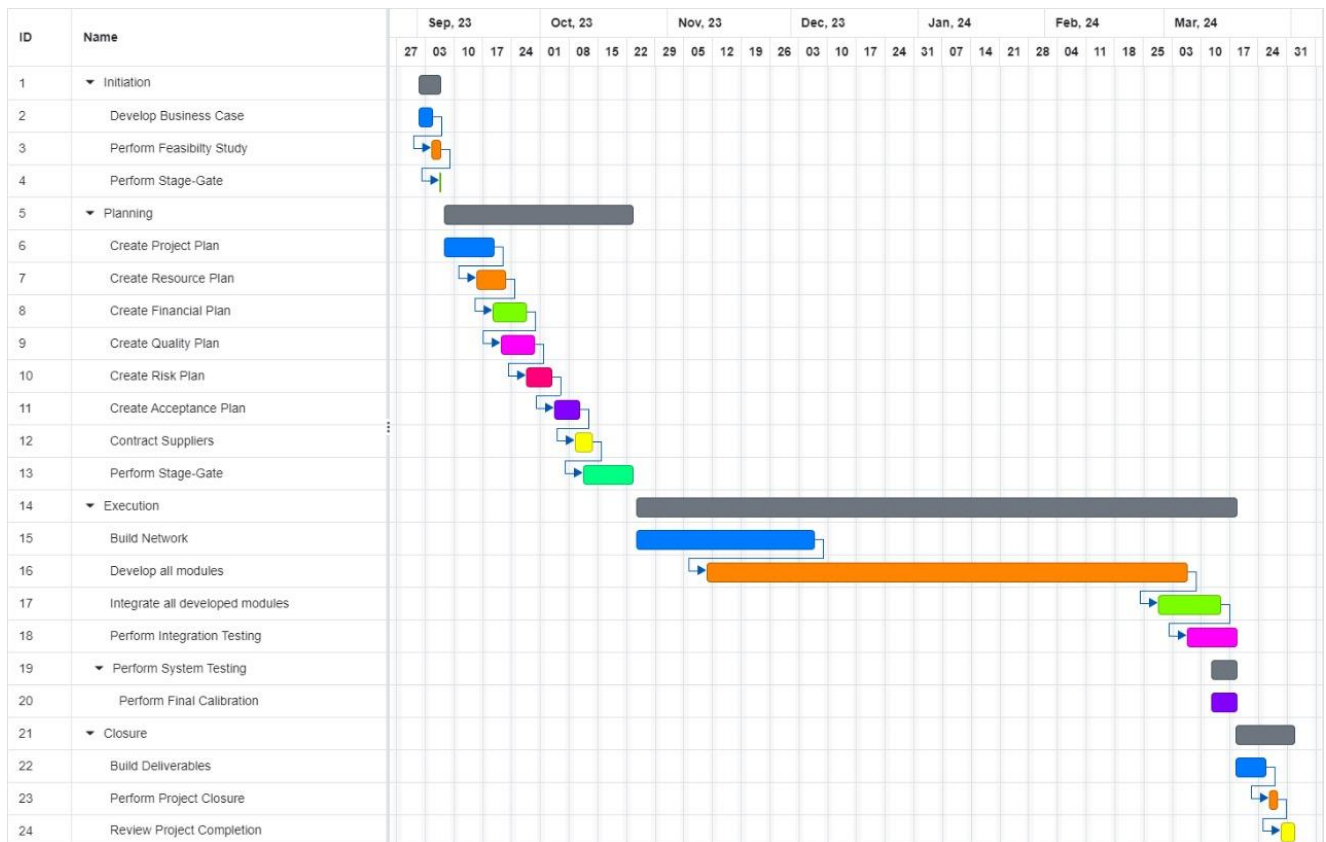
Figure 5.3: Fig. Time Line GANTT chart

5.4   Team Organization

Our strategy is to divide the tasks amongst four of us. We decided a deadline for each task. In the end we combine the results of individuals into one single outcome.This is an approach of a Stage-Gate SDLC

5.4.1   Team structure

Sr. No.	Name	Role
1	Sakshi Dherange, Shital Mehetre	UI/UX Design, Data Collection
2	Vrushali Datir, Vrushali Patil	Documentation, Backend
3	Shital Mehetre, Vrushali Patil	Model building and training, Data Preprocessing

Table 5.1: Team Structure for the Project

5.4.2 Management reporting and communication

Dedicated Team of four developers working together and taking ownership of different actions to be performed with project progress is the attitude followed by following ways:

- Daily Scrums

- Inter team communications via virtual platforms

- Github Collaboration

- Guidance from Mentors on monthly basis

6. Software requirement specification

6.1   Introduction

"Crop Recommendation and Plant Leaf Disease Prediction" is a cutting-edge project at the intersection of agriculture and technology. It seeks to address the pressing challenges faced by farmers by providing them with data-driven solutions. This project is divided into two crucial components. The first component focuses on crop recommendation, utilizing historical data, soil analysis, and weather information to advise farmers on the best crop choices for their specific region. The second component involves plant leaf disease prediction, employing image recognition and predictive modeling to detect and forecast disease outbreaks in their early stages.

6.1.1   Purpose and Scope of Document

The primary purpose of this document is to provide a comprehensive overview of the "Crop Recommendation and Leaf Disease Prediction using CNN" project. It aims to elucidate the project's objectives, methodologies, and outcomes in a structured manner. Within the scope of this document, readers will gain insights into the rationale behind developing a system for crop recommendation and leaf disease prediction using Convolutional Neural Networks (CNNs) in agriculture. Furthermore, this document outlines the project's key components, including dataset collection, data preprocessing, model architectures, training processes, and evaluation metrics. Additionally, it discusses the anticipated challenges, future work, and potential implications of the project. Readers can expect a detailed understanding of how CNNs can be applied to agricultural tasks, ultimately contributing to more informed and data-driven decisions in the agricultural sector.

