Major Project-I Report

On

AgroAI Assist: AI Powered Soil and Plant Health Detection with Real-Time Weather Alerts Using Image Feature Extraction Technique

Submitted in partial fulfillment of the requirement of
University of Mumbai for the Degree of

Bachelor of Technology
In
Information Technology

Submitted By

Adhish Biju
Ashwin Baburaj
Yash Karande
Yuvraj Kolekar

Supervisor
Dr. Jinesh Melvin Y I

Department of Information Technology

PILLAI COLLEGE OF ENGINEERING

New Panvel – 410 206

UNIVERSITY OF MUMBAI

Academic Year 2024– 25

DEPARTMENT OF INFORMATION TECHNOLOGY

Pillai College of Engineering

New Panvel – 410 206

CERTIFICATE

This is to certify that the requirements for the Major Project-I entitled ‘ **AgroAI Assist: AI Powered Soil and Plant Health Detection with Real-Time Weather Alerts Using Image Feature Extraction Technique**’ have been successfully completed by the following students:

Name	Roll No.
Adhish Biju	B602
Ashwin Baburaj	B604
Yash Karande	B621
Yuvraj Kolekar	B623

in partial fulfillment of Bachelor of Technology of Mumbai University in the Department of Information Technology, Pillai College of Engineering, New Panvel – 410 206 during the Academic Year 2024 – 2025.

Supervisor

Dr. Jinesh Melvin Y I

Head of Department

Dr. Prashant Nitnaware

Principal

Dr. Sandeep M. Joshi

DEPARTMENT OF INFORMATION TECHNOLOGY
Pillai College of Engineering
New Panvel – 410 206

SYNOPSIS APPROVAL

1. This Major Project-I Synopsis entitled " **AgroAI Assist: AI Powered Soil and Plant Health Detection with Real-Time Weather Alerts Using Image Feature Extraction Technique**" by **Adhish Biju , Ashwin Baburaj , Yash Karande , Yuvraj Kolekar** are approved for the degree of **B.Tech. in Information Technology**.

Examiners:

1. ________________

2. ________________

Supervisors:

1. ________________

2. ________________

Chairman:

1. ________________

Date:

Place:

Declaration

We declare that this written submission for B.Tech. Declaration entitled " **AgroAI Assist: AI Powered Soil and Plant Health Detection with Real-Time Weather Alerts Using Image Feature Extraction Technique**" represents our ideas in our own words and where others' ideas or words have been included. We have adequately cited and referenced the original sources. We also declared that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any ideas / data / fact / source in our submission. We understand that any violation of the above will cause disciplinary action by the institute and also evoke penal action from the sources which have thus not been properly cited or from whom paper permission have not been taken when needed.

Project Group Members:

Adhish Biju ______________________________

Ashwin Baburaj ______________________________

Yash Karande ______________________________

Yuvraj Kolekar ______________________________

Date:

Place:

Table of Contents

Abstract

Agriculture faces significant challenges like unpredictable weather, soil deficiencies, and plant diseases, which affect crop yields.Modern solutions are needed to help farmers navigate these issues effectively. Farmers often lack real-time data on plant health,soil conditions, and weather risks, making it difficult to make timely, informed decisions. This leads to crop losses, wasted resources, and missed opportunities for improvement. We propose AgroAI Assist , an AI powered web system designed to help farmers with real-time soil and plant health analysis, weather alerts, smart irrigation, and expert advice. Using deep learning and machine learning models, it detects plant diseases, deficiencies, and pests through image analysis. It also predicts weather risks like heat waves and storms using data from OpenWeatherMap. The system offers smart irrigation recommendations and sends timely alerts via Firebase Cloud Messaging.

List of Figures

List of Tables

Chapter 1

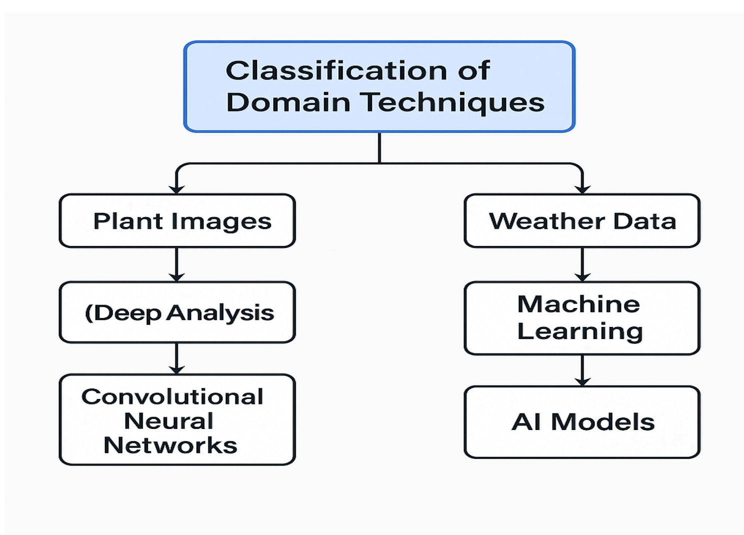
INTRODUCTION

1.1 Fundamentals

Agriculture is a cornerstone of India's economy and sustains the livelihood of over half the nation's population. Despite technological advancements, the sector grapples with persistent issues such as climate change, poor irrigation planning, lack of crop disease detection, and unpredictable weather patterns. These factors severely impact productivity, crop health, and ultimately the farmer’s income and stability.

AgroAI Assist is introduced as a solution to bridge this technological gap in farming. It is an AI-powered platform that combines machine learning, image feature extraction, real-time APIs, and NLP to monitor crop and soil health, detect plant diseases, send real-time weather alerts, and recommend optimal irrigation schedules. This system empowers farmers to make informed decisions and promotes sustainable agricultural practices.**AgroAI Assist** is introduced as a comprehensive AI-based web and mobile platform that empowers farmers through real-time analysis of crop and soil health and timely updates regarding weather and irrigation needs. The platform combines image feature extraction, NLP, real-time APIs, and deep learning techniques for this purpose.

Figure 1.1 Classification of Domain Techniques



1.2 Objectives

The Table 1.1 presents the major objectives of this project. The project aims to improve communication accessibility for the hearing and speech-impaired community through deep learning techniques.

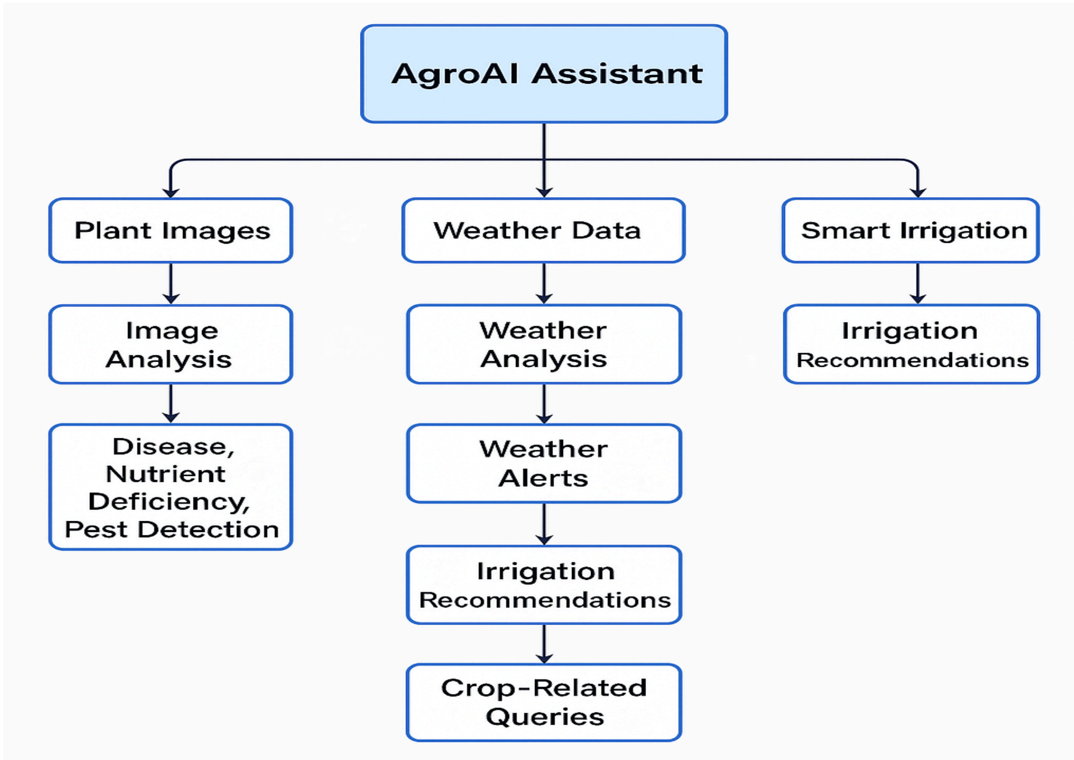
Table 1.1 : Objectives of the Project

Objective No.	Project Focus	Description
1	Plant Disease Detection	Detect plant diseases using CNN-based image feature extraction.
2	Soil Health Analysis	Analyse soil health through user input and historical data.
3	Real-Time Weather Alerting	Provide weather alerts using OpenWeatherMap API.
4	Smart Irrigation Recommendation	Recommend irrigation schedules based on crop, soil, and weather data.
5	Expert Advisory via AI Chatbot	Offer expert agricultural advice through a chatbot using NLP techniques.

1.3 Scope

The scope of this project includes the development of a deep learning-based gesture recognition system that recognizes both static and dynamic gestures and translates them into text. The project consists of several interconnected modules, including data preprocessing, deep learning model training and natural language processing. This system is designed to be in real-time, making it accessible for people with hearing and speech impairments. The project will explore different sign language datasets, focusing primarily on Indian Sign Language (ISL) but adaptable to other sign languages

Figure 1.3 Agro AI Assist Flowchart



1.4 Outline

The report is organized as follows:

●**Chapter 1** introduces the fundamentals of the project, highlighting the motivation, objectives, and scope.

●**Chapter 2** presents a literature survey of previous works in smart agriculture using AI and deep learning.

●**Chapter 3** explains the methodology, covering system architecture, CNN for plant detection, weather APIs, and NLP integration.

●**Chapter 4** describes the system implementation including platform, datasets, and software tools used.

●**Chapter 5** summarises results, key findings, and future scope of AgroAI Assist. the system architecture and algorithms used.

Chapter 2

Literature Survey

2.1 Introduction

The application of Artificial Intelligence (AI) and Machine Learning (ML) in agriculture has gained significant traction in recent years. Several research studies have explored plant disease detection, weather forecasting, and advisory systems using deep learning models, sensor data, and natural language interfaces. This chapter reviews key contributions in this domain to identify existing gaps and how AgroAI Assist builds upon them.