6.1.2 Overview of responsibilities of Developer

- System Design: Collaborate in designing the architecture and functionality of crop recommendation and plant leaf disease prediction using CNN, ensuring it aligns with the defined requirements.

- Coding: Write clean, efficient, and maintainable code in languages like Python, and others, implementing the features and functions.

- Testing: Thoroughly test the app for functionality, performance, and security, identifying and addressing issues and bugs.

- Security: Implement security measures, including data encryption and access controls, to protect user data and privacy.

- Machine Learning: Develop and integrate AI and ML models for price prediction, portfolio optimization, and real-time market analysis.

- User Experience (UX): Focus on delivering a user-friendly interface and responsive design across different web platforms.

- Scalability: Ensure the application can scale with increased user demand, optimizing performance and resource management.

- Collaboration: Collaborate with other team members, including designers and project managers, to achieve project goals and meet user expectations.

6.2   Usage Scenario

- **Scenario 1: A successful login with valid credentials:**

  1. User needs to enter his login credentials.

  2. User enters his username.

  3. User enters his password.

  4. User logins successfully into the system.

- **Scenario 2: An unsuccessful login with wrong credentials:**

  1. User needs to enter his login credentials.

  2. User enters his username.

  3. User enters his password.

  4. But User couldn't login successfully into the system.

  5. User presses forget password link.

  6. User gets password reset link on his registered email id.

  7. User resets his password and successfully logins into the system.

- **Scenario 3: Crop Suitability Assessment:**

  1. Capturing Leaf Images: When Sarah notices unusual spots or discolorations on her plant leaves, she takes clear photos of the affected leaves using her smartphone.

  2. Uploading Leaf Images: She uploads the leaf images to the app, specifying the type of plant the affected leaf belongs to (e.g., rose, tomato, or marigold).

  3. Disease Diagnosis: The app processes the images and provides a diagnosis of the likely disease affecting the plant. It might suggest possibilities like powdery mildew, aphid damage, or fungal infections.

  4. Treatment Recommendations: Based on the diagnosis, the app offers treatment recommendations. These suggestions may include organic remedies, chemical treatments, or pruning advice.

  5. Determine the suitability of various crops for planting based on the analyzed data. This assessment considers factors like soil type, temperature, precipitation, and the length of the growing season.

6.2.1   User profiles

Actor 1: Farmers

- **Role:** Primary users of the system.
- **Requirements:**
  - Access to a user-friendly interface for receiving crop recommendations and disease predictions based on local conditions.
  - Input capabilities to provide information about their farming practices, location, and environmental conditions.
  - Understandable recommendations and alerts for crop selection and disease management.
  - Access to historical data and reports for decision-making and planning.

Actor 2: Agricultural Experts and Consultants

- **Role:** Advisers and consultants in the agricultural sector.
- **Requirements:**
  - Access to an advanced version of the system to assist multiple farmers.
  - The ability to analyze aggregated data and provide expert recommendations.
  - Tools for monitoring and offering guidance on crop health and disease management.
  - Data visualization and reporting for making informed decisions.

Actor 3: System Administrators:

- **Role**: System administrators are responsible for maintaining the project's infrastructure and ensuring its proper functioning.
- **Requirements**:
  - Proficiency in managing servers, databases, and the application's backend.
  - Monitoring the system for errors, performance issues, and security concerns.
  - Keeping the application up-to-date and secure.

6.2.2   Use-cases

Sr. No	Use case	Description	Actors
1	**User Registration**	Allows users to create accounts for the system.	Farmers, Agricultural Experts
2	**User Login**	Enables registered users to log in to the system.	Farmers, Agricultural Experts
3	**Farm Profile Creation**	Users can input farm details such as location, soil type, and climate conditions.	Farmers, Agricultural Experts
4	**Crop Recommendation**	Based on farm profile, the system recommends suitable crops for planting.	Farmers, Agricultural Experts
5	**Image Upload**	Users can upload images of crop leaves for disease prediction.	Farmers, Agricultural Experts
6	**Disease Prediction**	The system analyzes uploaded images and predicts if the crop has any diseases.	Farmers, Agricultural Experts
7	**View Recommendations**	Users can access and review crop recommendations provided by the system.	Farmers, Agricultural Experts
8	**User Registration**	Allows users to create accounts for the system.	Farmers, Agricultural Experts
9	**User Login**	Enables registered users to log in to the system.	Farmers, Agricultural Experts
10	**Farm Profile Creation**	Users can input farm details such as location, soil type, and climate conditions.	Farmers, Agricultural Experts
11	**Crop Recommendation**	Based on farm profile, the system recommends suitable crops for planting.	Farmers, Agricultural Experts
12	**Image Upload**	Users can upload images of crop leaves for disease prediction.	Farmers, Agricultural Experts
13	**View Disease Predictions**	Users can check disease predictions for their crops and receive treatment suggestions.	Farmers, Agricultural Experts
14	**System Maintenance**	System administrators ensure the smooth functioning of the application and server.	System Administrators

6.2.3   Use Case View

Use Case Diagram. Example is given below
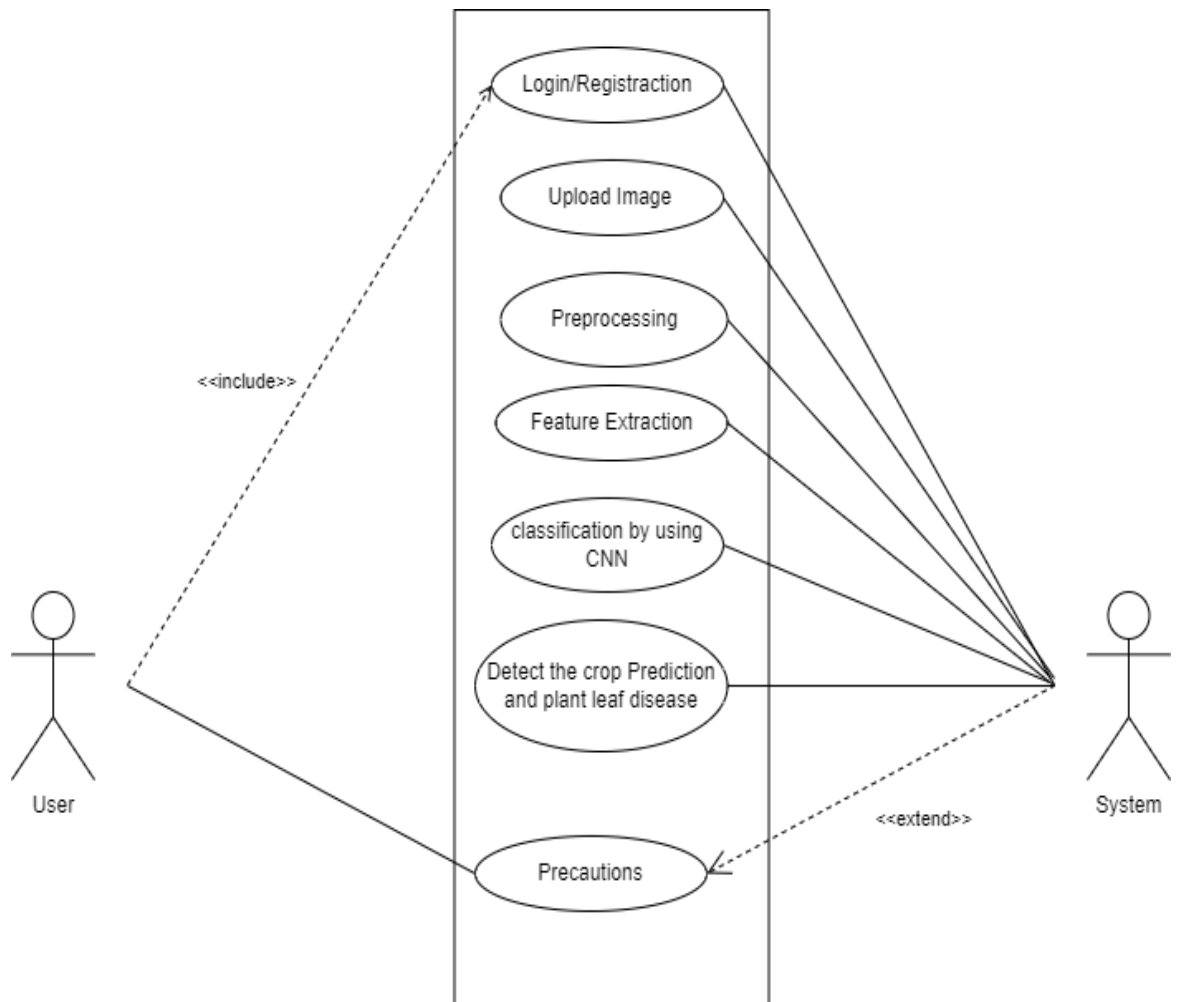
Figure 6.1: Use Case Diagram

6.3   Functional Model and Description

A description of each major software function, along with data flow (structured analysis) or class hierarchy (Analysis Class diagram with class description for object oriented system) is presented.