This literature survey explores five recent and strong research papers in the domain of agriculture, plant health monitoring, and crop yield prediction using modern technologies such as Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL), and Internet of Things (IoT). These works collectively reflect the rising trend of integrating technology into agricultural practices to improve productivity, sustainability, and early disease detection.

2.2 Literature Review

1. Enhancing Crop Productivity: Integrated Solutions for Crop Yield, Crop Recommendation, and Crop Disease Management (2023, IEEE)

Authors: Nishith S Shetty, Naman N Karanth, Dr Vinay V Hegde
DOI: 10.1109/CSITSS60515.2023.10334167

This paper introduces a comprehensive AI-based agricultural framework that integrates crop recommendation, disease detection, and yield forecasting models into a single decision-support platform. The novelty lies in combining multiple ML algorithms like Decision Trees, CNNs, and k-NN for different modules to ensure an end-to-end solution.

Key highlights:

- It processes over 3,000 agricultural records and 87,000 disease images.
- Achieved 90%+ accuracy in disease detection.
- Integrated multiple ML techniques like SVM, matrix factorisation, and time-series analysis for various tasks.

2. Plant Disease Detection and Classification Using Machine Learning and Deep Learning Techniques – Current Trends and Challenges (2023, ResearchGate)

Authors: Yasmin M. Alsakar, Nehal A. Sark, Mohammed Elmog
DOI: 10.1007/978-981-99-4764-5_13

Focusing specifically on potato leaf disease detection, this research paper demonstrates the effectiveness of deep learning models—particularly the VGG16 CNN architecture—in accurately classifying plant leaf images into diseased and healthy categories.

Key highlights:

- Utilised 600 annotated leaf images across 4 classes.
- Employed image preprocessing, data augmentation, and GPU-based training.
- Achieved a classification accuracy of **97.4%**, although recall and F1 scores indicate room for improvement.

This work is pivotal in proving how transfer learning and pre-trained models can significantly aid in early disease detection, particularly in small-scale datasets.

3. AI Chatbot for Plant and Animal Disease Detection Using CNN (2022, IJCRT)

Authors: Kunal Patil et al.
ISSN: 2320-2882

This study extends disease prediction beyond plants by integrating animal disease detection as well. It utilises CNNs and a chatbot interface, allowing users to upload images and receive instant disease diagnostics through a web-based application.

Key highlights:

- Dataset includes images from 13 plant species and various animals.
- CNN and ResNet architectures used; ResNet achieved **98.96%** accuracy.
- Included data augmentation and vector-based feature extraction.

The innovation here lies in merging disease detection with a chatbot interface, improving accessibility for farmers and veterinarians alike.

4. Real-Time Weather Detection and Notifications (2024, IJARSCT)

Authors: Prof. M. S. Dighe et al.
ISSN: 2320-2882

This research focuses on enhancing weather forecasting using IoT sensors and ML algorithms. Unlike conventional methods, this study embraces real-time data streams for continuous learning and prediction.

Key highlights:

- Sensors measure temperature, humidity, wind speed, etc.
- ML models such as Random Forest and Neural Networks are trained on real-time and historical data.
- Alerts sent via mobile notifications for extreme weather conditions.

The study effectively connects weather intelligence with proactive alert systems, potentially benefiting sectors like agriculture and disaster management.

5. Crop Yield Prediction Using Machine Learning Algorithms (2021, IEEE – ICCCT)

Authors: Ms. Ranjani J et al.
DOI: 10.1109/ICCCT53315.2021.9711853

This work centres on yield prediction using ML techniques, especially Random Forest. It uses data from reliable government sources to train robust models that assist in crop planning and decision-making.

Key highlights:

- Inputs include rainfall, temperature, soil type, and crop type.
- Focused on major crops like wheat, rice, maize, sugarcane, and cotton.
- Random Forest outperformed SVM and Decision Trees, showcasing over **90%** accuracy.

Its strength lies in practical application, offering a user-friendly interface for farmers to input data and receive actionable forecasts.

6. Plant Disease Detection and Classification Using Machine Learning and Deep Learning Techniques – Current Trends and Challenges

Authors: Yasmin M. Alsakar, Nehal A. Sakr, Mohammed Elmog
Published: January 2023
DOI: 10.1007/978-981-99-4764-5_13
Publisher: ResearchGate

Methodology
This paper categorises AI-based approaches into two main types:

- **Machine Learning Methods**: These use manually extracted features such as colour, shape, and texture, and apply classifiers like Support Vector Machine (SVM), Random Forest, K-Nearest Neighbour (KNN), and Decision Trees.

- **Deep Learning Methods**: These rely on Convolutional Neural Networks (CNNs) such as VGG16, EfficientNet, and MobileNet for automatic feature extraction and disease classification.

The proposed general workflow includes:

1. Data collection from public datasets including PlantVillage, Cotton, Cassava, and Rice.

2. Image preprocessing (resizing, noise removal).

3. Feature extraction through handcrafted techniques or CNN models.

4. Feature selection using Genetic Algorithms (GA) and Correlation-Based Feature Selection (CFS).

5. Classification using ML/DL algorithms.

Algorithms Used

- ML: SVM, KNN, Decision Trees, Random Forest, Naïve Bayes, ANN

- DL: CNN, VGG16, InceptionV3, EfficientNet, MobileNet, DenseNet

Results
The accuracy of different models was evaluated. EfficientNet and VGG16 achieved around 99% accuracy. CNN performed best on the Rice Plant dataset with 95.48% accuracy, and LeafNet gave

90.16% accuracy for Tea Plant disease classification.