6.3.1   Data Flow Diagram

6.3.1.1   Level 0 Data Flow Diagram

Figure 6.2: DFD Level 0

6.3.1.2   Level 1 Data Flow Diagram
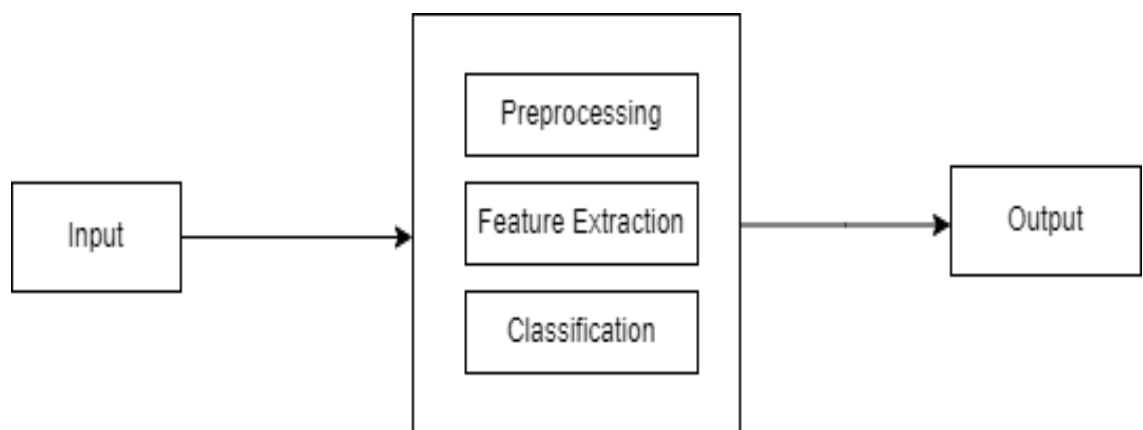
Figure 6.3: DFD Level 1

6.3.1.3   Level 2 Data Flow Diagram
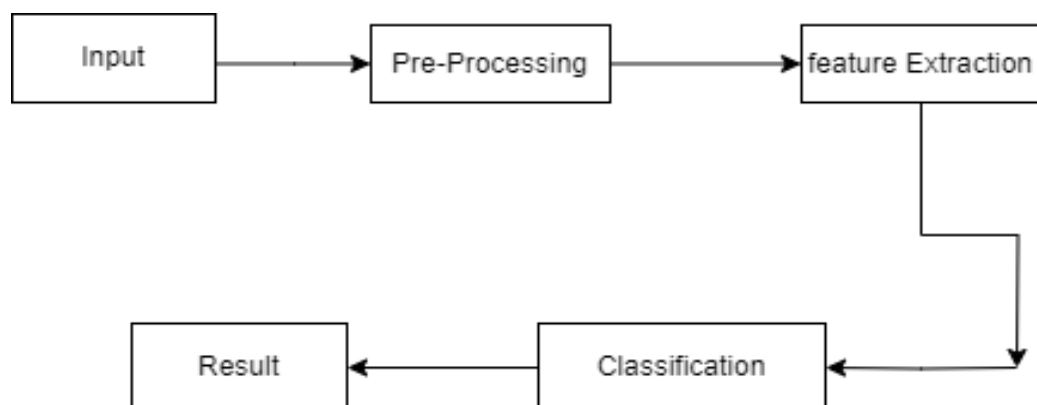
Figure 6.4 : DFD Level 2

6.3.2   Sequence Diagram:
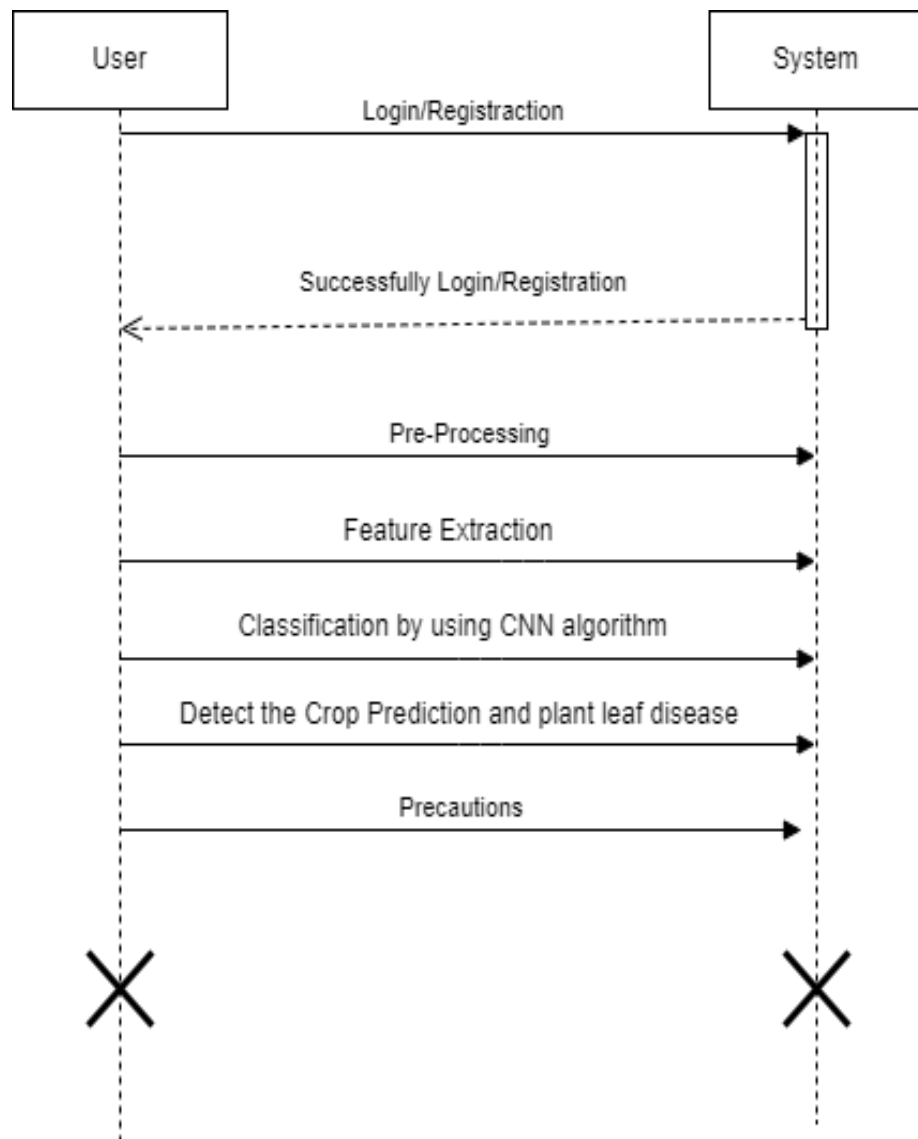
Figure 6.5: Upload Sequence Diagram

6.3.3 Non- Functional Requirements:

- **Usability:** The software must have a simple and User-friendly Interface. The navigation to various pages should make it more convenient for users to save time and confusion.

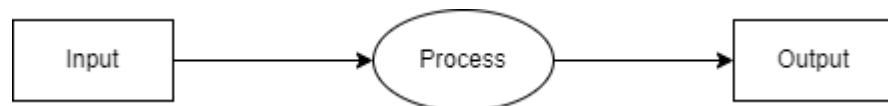- **Security:** Nobody should be allowed to tamper with data; Enhanced Security for sensitive data. It should be made sure that only users who are given specific rights can access data and all actions are logged, thus providing an extensive role-based authorization.

- **Deployment:** All users should connect to the application over the Internet using a web browser or app.

- **Backup:** There should be an enough back-up maintain feature for the entire data, to prevent losing any data.

- **Platform/Browser Independence:** The system should be able to work on any of the modern browsers like Firefox/ Chrome, and any of the common OS like Linux, Windows.