Conclusion and Future Scope
The study highlights challenges such as low-quality images, background clutter, and the need for multi-disease classification models. Future improvements include building hybrid models that combine both handcrafted and deep learning features.

7. AI Chatbot for Plant and Animal Disease Detection Using Convolutional Neural Network

Authors: Kunal Patil, Mohini Kilaskar, Tejaswini Yeole, Bhagyashri Suryavanshi, Dr. Makarand Shahade
Published: June 2022
Publisher: International Journal of Creative Research Thoughts (IJCRT)
ISSN: 2320-2882

Methodology
This research develops a chatbot-based system using deep CNN for real-time plant and animal disease detection.
The steps involved are:

1. Data collection from online and manually curated image datasets.
2. Preprocessing of RGB images by converting them to vectors and applying resizing and normalisation.
3. Feature extraction and classification using CNN and ResNet architectures.
4. Real-time prediction integrated into a chatbot system.

Algorithms Used

- CNN
- ResNet (Residual Neural Network)
- Animal Disease Diagnosis Expert System (ADDES)

Results and Accuracy

- ResNet achieved 98.96% accuracy
- CNN without augmentation: 94.80%
- CNN with data augmentation: 97.2%

Future Scope
Enhancing the model using transfer learning, optimising hyperparameters, expanding datasets, and integrating the system with IoT for smart farming are proposed future directions.

8. Potato Leaf Disease Detection using Machine Learning

Authors: Jayashree Pasalkar, Ganesh Gorde, Chaitanya More, Sanket Memane, Vaishnavi Gaikwad
Published: November 2023
Publisher: Agriculture Journal
ISSN: 2347-4688

Methodology
The paper uses the VGG16 CNN architecture to classify potato leaf diseases, specifically early blight, late blight, and leaf curl.
Steps:

1. Dataset collection of 600 leaf images (healthy and diseased).
2. Preprocessing includes resizing to 256x256 pixels and data augmentation.
3. Model training using an 80-10-10 train-validation-test split.

Algorithms Used

- CNN
- VGG16
- Backpropagation with categorical cross-entropy

Results

- Accuracy: 97.4%
- Precision: 1.00
- Recall: 0.44
- F1-Score: 0.61

Conclusion and Future Scope

The model performs well, especially in detecting early and late blight. Future plans include improving recall, expanding datasets, and deploying a web-based tool for real-time use by farmers.

9. Prediction Models for Identification and Diagnosis of Tomato Plant Diseases

Authors: Shradha Verma, Anuradha Chug, Amit Prakash Singh
Published: November 2018
Publisher: IEEE
DOI: 978-1-5386-5314-2/18

Methodology

This study integrates ML, DL, and IoT to detect tomato plant diseases.
Key approaches include:

1. Image analysis using RGB, multispectral, and hyperspectral images.
2. Classification using SVM, Decision Trees, ANN, CNN (AlexNet, GoogleNet).
3. IoT sensors for monitoring environmental parameters such as temperature and humidity.

Algorithms Used

- Deep Learning: AlexNet, GoogleNet
- Machine Learning: SVM, Decision Tree, Extreme Learning Machine (ELM)
- IoT: Spectral analysis and VOC detection

Results

- GoogleNet: 99.18%
- ELM: 97.1% to 100%

Conclusion and Future Scope

The paper highlights the strength of combining imaging technologies with IoT to improve disease identification. Further developments aim to automate the process using robotic systems and enhance real-time capabilities.

10. Vision-Based Plant Leaf Disease Detection and Recognition Model Using Machine Learning Techniques

Authors: R. Sathya, S. Ananthi, V. C. Bharathi, Dr. S. Senthilvadivu, Dr. G. Revathy
Year: 2023
DOI: 10.1109/ICECA58529.2023.10395620

This study focuses on detecting diseases in **brinjal (Solanum melongena)** leaves using machine learning techniques and handcrafted feature extraction methods.

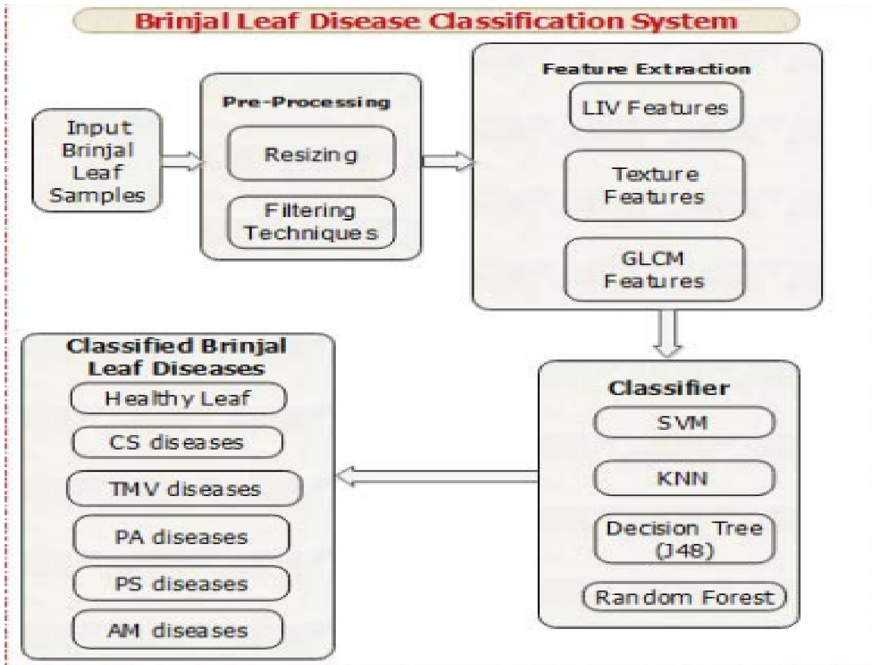
Dataset:

- 1700 real-time images of brinjal leaves, both healthy and diseased.
- Six categories: Healthy Leaf, Cercospora solani, Tobacco Mosaic Virus, Pythium aphanidermatum, Pseudomonas solanacearum, Alternaria melongenea.

Methodologies:

- **Preprocessing**: Image filtering, resizing, colour transformation, K-means clustering for segmentation.

Figure 3.10 : Brinjal Leaf Disease Classification System



- **Feature Extraction**:
  - **Leaf Intensity Vector (LIV)**: Divides the image into a 5×5 grid to measure brightness intensity.
  - **Texture Features**: Includes entropy, autocorrelation, variance, homogeneity, dissimilarity, etc.
  - **GLCM**: Analyses spatial relationships of pixels to extract texture features.
  - **PCA**: Reduces dimensionality, retaining only the most useful features.

Algorithms Used:

- SVM (RBF and Polynomial Kernel)
- K-Nearest Neighbour (KNN)
- Random Forest (RF)
- Decision Tree (J48)

Accuracy:

- **SVM with RBF Kernel** achieved the highest classification accuracy of **98.48%** across all disease classes.

Future Scope:

- Integrating deep learning models (like CNN or Transformer architectures).
- Extending the model to support other crops and real-time deployment via mobile or cloud platforms.

2.3 Literature Summary

A literature review is an objective, critical summary of published research literature relevant to a topic under consideration for research. The summary is presented here.

Table 2.1 Summary of literature survey

Sr. NO.	**Paper and Year**	**Methodology**	**Key Strengths and Main Limitations**	**Comparison with Our Proposed Model**
1.	Crop Yield Prediction Using Machine Learning Algorithm (2021)	Uses Random Forest to predict crop production based on rainfall, crop, and meteorological conditions.	**Strengths:** Provides a decision-support tool for crop yield prediction. **Limitations:** Addresses the impact of environmental factors on agriculture.	The proposed model uses machine learning for crop prediction, similar to this.

2.	Plant Disease Detection Leveraging Latent Space Based Mixing Methods for Image Data Augmentation (2024)	Uses Hadamard transform for image data augmentation and CNNs for plant disease detection.	**Strengths:** Generates synthetic images to address limited data. Hadamard transform is computationally simple. **Limitations:** Focuses on image data augmentation for CNNs.	The proposed model uses CNNs for disease detection, similar to this.
3.	AI Chatbot for Plant and Animal Disease Detection Using Convolutional Neural Network (2022)	Uses convolutional networks for plant and animal disease identification.	**Strengths:** Provides a solution for early detection of plant and animal diseases. **Limitations:** The dataset includes various plants and animals from freely available and manual sources.	The proposed model uses CNNs for disease detection, similar to this.
4.	Potato Leaf Diseases Detection Using Deep Learning (2020)	Uses pre-trained VGG19 for feature extraction and logistic regression for classification of potato leaf diseases.	**Strengths:** Automates the detection of potato leaf diseases. **Limitations:** Specifically detects early and late blight in potato leaves.	The proposed model uses deep learning for plant disease detection, similar to this.
5.	Plant Disease Detection and Classification Using Machine Learning and Deep Learning Techniques: Current Trends and Challenges (2023)	Surveys machine learning and deep learning techniques for plant disease detection and classification.	**Strengths:** Provides an in-depth study of plant disease detection, performance metrics, datasets, and challenges. **Limitations:** Discusses open challenges and the strengths/weaknesses of ML/DL techniques.	The proposed model aligns with the use of machine learning and deep learning for plant disease detection.
6.	Data Visualization for Mental Health Monitoring in Smart Home Environment: A Case Study (2023)	Presents a case study on data visualization for mental health monitoring in a smart home environment.	**Strengths:** The application allows users to visualize the correlation between mental health states and routines. **Limitations:** The study is a case study.	Our proposed model also focuses on utilizing data to understand specific patterns.

7.	Potato Leaf Disease Detection using Machine Learning (2023)	Proposes a CNN-based approach for potato leaf disease prediction.	**Strengths:** Achieves 97.4% accuracy in classifying potato leaf diseases. **Limitations:** Focuses specifically on early and late blight potato leaf diseases.	Our proposed model also uses CNNs for plant disease detection.
8.	Applications of Computer Vision on Automatic Potato Plant Disease Detection: A Systematic Literature Review (2022)	Presents a systematic literature review on computer vision techniques for identifying potato diseases.	**Strengths:** Provides a comprehensive review of the application of computer vision in potato disease detection. **Limitations:** It's a review; it doesn't propose a new detection method.	Our proposed model aligns with the use of computer vision for plant disease detection.
9.	An advanced deep learning models-based plant disease detection: A review of recent research (2023)	Reviews recent advancements in machine learning and deep learning techniques for plant disease identification.	**Strengths:** Provides insights into using ML and DL for improving the accuracy and efficiency of plant disease detection. **Limitations:** Discusses challenges like data availability and image quality.	Our proposed model employs ML/DL for plant disease detection.
10.	Design and Research of an Online Diagnosis Platform for Tomato Seedling Facilities Production Diseases (2023)	Proposes an online diagnosis platform for tomato plant diseases using deep learning and K-means clustering.	**Strengths:** Integrates deep learning with clustering to improve the accuracy of pest identification and develops a web-based platform. **Limitations:** Focuses specifically on tomato seedling diseases in a facility-based environment.	Our proposed model shares the goal of online disease diagnosis.

Chapter 3

Proposed System

3.1 Overview

AgroAI Assist is an AI-driven web platform conceived to modernize agricultural practices by addressing the critical need for real-time data and informed decision-making in farming. It aims to empower farmers to proactively manage various challenges that affect crop yields.

3.1.1 Proposed System Architecture :

The system integrates several modules to provide comprehensive support:

- Real-time Soil and Plant Health Analysis:
    - This module is central to AgroAI Assist, providing farmers with instant insights into the well-being of their crops and soil.
    - It likely involves techniques such as image processing and analysis to detect visual indicators of plant stress, disease, or nutrient deficiencies.
    - It may also integrate data from soil sensors to provide information on soil moisture, pH levels, and nutrient content.

- Weather Alerts:
    - This component keeps farmers informed about impending weather events that could impact their crops.
    - By leveraging data from sources like OpenWeatherMap, the system can predict and alert farmers to risks such as heatwaves and storms, enabling them to take preventive measures.

- Smart Irrigation:
    - AgroAI Assist offers data-driven recommendations for irrigation.
    - This could involve analyzing factors like weather forecasts, soil moisture levels, and crop water requirements to advise farmers on when and how much to irrigate, optimizing water usage and preventing water stress.

- Expert Advice:
    - The platform may also connect farmers with agricultural experts, providing a channel for personalized advice and support.
    - This feature can be crucial for addressing complex issues or making critical decisions.

- Alerts:
  - Firebase Cloud Messaging is used to deliver timely notifications and alerts to farmers' devices.
  - This ensures that farmers receive critical information, such as weather warnings or disease alerts, promptly, enabling them to take swift action.

3.1.1 Proposed System Architecture

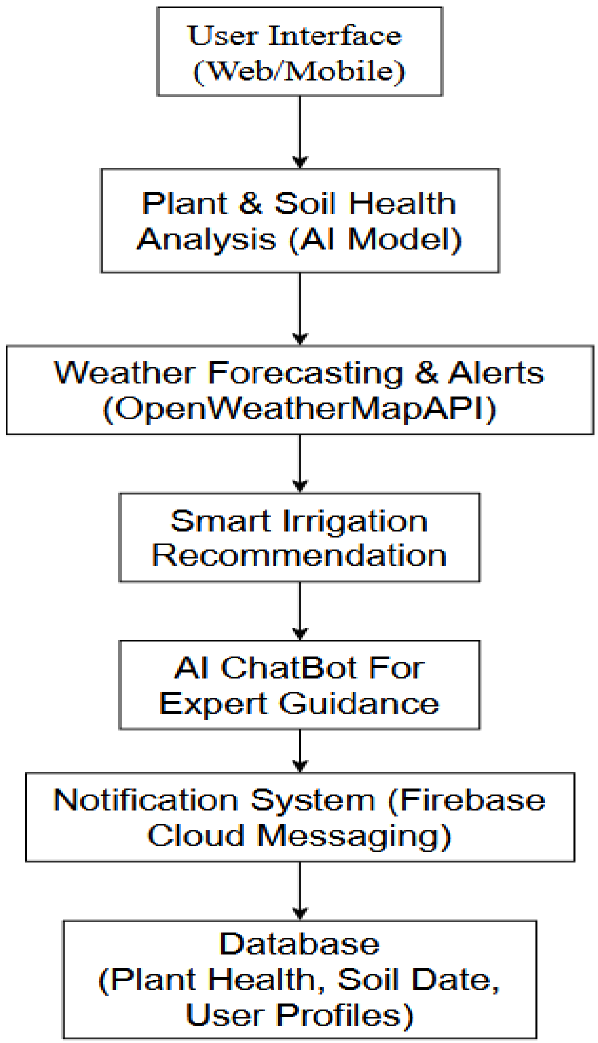


Fig. 3.1.1 Proposed system architecture

3.2 Requirements for Implementation

- AI Models:
    - Deep learning and machine learning models are at the core of AgroAI Assist, powering its analytical and predictive capabilities.

- Plant Analysis:
    - Image analysis, driven by CNNs and other computer vision techniques, is employed to detect plant diseases, deficiencies, and pest infestations.
    - This enables the system to identify problems early, even before they become visible to the naked eye.

- Weather Risk Prediction:
    - The system uses data from OpenWeatherMap to forecast and predict weather risks.
    - Machine learning models can be trained on historical weather data to improve the accuracy of these predictions.