6.3.4   State Diagram:

Fig.6.6 Below example shows the state transition diagram of crop recommendation and leaf disease prediction using CNN. The states are represented in ovals and state of system gets changed when certain events occur. The transitions from one state to the other are represented by arrows. The Figure shows important states and events that occur while creating new project.
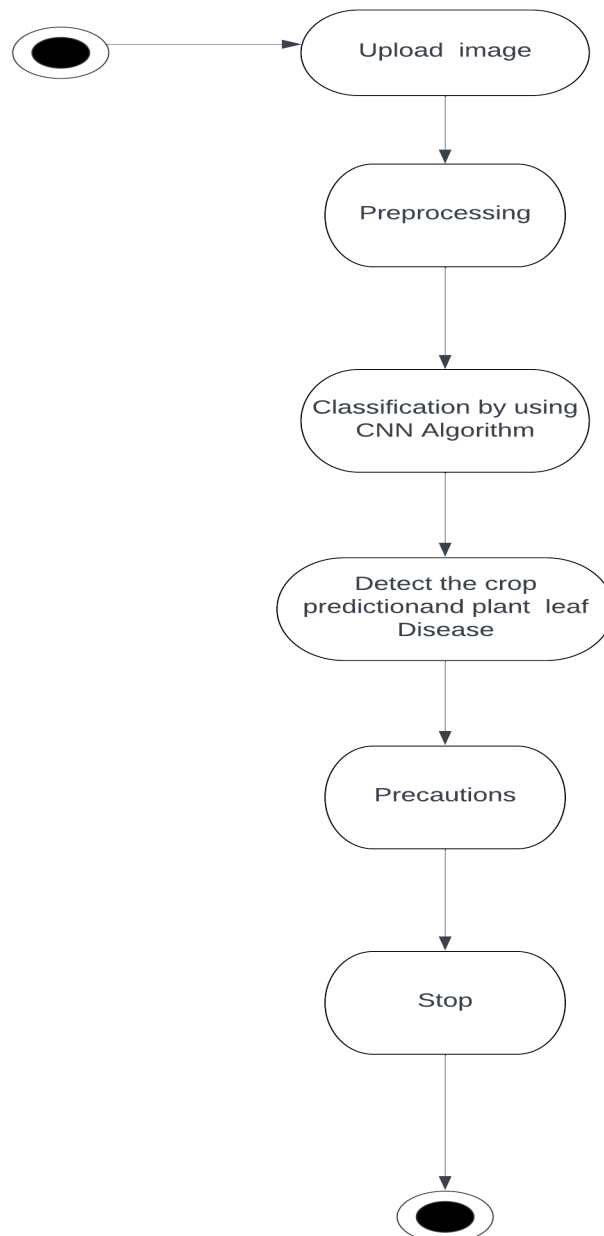
Figure 6.6: State Transition Diagram

6.3.5   Software Interface Description

1. User Registration: Allows account creation.

2. User Login: Enables user access.

3. Farm Profile Creation: Input farm details.

4. Crop Recommendation: Recommends suitable crops.

5. Image Upload: Allows uploading of crop images.

6. Disease Prediction: Analyze and predicts crop diseases.

7. View Recommendations: Access crop recommendations.

8. View Disease Predictions: Check disease predictions and treatment suggestions.

9. Data Collection: Collect and upload crop images with annotations.

10. System Maintenance: Ensures system functionality.

11. Research and Model Development: Experiment with CNN architectures.

12. Data Sharing: Allows access to aggregated data and insights.

7. Design Document

7.1   Introduction

"Crop Recommendation and Plant Leaf Disease Prediction" is a cutting-edge project at the intersection of agriculture and technology. It seeks to address the pressing challenges faced by farmers by providing them with data-driven solutions. This project is divided into two crucial components. The first component focuses on crop recommendation, utilizing historical data, soil analysis, and weather information to advise farmers on the best crop choices for their specific region. The second component involves plant leaf disease prediction, employing image recognition and predictive modeling to detect and forecast disease outbreaks in their early stages.

7.2   Data design

7.2.1   Internal software data structure

The internal software data structure for the "Crop Recommendation and Leaf Disease Prediction using CNN" project is designed to efficiently handle and organize data. It includes a database schema to store farm profiles, crop recommendations, and disease prediction results. Additionally, image repositories are set up to manage the collection of crop images and their annotations. These structures facilitate the seamless retrieval and storage of information critical to the project's decision-making processes and user interactions.

7.2.2   Database description

In the "Crop Recommendation and Leaf Disease Prediction using CNN" project, we employ the SQLite database system (SQLite3) as the underlying database for data management. SQLite is a lightweight, embedded database that is particularly suitable for applications where a full-fledged database server may be unnecessary. It stores data in a local file, making it highly efficient for our project's purposes. The database is structured to store essential information, such as user account data, farm profiles, crop recommendations, and disease predictions. It offers excellent support for data retrieval and management, and its simplicity ensures smooth integration into our application, whether for user registration, data storage, or information retrieval needs. By using SQLite3, we can maintain data consistency and reliability, crucial for the success of the project's decision-making and user-interaction functionalities.