3.2.1 Software Specifications

Table 3.2.1 System Requirements Table

Component	Specification
Operating System	Windows/Linux/macOS
Programming Language	Python, JavaScript
Frameworks	TensorFlow, Flask, OpenCV
Database	Firebase, SQLite
APIs Used	OpenWeatherMap, NOAA

Chapter 4

Applications

AgroAI Assistant is an AI-powered web-based system developed to support modern agriculture by offering real-time diagnostics, weather alerts, smart irrigation suggestions, and multilingual expert assistance. It utilizes computer vision, deep learning (CNNs), and external data APIs to enhance decision-making in farming. Below are the key applications of AgroAI Assistant explained in detail:

4.1 Plant Disease Detection & Diagnosis

One of the most impactful features of AgroAI Assistant is real-time plant disease detection using image analysis powered by Convolutional Neural Networks (CNNs). Farmers can upload images of affected leaves, and the system accurately identifies diseases such as blight, mildew, or rust. This allows for early diagnosis and timely treatment, reducing the spread of infections and minimizing crop loss. Unlike traditional manual inspection, AgroAI provides rapid, consistent, and scalable diagnosis across diverse crop types.

4.2 Nutrient Deficiency Analysis

AgroAI Assistant identifies signs of nutrient deficiencies (e.g., nitrogen, potassium, magnesium) through visual analysis of plant symptoms. Using deep learning and color segmentation via OpenCV, the system detects patterns like chlorosis, necrosis, or leaf curling. This enables targeted fertilization strategies, preventing overuse of chemicals and enhancing soil health, thus improving yield and sustainability.

4.3 Weather Forecasting & Alert System

Using real-time data from OpenWeatherMap and NOAA, the system predicts weather anomalies and extreme events such as heatwaves, storms, frost, or droughts. Based on machine learning risk models, it provides actionable alerts to farmers, enabling them to take preventive measures like rescheduling irrigation, applying pesticides early, or protecting crops with covers. Timely notifications via Firebase Cloud Messaging ensure immediate awareness of climate threats.

4.4 Smart Irrigation Recommendations

AgroAI offers smart irrigation suggestions by analyzing crop type, local weather forecasts, and plant health data. This helps farmers avoid under- or over-watering, saving water while ensuring adequate crop hydration. The recommendation engine is particularly useful in areas with limited water resources and supports more sustainable farming practices without relying on IoT hardware.

4.5 Multilingual AI Chatbot for Agricultural Guidance

The system includes a conversational AI chatbot capable of understanding and responding to farmer queries in multiple languages. It provides personalized recommendations on crop selection, pest control, harvesting schedules, fertilizer usage, and disease prevention. This feature empowers digitally underserved rural communities by bridging the language and knowledge gap through an accessible and interactive AI assistant.

4.6 Pest Infestation Detection

By analyzing patterns in uploaded leaf images, AgroAI Assistant can distinguish between disease symptoms and pest damage. It identifies signs of pest infestations such as holes, bite marks, or discoloration caused by insects like aphids or caterpillars. This allows early pest control intervention, helping to prevent widespread damage and yield reduction.

4.7 Educational and Research Support

AgroAI Assistant can be used as a research aid by students, agricultural researchers, and agronomists. Its real-time analysis tools and diagnostic features can support experimental data collection and help in studying regional disease patterns, crop performance, and environmental interactions. It also offers a testbed for training agricultural AI models without needing extensive field infrastructure.

4.8 Decision Support for Agribusiness & Cooperatives

Agricultural cooperatives and agribusinesses can utilize AgroAI's predictive features to optimize supply chain operations. For example, early disease warnings can be used to estimate future yield and plan logistics accordingly. Weather alerts can inform insurance claims, while nutrient deficiency analysis can guide cooperative-level fertilization policies.

4.9 Crop Planning and Seasonal Advisory

By integrating climate predictions and crop health insights, AgroAI can recommend suitable crop types for upcoming seasons. It helps farmers decide on planting schedules and select varieties resistant to expected climatic conditions or prevalent diseases. This proactive planning improves food security and economic stability for farming communities.

4.10 Offline-Supported Rural Deployment

Designed with low-connectivity areas in mind, AgroAI Assistant supports offline operation for essential features such as disease diagnosis and chatbot interaction. This makes it a practical tool in remote villages where internet infrastructure is limited but the need for agricultural support is high. The system syncs with the cloud when connectivity is available, ensuring data consistency and up-to-date recommendations.

Chapter 5

Summary

This report presents a study on AgroAI Assistant, an AI-powered web-based system designed to enhance modern agriculture through real-time data-driven decision-making. The platform addresses key challenges faced by the agricultural sector, such as unpredictable weather patterns, soil nutrient deficiencies, pest outbreaks, and plant diseases.

The system integrates various advanced technologies including deep learning (CNNs), machine learning models and OpenCV, to perform image-based analysis of crops for detecting diseases, nutrient issues, and pest infestations. It also fetches real-time weather data from APIs such as OpenWeatherMap and NOAA to deliver accurate weather predictions and alerts on extreme conditions like heatwaves, frost, and storms.

AgroAI Assistant incorporates a smart irrigation recommendation engine that analyzes environmental and soil conditions to optimize water usage. A multilingual AI chatbot serves as a virtual agricultural expert, enabling farmers to receive personalized crop-related guidance in real time. The system delivers critical notifications via Firebase Cloud Messaging, ensuring timely responses to potential agricultural risks.

The report further explores the system's modular architecture, real-world deployment strategies, and application in precision farming, resource optimization, and yield enhancement. Findings suggest that AgroAI Assistant significantly improves agricultural intelligence and supports farmers in making informed decisions, ultimately boosting productivity and reducing losses across diverse farming environments.