7.3   Architectural Design

This diagram depicts the process of uploading an image to a train database with images. The user, who is using a computer, uploads the image. The image is then preprocessed by converting it to grayscale. Next, the image is uploaded to the train database with images. After that, the image is processed by extracting features from it. This includes detecting parameters from the fetal image uploaded for testing. The CNN algorithm then works by matching the extracted features with the features of trained images in the dataset. The final step is to crop the prediction and plant disease, and display the output to the user.
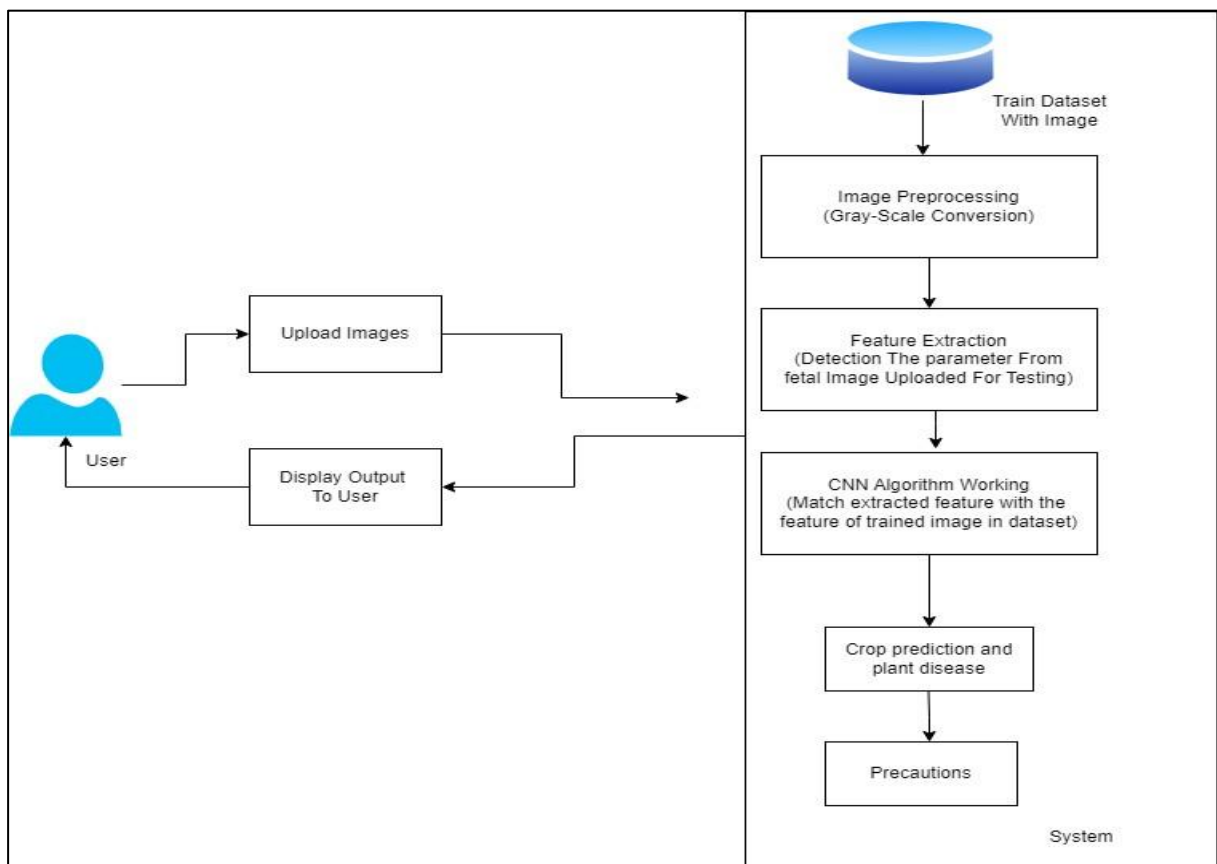
Figure 7.1: System Architecture

7.4 Component Design

7.4.1 Component Diagram
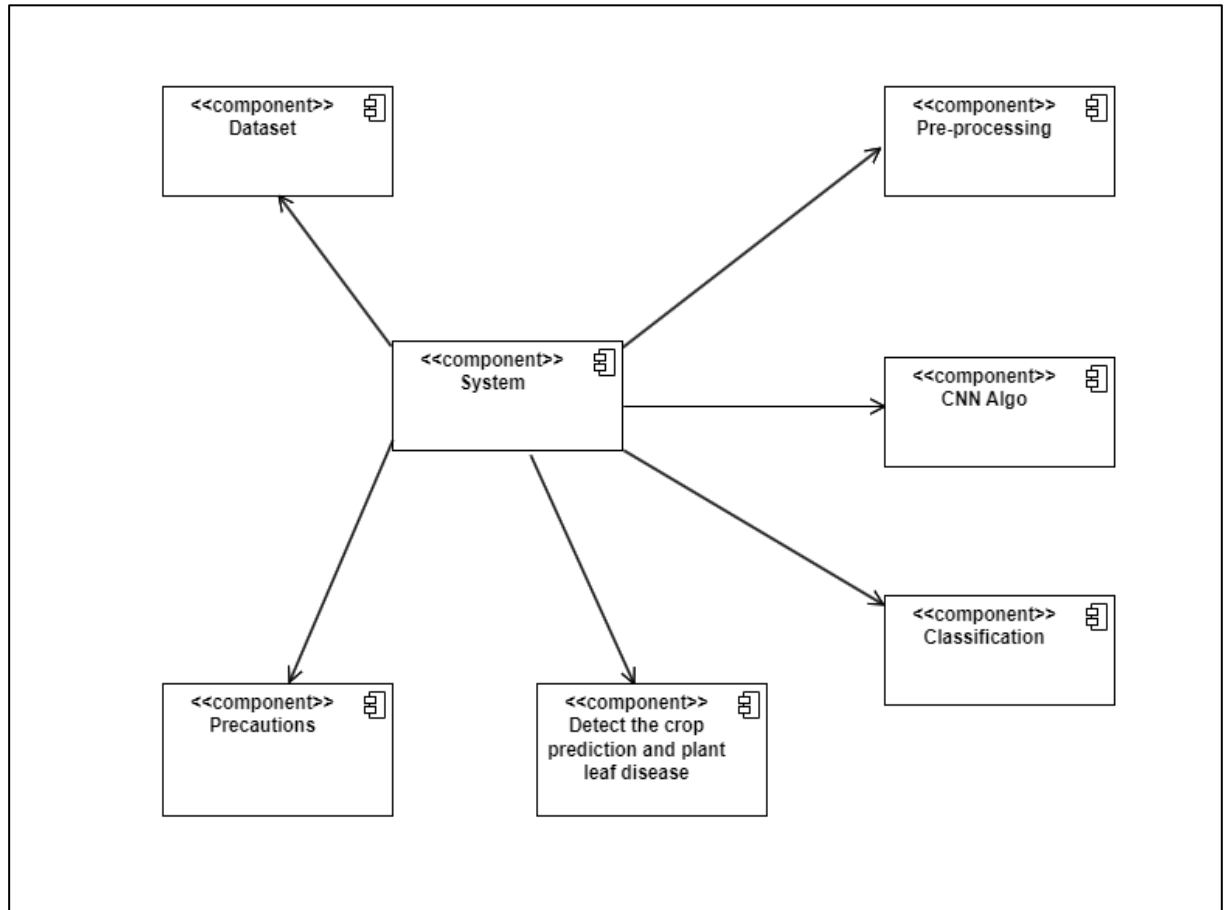
Figure 7.2: Component Diagram

8. Project Implementation

8.1   Introduction

"Crop Recommendation and Plant Leaf Disease Prediction" is a cutting-edge project at the intersection of agriculture and technology. It seeks to address the pressing challenges faced by farmers by providing them with data-driven solutions. This project is divided into two crucial components. The first component focuses on crop recommendation, utilizing historical data, soil analysis, and weather information to advise farmers on the best crop choices for their specific region. The second component involves plant leaf disease prediction, employing image recognition and predictive modeling to detect and forecast disease outbreaks in their early stages.

8.2   Tools and Technologies Used

1. Python

2. DBSQLITE3

3. Spyder

4. Anaconda

5. Python libraries

6. VS studio Code

8.3   System Modules

8.3.1   Admin

In this module, the admin has to log in by using valid user name and password. After login successful he can do some operations such as View All Users and Authorize, View All E-Commerce Website and Authorize, View All Products and Reviews, View All Products Early Reviews, View All Keyword Search Details, View All Products Search Ratio, View All Keyword Search Results, View All Product Review Rank Results.

8.3.2 View and Authorize Users

In this module, the admin can view the list of users who all registered. In this, the admin can view the user's details such as, user name, email, address and admin authorize the users.

8.3.3 Ecommerce User

In this module, there are n numbers of users are present. User should register before doing any operations. Once user registers, their details will be stored to the database. After registration successful, he has to login by using authorized user name and password Once Login is successful user will do some operations like Add Products, View All Products with reviews, View All Early Product's reviews, View All Purchased Transactions.

9. Software Testing

In order to check whether the product required and the product built is meeting the expected requirement, software testing has to be done. Software testing is an activity to checkwhether the actual result matches with the expected result and to make sure that the soft- ware is defect free. It helps to identify errors, gaps or missing requirements in contrary to the actual requirement. Software testing can be done either manually or by using automatedtools.

9.1   Type of Testing Used

- Functional Testing

- Non-Functional Testing or Performance Testing

- Maintenance (Regression and Maintenance)

  - **Integration Testing:** This testing is conducted to confirm the proper functioning of the fully integrated components of a food sales prediction application.It describes the scope and basis for integration testing, testing of internal and external system interface, testing of security capabilities, testing of accessibility features. System-level qualification tests address the integrated operation ofhardware, software to assess the system's response.

  - **Unit Testing:** Unit testing is used to test individual component of the application. Alpha testing: Alpha testing is conducted to identify all possible issues ordefects before releasing final working.

  - **Alpha testing:** Alpha testing is conducted to identify all possible issues or defects before releasing final working system.

  - **Back-end Testing:** Whenever an input or data is entered on front-end application, it stores in the databases and the testing of such database is called as back-end testing.

  - **Black-box testing:** This testing analyses the functionality of the system without knowing much about the internal structure or design of the item that is being tested and compares the input value with the output value.

  - **Component testing:** The testing of multiple functionalities as a single code and its objective is to identify if any defect exits after connecting those multiple functionalities with each other.

  - **End-to-End Testing:** Testing of complete application environment in a situation that mimics real world use is performed.

Functional Testing: Functional testing is performed by focusing only on the output to check if it is as per the requirement or not.

– **Graphical User Interface (GUI) Testing:** It includes the testing of size of the buttons and input field present on the screen, alignment of all text, tables and content in the table.

– **Performance Testing:** To check whether the system meets the performance requirements.

9.2 Test Cases

Test Case ID	Input	Expected Output	Actual Output	Result
TC-001	User profile creation data (location, soil type, climate)	Valid farm profile created successfully	Valid profile created successfully	Pass
TC-002	Crop image upload with disease	Accurate disease prediction and treatment recommendation	Accurate prediction and recommendation	Pass
TC-003	Crop image upload without disease	Accurate disease prediction (no disease detected)	Accurate prediction (no disease detected)	Pass
TC-004	User login with valid credentials	User successfully logged in	User successfully logged in	Pass
TC-005	User login with invalid credentials	Authentication error message displayed	Authentication error message displayed	Pass
TC-006	Access crop recommendations	Recommendations displayed based on farm profile	Recommendations displayed based on farm profile	Pass
TC-007	Access disease predictions	Disease predictions displayed for uploaded images	Disease predictions displayed for uploaded images	Pass
TC-008	Data collector uploads annotated crop images	Images and annotations successfully added to the dataset	Images and annotations successfully added to the dataset	Pass
TC-009	System maintenance and monitoring	No critical errors or issues reported	No critical errors or issues reported	Pass
TC-010	Researcher experiments with CNN models	Models produce accurate predictions and maintain performance	Models produce accurate predictions and maintain performance	Pass
TC-011	Data sharing with government agencies and NGOs	Access to aggregated data and insights provided	Access to aggregated data and insights provided	Pass

Table 9.1: Testcases

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10. Deployment and Maintenance

10.1 Operational Requirements to run the System

1. Python 3.11

2. Anaconda Navigator

3. Spyder 5.0

4. Microsoft Visual Studio Code

11. Conclusion and future scope

The "Crop Recommendation and Leaf Disease Prediction using CNN" project embodies the promise of data-driven innovation in agriculture. Through the strategic use of Convolutional Neural Networks (CNNs), the project empowers farmers with personalized crop recommendations and early disease detection, contributing to improved resource management and crop health. This initiative not only addresses immediate agricultural challenges but also paves the way for sustainable and efficient practices. In a world facing evolving environmental conditions and a growing need for food security, this project serves as a beacon of hope, highlighting the pivotal role of technology in transforming agriculture. It underscores the potential for data-driven decision-making to enhance crop yields, protect food supplies, and support the livelihoods of farmers, ultimately ensuring a more secure and sustainable future.

Future Scope:

1. Enhanced Disease Detection Models: Develop more advanced disease detection models, potentially using state-of-the-art deep learning architectures to improve accuracy.

2. Multi-lingual Support: Implement multi-lingual support for a broader range of users, especially in regions with diverse languages.

3. Mobile Application: Create a mobile application for on-the-go access to crop recommendations and disease predictions, making it more convenient for farmers.

4. IoT Integration: Integrate Internet of Things (IoT) devices for real-time data collection, such as soil moisture and weather conditions, to provide more precise recommendations.