References

1. 'Plant Disease Detection Leveraging Latent Space Based' by Vaishali Anup Suryawanshi, Tanuja Kiran Sarode, Sahil Ajay Adivarekar
DOI:10.12944/CARJ.12.3.34(http://dx.doi.org/10.12944/CARJ.12.3.34)

2. 'AI Chatbot for Plant and Animal Disease Detection' by Kunal Patil, Mohini Kilaskar, Tejaswini Yeole, Bhagyashri Suryavanshi, Dr. Makarand Shahade

3. 'Potato Leaf Diseases Detection Using Deep Learning' by Divyansh Tiwari, Mritunjay Ashish, Nitish Gangwar, Abhishek Sharma
DOI:10.1109/ICICCS48265.2020.9121067(https://doi.org/10.1109/ICICCS48265.2020.9121067)

4. 'Prediction Models for Identification and Diagnosis of Tomato Plant Diseases' by Shradha Verma, Anuradha Chug, Amit Prakash Singh

5. 'Vision Based Plant Leaf Disease Detection and Recognition Model Using Machine Learning Techniques' by R. Sathya, Dr. S. Senthilvadivu, S. Ananthi, V.C. Bharathi, Dr. G. Revathy

6. 'Plant Disease Detection and Classification Using Machine Learning and Deep Learning Techniques Current Trends and Challenges' by Yasmin Mahmoud, Nehal Sakr, Mohammed Elmogy
DOI:10.1007/978-981-99-4764-5_13(https://doi.org/10.1007/978-981-99-4764-5_13)

7. 'Design and Research of Tomato seed online' by A. Raghunath, D. Bharadwaj, M. Prabhuram, and A. D
DOI:10.21203/rs.3.rs-3121099/v1(https://doi.org/10.21203/rs.3.rs-3121099/v1)

8. 'Enhancing Plant Disease Detection Using Advanced Deep Learning Models' by Kamaldeep Kaur, Khusboo Bansal, 2024, Indian Journal of Science and Technology
DOI: 10.17485/IJST/v17i17.536

9. 'Automatic Rice Disease Detection and Assistance Framework Using Deep Learning and a Chatbot', 2022, Electronics (MDPI)
DOI: 10.3390/electronics11142110

10. ' Design of Machine Learning Based Smart Irrigation System for Precision Agriculture' by Abuzanouneh et al. , 2022, Computers, Materials & Continua
DOI: 10.32604/cmc.2022.022648

11. ' A Novel Autonomous Irrigation System for Smart Agriculture Using AI and 6G Enabled IoT Network' , 2023, Microprocessors and Microsystems
DOI: 10.1016/j.micpro.2023.104905

12. ' Paddy Disease Detection and Classification Using Computer Vision Techniques: A Mobile Application to Detect Paddy Disease' by Bimarsha Khanal, Paras Poudel, Anish Chapagai, Bijan

Regmi, Sitaram Pokhrel, Salik Ram Khanal, 2024, arXiv , DOI: arXiv:2412.05996

13. ‘Plant Disease Detection Using Deep Convolutional Neural Network’ by J. Arun Pandian, V. Dhilip Kumar, Oana Geman, Mihaela Hnatiuc, Muhammad Arif, Kanchana devi
DOI: 10.3390/app12146982

14. ‘Smart Irrigation System Based on IoT and Machine Learning’ by A. Benameur, H. Benameur, A. Benameur, M. Benameur
DOI: 10.1016/j.egyr.2022.07.088

15. ‘Explainable Vision Transformer Enabled Convolutional Neural Network for Plant Disease Identification: PlantXViT’ by Poornima Singh Thakur, Pritee Khanna, Tanuja Sheorey, Aparajita Ojha
DOI: arXiv:2207.07919

16. ‘IoT and Neural Network-Based Water Pumping Control System for Smart Irrigation’ by M. E. Karar, M. F. Al-Rasheed, A. F. Al-Rasheed, O. Reyad
DOI: arXiv:2005.04158

17. ‘Plant Disease Detection Using Hybrid Model Based on Convolutional Autoencoder and Convolutional Neural Network’ by M. S. Khan, M. A. Khan
DOI: 10.1016/j.aiia.2021.05.002

Acknowledgement

We express our deepest appreciation toward Dr. Jinesh Melvin Y I, our guide, for his direction, encouragement, and support throughout this project. His amassed expertise, together with a number of perceptive suggestions, have substantially contributed to the increasingly successful completion of this entire work. His consistent motivation has helped us in refining our ideas. His helpful feedback has assisted us in improving the quality of this project.

We offer our sincere gratitude toward Dr. Prashant Nitnaware, Head of the Department, for supplying necessary resources with a helpful research environment. His backing and direction have been very important in helping this project move forward without issues. His helpful understandings, with support, have been key in creating this project.

We are also grateful toward Dr. Sandeep M. Joshi, toward our respected Principal, for offering the necessary infrastructure and academic support. His specific viewpoint and complete dedication to scholastic distinction have afforded us the possibility to perform this study efficiently. We deeply appreciate his dedicated efforts at promoting a variety of educational settings that promote innovation and research.

Eventually, we would like to express our gratitude toward our friends along with our colleagues. We are also grateful for our family in light of their constant support, encouragement, as well as motivation. Their constant motivation and helpful aid has allowed us to stay concentrated and complete this attempt with success. We are additionally appreciative toward each person who assisted on this undertaking, either straightaway or circuitously.

Adhish Biju
Ashwin Baburaj
Yash Karande
Yuvraj Kolekar