5. Geographic Expansion: Expand the project's coverage to more regions and crops, catering to a wider agricultural audience.

Appendix B (Idea Matrix)

Modules	Technology to be used	How it will be used	Time Allotted	Responsible Person
Login/ Registration	Python	Primary programming language for developing the project's algorithms and backend.	1-2 weeks	Sakshi, Shital, Vrushali D., Vrushali P.
	Anaconda	Used for Python environment management, simplifying library and package installations.	2 weeks	
	DBSQLITE3	The chosen database system for efficient data storage and retrieval in the project.	2 weeks	
	Spyder	Integrated development environment (IDE) for Python, facilitating code development and debugging.	2-3 weeks	

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[5] Monali Paul, Santosh K. Vishwakarma, Ashok Verma, "Analysis Of Soil Behavior And Prediction Of Crop

[6] Yield Using Data Mining Approach", 2015

[7] International Conference On Computational Intelligence And Communication Networks.

[8] N. Heemageetha, "A Survey On Application Of Data Mining Techniques To Analyze The Soil For Agricultural Purpose", 2016ieee.
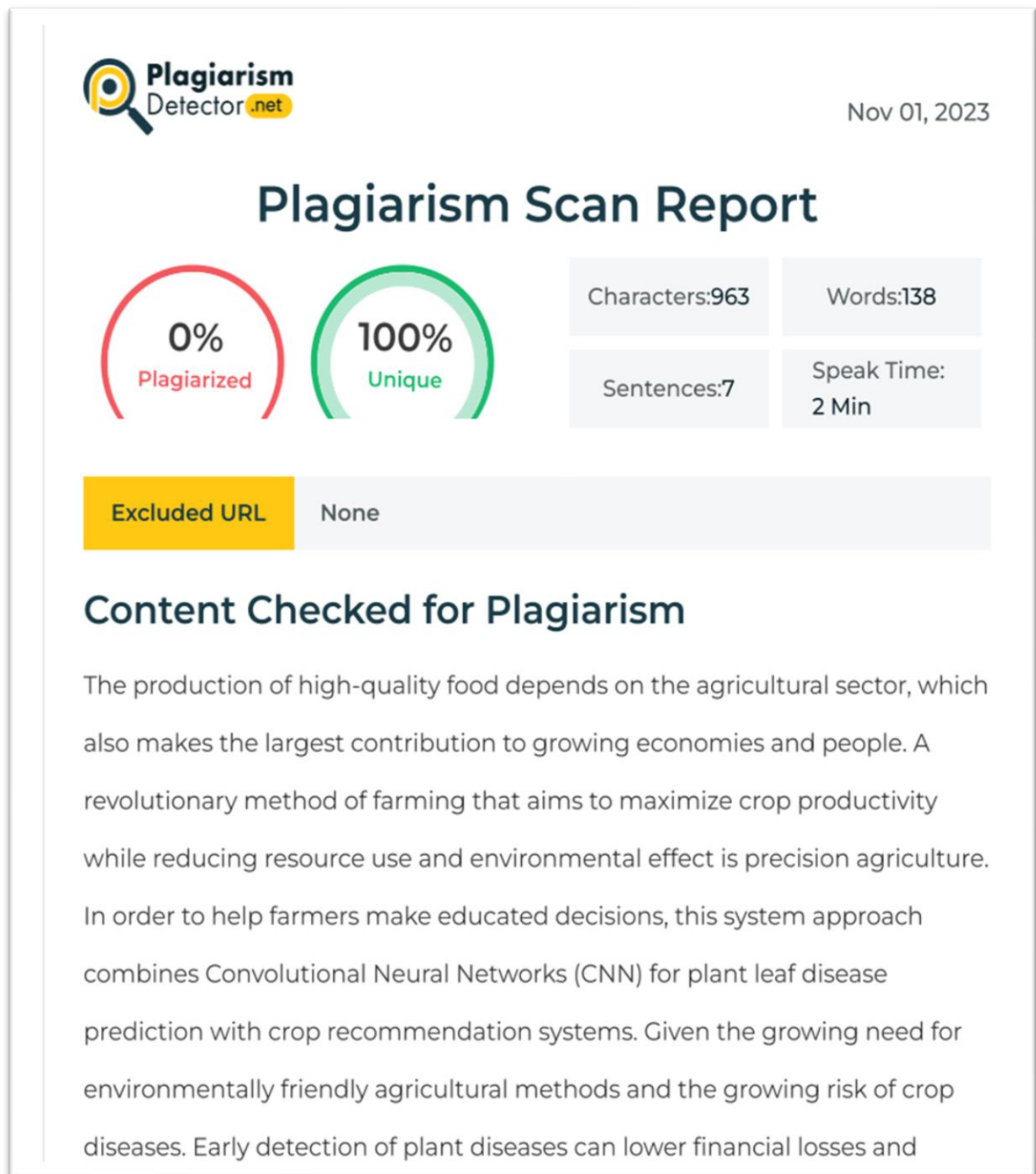
Plagiarism Report

Figure 1: Plagiarism Report of Abstract

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In today's ever-evolving agricultural landscape, the integration of technology is revolutionizing the way we approach crop cultivation and disease management. "Crop Recommendation and Plant Leaf Disease Prediction" is a cutting-edge project at the intersection of agriculture and technology. It seeks to address the pressing challenges faced by farmers by providing them with data-driven solutions. This project is divided into two crucial components. The first component focuses on crop recommendation, utilizing historical data, soil analysis, and weather information to advise farmers on the best crop choices for their specific region. The second component involves plant leaf disease prediction, employing image recognition and predictive

Figure 2: Plagiarism Report of Introduction

Figure 3: Plagiarism Report of Problem Statement

Figure 4: Plagiarism Report of Application

Sr. No	Chapter	Unique Content
1	Abstract	100%
2	Introduction	100%
3	Problem Statement	100%
4	Applications	100%

Table 1: Plagiarism Report

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